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Evaluations of faba bean (*Vicia faba* L.) varieties for yield and yield related traits in central zone of Tigray, Northern Ethiopia

Kiros Wolday

Department of Crop, Axum Agricultural Research Center, Ethiopia.

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A field experiment was carried out at Laelay maichew and Tahtay maichew districts in central zone of Tigray, Northern Ethiopia, for two consecutive seasons (2014/2015 to 2015/2016) under rain fed conditions. The objective of the study was to evaluate and select best performing faba bean varieties. Ten faba bean varieties including the local check were evaluated in randomized complete block design (RCBD) in three replications. The data on days to maturity, plant height, number of pods plant$^{-1}$ and number of seed spod$^{-1}$, grain yield and hundred seed weight were collected. The collected data were subjected to analysis of variance using statistical analysis software (SAS). Combined analysis of variance revealed that there was no significant difference for all studied traits. However, there were significant differences among varieties for all traits in each location. The highest grain yield was recorded from Walki (1943.2 kg ha$^{-1}$), followed by Hachalu (1836.70 kg ha$^{-1}$). Regarding the hundred seed weight, Hachalu possessed the 4th heaviest in seed weight (g) among the ten varieties, and 2nd in seed yield next to Walki. Highly significant and positive association of grain yield with plant height and number of pods per plant were found. Based on the result obtained, Walki was the best performing variety and selected to be promoted in farmer's field in the study areas and similar agro-ecologies.

Key words: Faba bean, *Vicia faba*, grain yield, yield characters, randomized complete block design (RCBD), Central Tigray.

INTRODUCTION

Faba bean (*Vicia faba* L.) is also referred to as broad bean, horse bean or field bean (Sainte, 2011). Ethiopia is one of the largest faba bean producing country in the world next to China (Hebblethwaite et al., 1993). Faba bean (*V. faba* L.) is one of the major pulse crops occupying about 35% both in terms of area coverage and volume of annual production of all pulses produced in the country and grown in the highlands (1800 to 3000 meter above sea level) of Ethiopia (Gemechu et al., 2003). Ethiopia is now considered as one of the center of secondary diversity for faba bean (Yohannes, 2000). The crop occupies close to 459,183.51 hectares of land with an annual production close to 6977,983.87 tons (CSA, 2011).

E-mail: kiroswolday@gmail.com.

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The grain of faba bean contains a high protein content of 24 to 33% (Winch, 2006). It serves as a source of food and feed with a valuable and cheap source of protein. It is a suitable rotational crop with nationally important cereal crops like teff, wheat and barley etc due to its nitrogen fixing capacity (MoA, 2014). It is a good source of cash to the farmers, and generates foreign currency to the country. However, its share in the countries pulse export is small (Newton et al., 2011; Amanuel et al., 1993).

Production has been constrained by several yield limiting factors. The inherent low yielding potential of the local varieties is one of the most important production constraints. Even the yields of improved varieties of faba bean varieties are severely affected by the variability among locations and years. Therefore, the present investigation aimed at finding out high yielding and most adaptable faba bean varieties in central zone of Tigray, northern Ethiopia. We hypothesized that at least one of the released faba bean variety group means would be significantly higher yielder than the local check.

MATERIALS AND METHODS

Study areas description

Field experiments were carried out in Laelay maichew and Tahtay maichew districts of the Central zone of Tigray, northern Ethiopia. They are located at 14°6’N to 38°46’E and 14°11’N to 38°43’E, and at an altitude of 1500 to 2250 and 1500 to 2260 meters above sea level, respectively. They are situated in the northern semi-arid tropical belt of Ethiopia. The rainy season is mono modal concentrated in one season from July to September and receives from 700 to 800 mm rainfall per annum.

Experimental design, treatments and procedures

Nine released faba bean varieties (Walki, Hachalu, Tumsa, moti, Dagm, Obse, Gebelcho, Dosta, and Lalo) and one local check were evaluated for their yield and yield contributing characters at Laelay maichew and Tahtay maichew districts. Varieties were obtained from Holetta Agricultural Research Center (45 km from Addis Ababa) and Debribirhan Agricultural Research Center in (130 km from Addis Ababa) in 2014. Treatments were laid out in randomized complete block design (RCBD) with three replications. Seed rate of 200 kg ha\(^{-1}\) was used. The plots were 4 m (length) x 2.4 m (width) with six total rows (4 middle or harvested rows). Spacing between replications was 1.5 m and spacing between plots, rows and plants were 1 m, 40 and 10 cm, respectively. Two seeds where planted per hill. After emergence, plants where thinned to one seed to maintain normal plant density. DAP (Di-ammonium phosphate) fertilizer at 100 kg ha\(^{-1}\) rate was whole applied at sowing. Weeds were controlled by hand weeding.

Data collected

Data were collected on plant and plot bases on yield and yield related traits. Data on days to 50% maturity was taken on plot bases. Whereas, data like plant height, numbers of pods per plant, and number of seeds per pod were determined on plant bases from the 4 middle rows of 10 randomly pre-tagged plants. Grain yield was recorded from 4 harvested middle rows. Grain yield was separated from the straw after sun drying for two weeks and yield per plot was converted into kg ha\(^{-1}\). Finally, hundred seed weight was recorded by counting 100 seeds from each harvested plots.

Data analysis

Prior to analysis of the data, homogeneity of residual variances were assessed whether the normality assumptions of the data was violated. Thus, data were homogenous and showed normal distribution. All the collected data were subjected to analysis of variance (ANOVA) with statistical analysis software (SAS) computer software version 9.2 (SAS, 2002). Correlation analysis and treatments means were compared using least significance difference (LSD) at 5% probability level (Fisher, 1935).

RESULTS AND DISCUSSION

Statistical analysis shows that there was significant difference among varieties for all yield and yield related traits (days to maturity, plant height, Number of pods per plant, number of seeds per pod, grain yield and hundred seed weight). However, the combined results showed no significant difference for genotype environment interaction for all studied traits (Table 1).

Analysis of variance revealed that days to 50% maturity had significant (P< 0.05) effect at each location. Local check (104.5) and Moti (104.5) matured early compared to Tumsa (188) and Gebelcho (107.42). However, no significant difference was observed with Walki (106.41), Hachalu (106.58), Dagm (105.83), Obse (104.83), Dosta (105.50) and Lalo (106.83) (Table 1).

The result is in line with the finding of Ashenafi and Mekuria (2015) and Tafere et al. (2012) who reported that Moti was the early maturing genotype; whereas Gebelcho (107.42) and Tumsa (108) were late maturing varieties. Early maturing varieties are the most adaptable varieties and have advantage over the late maturing varieties in areas where rain starts late and withdraws early.

Combined analysis for the two years showed that the highest grain yield was obtained from Walki (1943.2 kg ha\(^{-1}\)) followed by Hachalu (1836.70kg ha\(^{-1}\)) and Dosta (1828.10), and in each locations. Similar results were reported by Ashenafi and Mekuria (2015) at Sinana and Agarfa areas. The highest plant height was recorded in local genotype (94.97cm) followed by Dosta (94.83cm).

Similar result was found by Tafere et al. (2012) who reported Dosta was the tallest in plant height. It may be due to the fact that plant height is highly affected by the genetic make of the varieties. Moreover, Talal and Munqez (2013) reported that plant height was significantly affected by faba bean accessions.

The highest values for number of pods per plant were recorded from Dagm (17.6) followed by local check (17.1) and Lalo (17.02). Whereas, Obse and Gebelcho possessed the lowest values for the number of pods per plant. Regarding the number of seeds per pod,
Hence, faba bean production and productivity could be improved by selecting faba bean yield traits like number of pods per plant and plant height.

### Table 1. Combined mean performance of different faba bean varieties for different yield and yield related traits across years and locations.

<table>
<thead>
<tr>
<th>Variable</th>
<th>50% DM</th>
<th>PH (cm)</th>
<th>NPP</th>
<th>NSP</th>
<th>GY (kg ha⁻¹)</th>
<th>HSW (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hachalu</td>
<td>106.58bcd</td>
<td>92.82abc</td>
<td>14.37bcd</td>
<td>2.42b</td>
<td>1836.70ab</td>
<td>64.10a</td>
</tr>
<tr>
<td>Tumsa</td>
<td>108a</td>
<td>93.40abc</td>
<td>11.83cde</td>
<td>2.48ab</td>
<td>1494.70ed</td>
<td>64.33a</td>
</tr>
<tr>
<td>Moti</td>
<td>104.75d</td>
<td>88.86bc</td>
<td>11.59a</td>
<td>2.62ab</td>
<td>1443.00ed</td>
<td>60.76a</td>
</tr>
<tr>
<td>Dagm</td>
<td>105.83bcd</td>
<td>91.97abc</td>
<td>17.6a</td>
<td>2.82a</td>
<td>1606.80hcd</td>
<td>37.31f</td>
</tr>
<tr>
<td>Obse</td>
<td>104.83bc</td>
<td>88.68c</td>
<td>10.23e</td>
<td>2.72ab</td>
<td>1270.70e</td>
<td>66.60a</td>
</tr>
<tr>
<td>Gebelcho</td>
<td>107.42ab</td>
<td>94.80d</td>
<td>10.28e</td>
<td>2.37a</td>
<td>1510.90hde</td>
<td>64.64a</td>
</tr>
<tr>
<td>Dosha</td>
<td>105.50bcd</td>
<td>94.83a</td>
<td>14.93abc</td>
<td>2.50ab</td>
<td>1828.10abc</td>
<td>64.08a</td>
</tr>
<tr>
<td>Lalo</td>
<td>106.83abcd</td>
<td>90.35abc</td>
<td>17.017ab</td>
<td>2.38b</td>
<td>1270.40e</td>
<td>42.22c</td>
</tr>
<tr>
<td>Local</td>
<td>104.75d</td>
<td>94.97a</td>
<td>17.10ab</td>
<td>2.48ab</td>
<td>1605.10hcd</td>
<td>36.63c</td>
</tr>
<tr>
<td>GMS</td>
<td>15.86*</td>
<td>71.28*</td>
<td>106.31**</td>
<td>0.27*</td>
<td>643966**</td>
<td>19.35**</td>
</tr>
<tr>
<td>EMS</td>
<td>9205**</td>
<td>5540.64**</td>
<td>1244**</td>
<td>1.12*</td>
<td>468025ns</td>
<td>24.30**</td>
</tr>
<tr>
<td>GxE</td>
<td>4.19ns</td>
<td>40.35ns</td>
<td>16ns</td>
<td>0.31ns</td>
<td>163526ns</td>
<td>145ns</td>
</tr>
<tr>
<td>CV</td>
<td>2.38</td>
<td>7.22</td>
<td>27</td>
<td>17</td>
<td>25</td>
<td>17.17</td>
</tr>
<tr>
<td>LSD</td>
<td>2.06</td>
<td>5.41</td>
<td>3.1</td>
<td>0.35</td>
<td>321.43</td>
<td>7.71</td>
</tr>
</tbody>
</table>

*, **Significant at 0.05 and 0.01 probability level respectively; and NS: Non significant; DM: Days to maturity; PH: Plant height; NPP: Number of pods per plant; NSP: Number of seeds per pod; GY: Grain yield; HSW: Hundred seed weight, GMS: Genotype mean square; EMS: Environment mean square; GxE: genotype by Environment interaction.

### Table 2. Pearson's correlation coefficient among faba bean yield and yield related traits.

<table>
<thead>
<tr>
<th>Trait</th>
<th>PH</th>
<th>NPP</th>
<th>NSP</th>
<th>GY</th>
<th>HSW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maturity</td>
<td>0.35879**</td>
<td>0.19212*</td>
<td>-0.3489**</td>
<td>-0.3502**</td>
<td>-0.1958*</td>
</tr>
<tr>
<td>PH</td>
<td>-</td>
<td>0.51381**</td>
<td>0.11926**</td>
<td>0.30346**</td>
<td>-0.1813*</td>
</tr>
<tr>
<td>NPP</td>
<td>-</td>
<td>-</td>
<td>0.03865ns</td>
<td>0.42136**</td>
<td>-0.4708**</td>
</tr>
<tr>
<td>NSP</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>0.16961ns</td>
<td>0.03143ns</td>
</tr>
<tr>
<td>GY</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-0.074ns</td>
</tr>
</tbody>
</table>

*, **Significantly correlated at 5 and 1% probability levels, respectively. NS: Non significant; PH: plant height (cm); NPP: number of pods per plant; NSP: Number of seeds per pod; GY: Grain yield (kg ha⁻¹); HSW: Hundred seed weight (g).

The maximum number of seeds per pod were obtained from Dagm (2.82), and followed by Obse (2.72). Obse possessed the heaviest seed weight (66.60g) among the ten varieties followed by Gebelcho (64.64g), Tumsa (64.33 g) and Hachalu (64.10 g). Similar result was reported at Sinana on Gebelcho and Hachalu by Ashenafi and Mekuria (2015). However, local check and Dagm possessed the lowest value for hundred seed weight (HSW).

Grain yield showed highly significant and positive association with plant height and number of pods plant⁻¹ (Table 2). These findings are in line with the findings of Abdelmula and Abuanja (2007) who reported significant and positive correlation of seed yield with plant height and number of pods per plant. HSW is significantly and negatively associated with plant height, number of pods/plant and number of seeds per pod. Similar results were also reported by Ashenafi and Mekuria (2015). Hence, faba bean production and productivity could be improved by selecting faba bean yield traits like number of pods per plant and plant height.

### CONCLUSION AND RECOMMENDATION

The lack of best performing and high yielding variety is the main challenge for faba bean production and productivity in central zone of Tigray. Ten varieties including the local check were evaluated for their adaptability, yield and yield related traits. Walki variety was found to be the most adaptable and high yielding genotype followed by Hachalu. Hence, faba bean production and productivity could be improved by using better yielding varieties such as Walki and Hachalu. In addition, a strong and positive correlation between the different traits and seed yield of faba bean could be used as a selection criterion in order to improve faba bean production and productivity.
CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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REFERENCES


