African Journal of Plant Science

Vol. 11(1), pp. 1-5, January 2017
DOI: 10.5897/AJPS2016.1464
Article Number: 4B6E27E62320
ISSN 1996-0824
Copyright © 2017
Author(s) retain the copyright of this article
http://www.academicjournals.org/AJPS

Full Length Research Paper

Performance evaluation of common bean (*Phaseolus vulgaris* L.) varieties in Raya Valley, Northern Ethiopia

Teame Gereziher1*, Ephrem Seid2 and Getachew Bisrat3

1Ethiopian Institute of Agricultural Research, Mehoni Agricultural Research Center, P. O. Box 71 Maichew, Tigray, Ethiopia.
2Ethiopian Institute of Agricultural Research, Holleta Agricultural Research Center, Ethiopia.
3International Livestock Research Institute, Africa RISING Project, Maichew, Tigray, Ethiopia.

Received 27 August, 2016; Accepted 11 October, 2016

*Phaseolus vulgaris* L. (Leguminosae) is a crop widely distributed in all parts of the world. In Ethiopia, common bean is cultivated as a source of protein for local consumption and for export. Mostly, it grows in the warm and lowland areas of the country. The aim of this research was to identify and investigate the performance and genetic potential of *P. vulgaris* varieties in raya valley of southern tigray. Twelve varieties of *P. vulgaris* L. were used to evaluate their genetic variation within varieties using randomized complete block design (RCBD) in plot size of 4 x 2.4 m = 9.6 m² with six rows per plot. The data was subjected for analysis of variance (ANOVA) using SAS PROC GLM (2004) at P<0.05. The analysis of variance (ANOVA) showed significant at P ≤ 0.001 among treatments for the 10 variables: Emergence date, stand count after thinning, days to flowering, days to maturity, harvesting date, pod per plant, seed per pod, hundred seed weight, yield per hectare measured, significant (P<0.05) and non significant (P=0.05) for plant height and stand count at harvest, respectively. Among the varieties, Batu variety matures early (77 days) and both Dinkinesh and Lyamungo-85 matures late (100 days). Grain yield per hectare shows low in Dinkinesh variety (320.1 kg ha⁻¹) and highest in Nasir variety (2764.9 kg ha⁻¹) followed by Alpine (2470.8 kg ha⁻¹) and Awash Melka varieties (2145.5 kg ha⁻¹). Therefore, Nasir variety was well performed to Raya Valley condition. Therefore, this variety has to be promoted in farmers field for dissemination and scaling up.

**Key words:** *Phaseolus vulgaris* L, common bean, lowland, yield, yield components.

INTRODUCTION

Pulses are extremely important crop in food and dietary security. Pulses have about 18% of share in total dietary protein utilization and 7% of share in total energy consumption in Ethiopia. Lowland pulses are particularly adaptable and are cooked in many ways. Whole dry seeds are used in plain cooking (soups, stews, samosa, boiled or roasted) while the flour or paste is used in processed dishes (boiled, steamed, fried or baked). Even

*Corresponding author. E-mail: fiamiefa21@gmail.com.

Author(s) agree that this article remains permanently open access under the terms of the Creative Commons Attribution License 4.0 International License.
the green leaves and green pods of common beans, cowpeas and pigeon peas are consumed as vegetables in some parts of the country (FAO, 2009). While pulses are grown all over the country, and account for 13% of cropped land area, production is concentrated in the Amhara and Oromiya regions, which jointly account for 92% of chickpea production, 85% of faba bean production, 79% of common bean production, and 79% of field pea production. The region is also the major producer of three out of the four major pulses varieties in the country (faba beans, chickpeas and common beans), while Oromiya leads production in the other major variety - field peas (IFPRI, 2010).

Twelve pulse species are grown in Ethiopia. Of these, Faba bean (Vicia faba L.), field pea (Pisum sativum L.), chickpea (Cicer arietinum L.), lentil (Lens culinaris), grass pea (Lathyrus sativus L.), fenugreek (Trigonella foenum-graecum L.) and lupine (Lupinus albus L.) are categorized as highland pulses and grown in the cooler highlands. On the contrary, common bean (Phaseolus vulgaris L.), soya bean (Glycine max L.), cowpea (Vigna unguiculata L.), pigeon pea (Cajanus cajan L.) and mung beans are principally grown in the warmer and low land parts of the country. Among the individual varieties, faba beans (broadly known as horse beans) accounts for the maximum fraction of production, at 36%, followed by common beans (17%) and chickpeas (16%). Other pulses (e.g., lentils, peas, lupines and mung beans) account for the remaining 32% (IFPRI, 2010).

Common bean is a diploid (2n=22) annual leguminous plant that belongs to the genus Phaseolus, and it is characterized by pinnately compound trifoliate leaves. There are about 50 species under the genus Phaseolus. Phaseolus vulgaris L. was follow-on from wild ancestors distributed from Northern Mexico to Northwestern Argentina (Ibarra-Perez et al., 1997; Debouck, 1999). The ancestors of P. vulgaris L. become visible to have created two distinctive gene pools one in Mesoamerica (Mexico and Central America) and the other in the Southern Andes, a mountain range in South America (Burle et al., 2010). An ancestral wild form is still found at the border line between temperate and sub-tropical dry climatic regions (Debouck, 1999). They were brought to Europe and Africa during the 16th century by returning Spanish and Portuguese explorers (Ibarra-Perez et al., 1997).

Common bean (P. vulgaris L.) is the world’s most significant food legume for direct human consumption. Average per capita utilization of common bean in the main bean production areas is higher in Africa, projected at 31.4 kg year^{-1}. High in nutrients and commercial potential, common bean holds large guarantee for combating hunger, increasing income and improving soil fertility in sub Saharan Africa. The crop occupies more than 3.5 million hectares in sub-Saharan, accounting for about 25% of the worldwide production but production is concentrated in the densely populated areas of East Africa, the lakes region and the highlands of southern Africa. In Africa, common bean is an admired crop among small-scale farmers, given its short growth cycle (about 70 days) which permits production when rainfall is irregular. Common bean is often grown by women farmers for mainly for subsistence and markets (Schoonhoven and Voysest, 1991).

Haricot beans are a grain crop primarily grown in Ethiopia for human utilization and export. It grows in most of the agro-ecology zones of low and mid altitude areas of the country. A market demand for the haricot beans both in the domestic and export market has become the main mechanism for the growing trends in quantity of production (Frehiwot, 2010).

Haricot bean is grown on an estimated 323,327.27 hectares by nearly 3.2 million smallholder farmers. Its production also reaches 5,137,248.07 quintals with an average of 15.9 QuHa^{-1}. In case of Tigray region, the production is 7,769.65 quintals in 1,051.32 hectare of land, which is 7.4 QuHa^{-1} (CSA, 2015).

The wide range of growth habits among bean varieties has enabled the crop to be cultivated well under different agro-ecological surroundings. Common bean is very favored by Ethiopian farmers because of its fast maturing uniqueness that enables households to get cash returns essential to pay for food and other household needs when other crops have not yet matured (Legesse et al., 2006). The major producing regions are Oromiya (mainly East Shewa, East Hararghe, and West Hararghe, West Arsi, and Arsi zones) and SNNPR (Wolaita, Sidama, Gedeo, Alaba, Dauro and Gurageh zones). The production in the Central Rift Valley is conquered by white pea bean types that are intended for export market. In the rest of the growing regions, other bean types, cultivars of different seed color, size and shapes are grown primarily for domestic consumption. The improved trend in the production of pulses due to productivity improvement and area expansion, the appearance of new pulse crops for export, improvement in the storage, cleaning, and grading capacity of exporters and wholesalers and the presented approving community support for export have supported the increase of export over the years (Dawit et al., 2010). Therefore, as the research area was low altitude it is believed to be potential for lowland pulses production. In view of this, the study was conducted to identify and evaluate the performance and genetic potential of released common bean varieties for further utilization in the lowland areas of Southern Tigray.

MATERIALS AND METHODS

Description of the experimental area

The study was conducted at the research station of Mehoni Agricultural Research center in the Raya Valley in 2012/13 main season, Northern Ethiopia, (12° 41’50” S or N; 39° 42’08” W or E; 1578 m). The site receives a mean annual rainfall of 600 mm with
Table 1. Analysis of variance for phonological, agronomic and yield characters of 12 common bean varieties evaluated at Raya Valley, southern Ethiopia.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Treatment</th>
<th>Replication</th>
<th>Error</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degree of freedom</td>
<td>11</td>
<td>2</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Emergence date</td>
<td>1.11***</td>
<td>0.11</td>
<td>0.20</td>
<td>4.30</td>
</tr>
<tr>
<td>Stand count after thinning</td>
<td>305.66***</td>
<td>20.86</td>
<td>59.64</td>
<td>5.94</td>
</tr>
<tr>
<td>Stand count at harvest</td>
<td>228.68 ns</td>
<td>26.69</td>
<td>2395.94</td>
<td>8.88</td>
</tr>
<tr>
<td>Plant height</td>
<td>88.79*</td>
<td>9.95</td>
<td>33.29</td>
<td>13.67</td>
</tr>
<tr>
<td>Days to flowering</td>
<td>71.17***</td>
<td>2.19</td>
<td>5.64</td>
<td>4.59</td>
</tr>
<tr>
<td>Days to maturity</td>
<td>196.21***</td>
<td>1.75</td>
<td>31.59</td>
<td>6.39</td>
</tr>
<tr>
<td>Harvesting date</td>
<td>131.42***</td>
<td>8.36</td>
<td>10.66</td>
<td>3.49</td>
</tr>
<tr>
<td>Pod per plant</td>
<td>56.92***</td>
<td>1.86</td>
<td>7.28</td>
<td>19.59</td>
</tr>
<tr>
<td>Seed per pod</td>
<td>0.66***</td>
<td>0.68</td>
<td>0.12</td>
<td>12.92</td>
</tr>
<tr>
<td>Hundred seed weight</td>
<td>148.67****</td>
<td>4.90</td>
<td>22.04</td>
<td>15.73</td>
</tr>
<tr>
<td>Yield per hectare</td>
<td>1753848.91***</td>
<td>70456.47</td>
<td>29306.99</td>
<td>12.34</td>
</tr>
</tbody>
</table>

***= Very highly significant at P ≤ 0.001, ** = highly significant at P ≤ 0.01, *= significant at P ≤ 0.05, ns = non-significant at P = 0.05, CV= coefficient of variance.

an average minimum and maximum temperature of 22 and 32°C, respectively. The soil textural class of the experimental area is clay loam with pH of 7.9-8.1 (MhARC, 2015).

Treatments and experimental procedures

The design of the experiment was randomized complete block design (RCBD) with three replications. A recently released 12 improved common bean varieties (Red kidney, Batu, Alpine, Awash melka, Dinkinesh, ECAB-0081, Nasir, VTTT/925-14, Lyamungo-85, Calima, F9 Kaki-18 and Crestwood) were used in the study. The plot size was 4 × 2.4 m (9.6 m²) having 6 rows with harvestable plot size of 1.6 × 4 m (6.4 m²) and a spacing of 0.40 m between rows and 0.10 m between plants was maintained. 1.50 m between replication, 1 m between blocks and leave 0.50 m between plots within each block. 100 kg of DAP and 100 kg of urea fertilizers were set aside homogeneous for all treatments and urea was applied in split three times. Management practices like weeding, watering and thinning were done uniformly to all plots as per recommendations.

Data collection and statistical analysis

During the experiment data on individual plant basis plant height, number of pods per plant, number of seeds per pod, and on plot basis emergence date, stand count after thinning, days to 50% flowering, days to maturity, stand count at harvest, grain yield per plot, 100 seed weight were collected.

Data were subjected to analysis of variance (ANOVA) using SAS computer package version 9.1 (SAS, 2004) at P<0.05. when there were a significant difference among the treatment means the least significant difference (LSD) test will be used to compare the mean separations at P<0.05 (Gomez and Gomez, 1984).

RESULT

Phonological and agronomic characters

Result of the analysis of variance (ANOVA) of the traits studied in the experiment was very highly significant (p≤0.001, Table 1). Days to emergence ranged from 9.33 to 11.00 days. Nasir variety emerges early (9.33 days) after sowing, whereas Red Kidney, Alpine, VTTT/925-14, Lyamungo-85 and Calima Varieties emerged late at (11 days) after sowing. Stand count after thinning, days to 50% flowering and stand count at harvest scored lowest (111.33, 46.66 days and 101.00 respectively) at variety Red kidney, while Awash melka scored significantly higher for traits of stand count after thinning and stand count at harvest (144.00 and 130.00). Significantly, higher plant height was recorded at variety VTTT/925-14 (51.13 cm) followed by Dinkinesh variety (51.13 cm) whereas significantly lower plant height was recorded at Calima variety (33.06 cm), whereas, the lowest days to 90% maturity (70 days) was obtained at variety Batu which indicated that Batu was matured earlier by an average of 28 days from late matured variety Lyamungo-85 (98 days) followed by Dinkinesh variety (97 days) (Table 2).

Yield and yield component characters

The results from the analysis of variance for number of pods per plant showed a very highly significant (P<0.001) difference (Table 1). The highest number of pods per plant was obtained from Crestwood and Alpine (20 pods/plant), while the lowest number of pods per plant was obtained at Dinkinesh (8.33 pods/plant) followed by Calima (8.66 pods/plant). Nasir variety scores the highest number of seed per pod (3.65) and the lowest hundred seed weight was recorded at Calima variety (39.83 g) and the lowest hundred seed weight recorded at
Table 2. Mean for phonological, agronomic and yield characters of 12 common bean varieties evaluated at Raya Valley, southern Ethiopia.

<table>
<thead>
<tr>
<th>Variety</th>
<th>ED</th>
<th>SCT</th>
<th>SCH</th>
<th>PH</th>
<th>DF</th>
<th>DM</th>
<th>HD</th>
<th>PPI</th>
<th>SP</th>
<th>100SW</th>
<th>YH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Red Kidney</td>
<td>11.00</td>
<td>111.33</td>
<td>101.00</td>
<td>34.86</td>
<td>46.66</td>
<td>87.66</td>
<td>89.66</td>
<td>11.00</td>
<td>2.65</td>
<td>33.96</td>
<td>889.6</td>
</tr>
<tr>
<td>Batu</td>
<td>9.66</td>
<td>130.66</td>
<td>121.66</td>
<td>36.76</td>
<td>48.66</td>
<td>70.00</td>
<td>77.33</td>
<td>14.33</td>
<td>2.78</td>
<td>33.56</td>
<td>1538.6</td>
</tr>
<tr>
<td>Alpine</td>
<td>11.00</td>
<td>133.00</td>
<td>118.00</td>
<td>46.40</td>
<td>50.00</td>
<td>84.66</td>
<td>90.66</td>
<td>20.00</td>
<td>3.02</td>
<td>31.50</td>
<td>2470.8</td>
</tr>
<tr>
<td>Awash Melka</td>
<td>10.00</td>
<td>144.00</td>
<td>130.00</td>
<td>42.66</td>
<td>60.00</td>
<td>93.66</td>
<td>97.66</td>
<td>18.33</td>
<td>3.15</td>
<td>20.70</td>
<td>2145.5</td>
</tr>
<tr>
<td>Dinkinesh</td>
<td>10.00</td>
<td>131.00</td>
<td>117.33</td>
<td>51.13</td>
<td>55.00</td>
<td>97.66</td>
<td>100.00</td>
<td>8.33</td>
<td>2.16</td>
<td>28.13</td>
<td>320.1</td>
</tr>
<tr>
<td>ECAB-0081</td>
<td>10.66</td>
<td>124.33</td>
<td>114.33</td>
<td>40.80</td>
<td>52.00</td>
<td>89.66</td>
<td>98.00</td>
<td>10.33</td>
<td>2.61</td>
<td>31.06</td>
<td>682.9</td>
</tr>
<tr>
<td>Nasir</td>
<td>9.33</td>
<td>143.33</td>
<td>129.00</td>
<td>45.40</td>
<td>48.00</td>
<td>86.00</td>
<td>96.33</td>
<td>18.33</td>
<td>3.65</td>
<td>21.76</td>
<td>2764.9</td>
</tr>
<tr>
<td>VTTT/925-14</td>
<td>11.00</td>
<td>114.33</td>
<td>105.00</td>
<td>51.13</td>
<td>60.33</td>
<td>93.33</td>
<td>97.66</td>
<td>12.33</td>
<td>3.02</td>
<td>30.23</td>
<td>683.6</td>
</tr>
<tr>
<td>Lyamungeo-85</td>
<td>11.00</td>
<td>137.00</td>
<td>125.00</td>
<td>40.13</td>
<td>49.66</td>
<td>98.00</td>
<td>100.00</td>
<td>10.33</td>
<td>2.62</td>
<td>36.96</td>
<td>1108.4</td>
</tr>
<tr>
<td>Calima</td>
<td>11.00</td>
<td>136.00</td>
<td>119.33</td>
<td>33.06</td>
<td>47.33</td>
<td>80.33</td>
<td>90.33</td>
<td>8.66</td>
<td>1.81</td>
<td>39.83</td>
<td>903.9</td>
</tr>
<tr>
<td>F9 Kaki-18</td>
<td>10.66</td>
<td>128.00</td>
<td>111.66</td>
<td>41.53</td>
<td>47.33</td>
<td>81.00</td>
<td>88.00</td>
<td>13.33</td>
<td>2.57</td>
<td>34.16</td>
<td>1631.8</td>
</tr>
<tr>
<td>Crestwood</td>
<td>10.00</td>
<td>125.33</td>
<td>117.00</td>
<td>46.26</td>
<td>55.33</td>
<td>92.00</td>
<td>96.66</td>
<td>20.00</td>
<td>2.88</td>
<td>16.10</td>
<td>1497.9</td>
</tr>
<tr>
<td>CV (%)</td>
<td>4.30</td>
<td>5.94</td>
<td>8.88</td>
<td>13.67</td>
<td>4.59</td>
<td>6.39</td>
<td>3.49</td>
<td>19.59</td>
<td>12.92</td>
<td>15.73</td>
<td>12.34</td>
</tr>
<tr>
<td>LSD (5%)</td>
<td>0.76</td>
<td>13.07</td>
<td>17.67</td>
<td>9.77</td>
<td>4.02</td>
<td>9.51</td>
<td>5.52</td>
<td>4.57</td>
<td>0.60</td>
<td>7.95</td>
<td>289.88</td>
</tr>
</tbody>
</table>

CV = Coefficient of Variance, LSD = least significant difference, ED = emergence date, SCT = stand count after thinning, SCH = stand count at harvest, PH = plant height, DF = days to flowering, DM = days to maturity, HD = harvesting date, PPI = pod per plant, SP = seed per pod, 100SW = 100 seed weight, YH = yield per hectare.

Crestwood variety (16.10g). Finally, Dinkinesh variety produced the lowest grain yield per hectare (320.1 kg). Whereas, Nasir variety produced the highest (2764.9 kg) grain yield per hectare followed by Alpine (2470.8 kg) and Awash Melka varieties (2145.5 kg) (Table 2).

DISCUSSION

Generally, very highly significant difference was observed for emergence date, stand count after thinning, days to flowering, days to maturity, harvesting date, pod per plant, seed per pod, 100-seed weight and yield per hectare. Plant height and stand count after harvest showed significant and non-significant difference, respectively.

With regards to the present experiment, the existence of genotypic variation in grain yield and yield components (Emishaw, 2007) has been reported for common bean. Data for number of pods per plant, seeds per pod, branches per plant, plant height, seed yield and hundred seed weight were showed highly significant (P<0.01) differences among varieties. The current variations in yield components among varieties consent with previous reports (Daniel et al., 2014).

In line with the finding (Kassaye, 2006; Shahid and Kamaluddin, 2013; Fahad et al., 2014), it was reported that significant variability was observed for plant height, days to 50% flowering, days to 90% physiological maturity, pods per plant, seed yield per pod, hundred seed weight and yield characters. The obtained result was in accordance with the works of Zelalem (2014). Combined analysis showed that plant height, seed pod, and hundred seed weight and grain yield were significantly different. But stand count at emergency, stand count at harvest, days for flowering, days for maturity and pods per plant did not show significant difference (P < 0.05).

Conclusion

Testing of improved varieties is among the best technologies to improve productivity and for specific area recommendation. Results of this experiment showed that Nasir variety had early maturation, highest stand count after harvest, highest seed per pod, produced the highest grain yield, and good performance in other parameters. However, the experiment should be repeated across locations and years for a wide range of recommendation.

Conflict of Interests

The authors have not declared any conflict of interests.

ACKNOWLEDGMENTS

The authors acknowledge Ethiopian Institute of Agricultural Research (EIAR), Mehoi Agricultural Research Center, Maichew, Tigray, Ethiopia for covering the financial expenses in conducting this study. In addition, they acknowledge all individuals who directly or indirectly contributed to the successful completion of the study.

REFERENCES


