Evaluating yield and related trait of Haricot Bean varieties at Dambi Dollo University Research Site, Ethiopia

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ABSTRACT

Haricot bean (Phaseolus vulgaris L.) is an annual crop cultivated for food as it has high protein content. The objective of this study was to evaluate yield and yield-related traits of haricot bean varieties at the Dambi Dollo University research site. Five released and four local haricot bean varieties were used on 3 × 2 m (6 m²) experimental plots using randomized complete block design with three replications. Data pertaining to agronomic traits and yield performance of each variety were recorded and analyzed using R software version 4.0.5 and Microsoft Excel 2010. One way multivariate analysis showed a significant difference (p < 0.05) in thousand seed weight. SAB-632, Local-4 ('Burree') and SAB-736 showed higher yield than the other haricot bean varieties. They are also high in all agronomic traits except SAB-736. Thousand seed weight and yield were high and significant with positively correlated to each other. Plant height had a high and significant positive correlation with the number of branches and seeds per plant. Generally, it is possible to say that haricot bean varieties, SAB-632 and Local-4('Burree') are preferable in yield at the Dambi Dollo University research site according to the present findings. Therefore, it is good if these two haricot bean varieties are practised for multiplication at Dambi Dollo Research site and other related agro ecologies.

Introduction

Haricot bean (Phaseolus vulgaris L.) is an important source of protein, calories and cash for smallholder farmers (1). It is a favourable vegetable because of its delicious taste and moderate price, available throughout the year (2). The crop is an annual crop that belongs to the family Fabaceae (1) and cultivated primarily for dry seeds, green pods (as snap beans), and green-shelled seed (3). Haricot bean is locally known as “Boleqe” or common bean, and is an important legume crop and one of the most widely cultivated species of Phaseolus in Ethiopia. The crop is grown on an area of about 166000 htr and ranks third in the area among legumes with an average yield of 800 kg/htr (4).

Haricot bean is grown predominantly in low land area (300–1100 m), mainly in the rift valley and some mid highland areas (1400–2000 m). It requires a warm, frost-free climate, but the plant may drop its flowers or pods during excessively hot or rainy weather (2). It cannot tolerate frost or elevations above 3000 m but can grow as annuals in temperate climates.

Potential haricot bean varieties released by Ethiopian Agricultural Research centres should be tested in different areas where not tested before to expand its production area and increase productivity (1). This study evaluated the yield and related traits of haricot bean varieties at the Dambi Dollo University research site.

Materials and Methods

Description of the Study Areas

The field experiment was conducted at Dambi Dollo University research site, Oromia regional state, Ethiopia, during the July-September under rain fed growing conditions of 2020. A testing site has the potential for haricot bean cultivation. The sites are located at a latitude and longitude of 8°55’ N and 34°54’ E with an elevation of 1580 m above sea level.

Experimental Design and Layout

Nine haricot bean varieties namely ‘SAB-736’, ‘NASIR’, ‘BOLE’, ‘AWASH-2’, ‘SAB-632’, ‘Local-1(‘Gad-Tuulee’),
Agronomic Traits

There were no significant differences (p < 0.05) among haricot bean varieties for pods per plant. More pods per plant were recorded from the variety SAB-632 (18.40). On the other hand, the lowest number of pods per plant was recorded from AWASH-2 variety with a pod per plant of 10.13 (Table 3).

It was investigated that there was no significant difference in plant height. But, relatively Local-4 ('Burree'), SAB-632 and Local-1 ('Gad-Tuulee') varieties are high in plant height while SAB-736 is the least.

SAB-632, Local-1 ('Gad-Tuulee') and Local-4 ('Burree') varieties are the highest 6.07, 5.07 and 5.00 respectively while Local-2 ('Naziret') variety is the least one in the number of branches.

Haricot bean varieties revealed variation (p < 0.05) for the number of seeds per plant. The variety SAB-632 produced more seeds per pod (5.67) compared to the other varieties. On the other hand, SAB-736 produced the lowest number of seeds per pod (3.41) (Table 3). Local-4('Burree'), Local-1 ('Gad-Tuulee') and NASIR are relatively higher in seed per plants than other haricot bean varieties. The present study indicates these varieties are more competent than other haricot bean varieties by their seed per plant in the study site.

The haricot bean varieties tested had a significant variation (p < 0.05) among each other for 1000 seed weight. The variety SAB-632 produced the highest 1000 seed weight (366.67 gm). The variety Local-2 (Naziret) was the least in seed weight (203.33 gm) (Table 3). This significant difference in 1000 seed weight may be the difference in genetic makeup, seed size or moisture-holding capacity of the varieties. According to an earlier report (5), NASIR has a 20.9 gm 1000 seed weight is less than the result of the present study.

It has been evaluated that the yield of haricot bean varieties varies from each other. SAB-632 showed the highest yield (2106.89kg/hrtr) followed by Local-4 ('Burree') which is 1809.33kg/hrtr. SAB-736, Local-3 ('Diimtuu') and BOLE are relatively high when compared to other varieties respectively. The least variety in yield is AWASH-2 and Local-2 ('Naziret') respectively (Table 3). This shows that a variety that performs best in a certain environment may not be as productive in another area (5).

Correlation and Regression Analysis of Haricot Bean Agronomic Traits

An analysis of correlation and regression between each agronomic trait of haricot bean varieties at the study site was done. Yield is high and positive significantly correlated with thousand seed weight and low with seed per plant. Plant height has high and showed a significant positive correlation with both branches and seeds per plant. This shows that the increment of plant height increases the number of branches and seeds per plant. The rest traits were positively correlated with yield and with each other,
Table 1. Statistical values of each agronomic traits of Haricot Bean

| Varieties     | YLD | TSW | PH  | BR  | PPP | SPP |
|---------------|-----|-----|-----|-----|-----|-----|
| Minimum       | 836.70 | 180 | 23.60 | 2.80 | 6.80 | 2.73 |
| Median        | 1760.00 | 270 | 38.80 | 4.60 | 10.80 | 5.00 |
| Mean          | 1652.20 | 283 | 40.78 | 4.61 | 12.09 | 4.85 |
| Maximum       | 2611.00 | 460 | 61.00 | 6.60 | 23.00 | 6.76 |
| S. Error of Mean (S. Em.) | 167.13 | 32.45 | 5.81 | 0.52 | 1.75 | 0.39 |
| CV%           | 23.34 | 25.85 | 31.67 | 20.94 | 32.45 | 20.41 |

Where: YLD= yield in Kg, TSW= thousand Seed Weight, PH= Plant Height, BR= Branches, PPP=Pods per Plant, SPP= Seeds per Plant

Table 2. Summary of one way Multivariate Analysis of Variance (MANOVA)

| Varieties     | DF | Sum Sq | Mean Sq | F value | Pr(>F) |
|---------------|----|--------|---------|---------|--------|
| TSW           | 1  | 1006293 | 1006293 | 9.480 | 0.00569** |
| PH            | 1  | 223407  | 223407  | 2.105 | 0.16163 |
| BR            | 1  | 65348   | 65348   | 0.616 | 0.44144 |
| PPP           | 1  | 29402   | 29402   | 0.277 | 0.60420 |
| SPP           | 1  | 313217  | 313217  | 2.951 | 0.10055 |
| Residuals     | 21 | 2229124 | 106149  |        |        |

Significance codes: 0 **** 0.001 *** 0.01 ** 0.05 ' 0.1 ' 1

Where: TSW=1000 Seed Weight, PH=Plant Height, BR=Branches, PPP=Pods per Plant, SPP=Seeds per Plant

Table 3. Mean values of yield and other related traits of each haricot bean varieties

| Varieties     | YLD | TSW | PH  | BR  | PPP | SPP |
|---------------|-----|-----|-----|-----|-----|-----|
| SAB-736       | 1798.89 | 326.67 | 25.27 | 4.27 | 10.20 | 3.41 |
| NASIR         | 1566.00 | 283.33 | 45.73 | 4.47 | 11.40 | 5.51 |
| BOLE          | 1735.00 | 296.67 | 30.40 | 4.00 | 10.87 | 4.93 |
| AWASH-2       | 1033.22 | 246.67 | 32.20 | 4.60 | 10.13 | 4.69 |
| SAB-632       | 2106.89 | 366.67 | 53.07 | 6.07 | 18.40 | 5.67 |
| Local-1('Gad-Tunlee') | 1853.87 | 223.33 | 48.80 | 3.97 | 14.67 | 5.48 |
| Local-2('Naziret') | 1393.78 | 203.33 | 37.30 | 3.87 | 10.60 | 4.98 |
| Local-3('Diimtuce') | 1773.33 | 253.33 | 37.67 | 4.13 | 12.20 | 3.44 |
| Local-4('Burree') | 1809.33 | 346.67 | 56.60 | 5.00 | 10.33 | 5.55 |

Where: YLD= yield in Kg, TSW= thousand Seed Weight, PH= Plant Height, BR= Branches, PPP=Pods per Plant, SPP= Seeds per Plant

Table 4. Correlation analysis between yield and related traits of haricot bean varieties

| Varieties     | YLD | TSW | PH  | BR  | PPP | SPP |
|---------------|-----|-----|-----|-----|-----|-----|
| YLD           | 0.510** | 1   |     |     |     |     |
| TSW           | 0.358  | 0.245 | 1   |     |     |     |
| PH            | 0.418  | 0.385 | 0.583** | 1   |     |     |
| BR            | 0.104  | 0.116 | 0.376 | 0.437 | 1   |     |
| PPP           | 0.002  | 0.141 | 0.629** | 0.418 | 0.335 | 1   |

Where: YLD= yield in Kg, TSW= thousand Seed Weight, PH= Plant Height, BR= Branches, PPP=Pods per Plant, SPP= Seeds per Plant, Significant codes 0 **** 0.001 *** 0.01 ** 0.05 ' 0.1 ' 1

Table 5. Regression analysis of haricot bean parameters on yield

| Parameters     | Estimate | Std. Error | t value | Pr. (> |t |)
|----------------|----------|------------|---------|--------|
| (Intercept)    | 960.4690 | 414.5491  | 2.317  | 0.0307* |
| TSW            | 2.0447   | 0.9498    | 2.153  | 0.0431* |
| PH             | 11.5882  | 7.1700    | 1.616  | 0.1210 |
| BR             | 89.5307  | 89.8272   | 0.997  | 0.3803 |
| PPP            | -5.9897  | 18.5325   | -0.323 | 0.7497 |
| SPP            | -144.2135 | 83.9539   | -1.718 | 0.1096 |

Significant codes 0 **** 0.001 *** 0.01 ** 0.05 ' 0.1 ' 1

although there were no significant variation between them.

The intercept estimate value of all traits with yield is high, and a significant difference is there. It has been evaluated that there was a significant positive correlation between yield and thousand seed weight, which has a high value of prediction, as shown in Fig. 1. A-E.

Conclusion

The study was conducted at Dambi Dollo University Research Site, Ethiopia with the objective to evaluate yield and related traits of haricot bean varieties. The result showed that there was a significant difference in 1000 seed weight. SAB-632, Local-4 (‘Burree’) and SAB-736 showed higher yield than the rest of the varieties. These varieties are also high in agronomic traits except SAB-736. 1000 seed weight and yield were high and positive significantly correlated with each other. Plant height was high and positive significantly correlated with the number of branches and seeds per plant.

It is possible to say that SAB-632 and Local-4 (‘Burree’) are the best varieties in yield at the Dambi Dollo university research site, Ethiopia and similar agro ecology according to the finding of the present study. Therefore, it is preferable to practice these two varieties for multiplication at this site and related agro-ecology.
Fig. 1. A–E: Measured and predicted values of yield and yield related traits of haricot bean.
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Authors’ contributions

Soresa Shuma and Abdisa Abriham have contributed to the present study by collecting plant materials, plantation, onsite management and data collection. Itefa Degefa contributed to the present study by data collection, data analysis with interpretation and writing for publication.

Conflict of interests

There is no conflict of interest.

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