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VARIABILITY IN YIELD AND YIELD COMPONENTS AMONG COMMON BEAN (*Phaseolus Vulgaris L.*) GENOTYPES

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ABSTRACT: *Common bean is an important leguminous crop grown by farmers for home consumption and local market in Lesotho. Its low productivity has been a great concern necessitating introduction of new improved cultivars that are tested for adaptation and yield potential. The study was conducted at National University of Lesotho located in the Maseru District of Lesotho with specific objectives of (1) determining the difference in yield and yield components of common bean genotypes obtained from CIAT and also (2) determining correlation coefficient among the yield components of the genotypes. Randomized Complete Block Design was applied with four replications to lay-out an experiment. Twenty cultivars of common beans obtained from CIAT were used as treatments. Parameters measured were plant height, number of pods per plant, number of seeds per pod and weight of 100 seeds (g). Data generated were subjected to analysis of variance using Genstat recovery version (2015). The results revealed significant differences in number of pods per plant, yield and plant height among twenty cultivars. No significant difference was obtained among different bean cultivars for weight of 100 seeds per pod and number of pods per plant. Number of pod per plant showed a positive correlation between number of seed per pod, plant height and seed weight per pod but had negative correlation with weight per 100 seeds. Seed weight had negative correlation with all components of beans.*

KEYWORDS: Common bean, yield component, Lesotho

INTRODUCTION

Common bean (*Phaseolus vulgaris* L.) is an economically important leguminous crop ranking first, followed by field peas (*Pisum sativum* L.) as evidenced by production and area under which it is grown in Lesotho (Bureau of Statistics, 2014). It is grown in all four agro-ecological zones of Lesotho, namely; Lowlands, Foothills, Highlands and Orange River basin (Lesotho review, 2015; Van Schoonhoven, 1991)). Its production levels differ greatly among these zones as a result of variation in climatic and edaphic factors (Bureau of Statistics, 2014). Common beans is produced by most farming house-holds under dryland conditions with less external production inputs resulting in low productivity (Bureau of Statistics, 2014). Efforts are made to introduce exotic common bean cultivars that out-yield the current ones (Sefume, 2010). Economic yield

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has increased with advent of these cultivars. The economic yield of a bean crop is a culmination of many processes that take place in the plant during its growing period until it reaches physiological maturity (Lemoine, 2013; Marschner, 2012; Westermann and Crothers, 1977). Among the processes are photosynthesis, respiration, xylem transportation of nutrients and water, mobilization, remobilization and partitioning of photosynthates and assimilates, and source-sink relationships to mention the major ones (Maschner, 2012; Mengel and Kirby, 2001). All these play important part in determining the economic yield of common bean. In order for the cultivar to be high yielding, it has to be efficient in these processes (Alihan *et al*, 2013; Lemoine, 2013). Economic yield is the function of many components in common bean such as number of pods in each plant, number of seeds in each pod, weight of 100 seeds and plant height. The contribution of these yield components differ greatly depending on the bean genotypes, environment and management practices (Nduwarugira *et al*, 2016; Onder *et al*., 2013; Hossein *et al*., 2012). Manipulation of these individually or in combination can boost production significantly. Introduction of exotic common bean genotypes in Lesotho has been a common practice aimed at screening for adaption and yield potential (Sefume, 2010), and no study has been conducted to establish the differences in yield and yield components among the bean genotypes being introduced, hence this research was undertaken. The specific objectives of study were to (1) determine the difference in yield and yield components of common bean genotypes obtained from CIAT and being tested for adaptation in Lesotho, (2) determine correlation coefficient among the yield components of these genotypes

MATERIALS AND METHODS

Study area

The study was conducted at Roma Campus of the National University of Lesotho which is situated 34km south west of Maseru, the capital city of Lesotho. The coordinates for Roma campus are 29^0 26’ 48 south latitude and 27^0 42’ 29 east longitude, with an altitude of 1610m above sea level.

Site description

Roma valley is broad, fertile and surrounded by sand stone cliffs topped to the east. The soil type consists of Berea series (Plinthaquic dystruchrepts). Top soil is a sandy loam with hue of 10 YRS, 4/3 while sub-soil is dark yellowish sandy clay loam with hue of 10yrs 4/4. The soil analysis revealed pH 3.63 with phosphorus of 0.033 and 0.000 at 0ppm, 0.197 at 1ppm, 0.223 at 2ppm, 0.329 at 3ppm and 0.525 at 4ppm.

Experimental design

The experiment was carried out using Completely Randomized Block Design with 20 treatments (bean genotypes) and four replications. The size of the field was 36 m x 17.2 m equivalent to

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619.2m^2 which was divided into 4 blocks where each block had 20 plots. Each plot had 2 rows with the length of 4 m each. The inter-row and intra-row spacing were 0.9 m and 0.10 m. Bean seeds used in experiment were obtained from CIAT in Malawi through Department of Agricultural Research.

Agronomic practices

The land was first prepared using tractor mounted mouldboard plough, after which disc harrow was used to level the seedbed and break the clods. A compound fertilizer of 2:3:2(22) + Zn was applied by hand over the field at the rate of 250 kg ha^{-1} as basal dressing. Top-dressing was not applied. Sowing of seeds was done by hand. The field was irrigated twice a week due to prolonged drought that prevailed. Weeding was done by hand-hoeing twice during the growing period of the beans to control nutsedge (*Cyprus esculentum* L.) which was very problematic. Cape Mount rifles (*Mylabris spp.*) feeding on flowers of the plants was controlled chemically by applying ripcord (Cypermethin).

Data collection

Data on plant height, number of pod per plant, number of seed per pod, seed weight per pod (grams per pod), seed weight per 100 seeds and yield was collected. A formula for yield component of common beans is stated as follows;

$Yb=\mu+Pht+PP+SP+SP+SW+SW100+\varepsilon$

Where Yb =Bean yield, μ = overall mean, Pht=plant height, PP=pods/plant, SP=seed/pod, SW=Seed weight/pod +

SW100=seed weight per 100 seeds

Data analysis:

Data collected was subjected to the GEN STAT recovery to perform analysis of variance and correlation coefficient.

RESULTS

Yield and yield components

Number of pods per plant among different bean cultivars showed a highly significant difference ($p>0.01$) as revealed by analysis of variance indicated below (Table 1). The analysis of variance showed that bean cultivars CAL 143 had the highest mean of 40.75 pods, followed by 2-CIM-NAV 02-12-1 with 35.3 pods while SUGAR 131 had 32.75pods. The cultivars with the least number of pods per plant were MR 13905-6 with 12 while PAN 148 and PAN 9249 had 12.75

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and 13 pods, respectively. Among the cultivars with highest mean, the difference was greater than the difference among the cultivars showing the least number of pods. The cultivars with the highest mean number of pods showed larger differences than that shown by cultivars with lower number of pods.

There was a highly significant difference ($p>0.01$) among the bean cultivars for plant height. The table of means (Table 1) revealed that pinto-nodark had the highest mean height of 117cm, followed by VTTT 925/9-1-2 with height of 113cm. SER 83 recorded mean plant height of 35.3cm, followed by PAN 148 with mean height of 31.5cm (Table2). There was no significant difference among the number of seeds per plant. Similarly, no significant difference was observed among the cultivars of beans for seed weight. Highly significant difference ($p>0.01$) among bean cultivars for yield was revealed (Table1). CAL 143 had highest mean weight of 11452.5 g while SER 45 had the lowest mean of 2200g and it also had lowest mean on number (Table 2).There was no significant difference on seed weight among different cultivars as indicated in table 1.

Correlation coefficient

Among the yield components: Number of pod per plant shows a low positive relationship between number of seed per pod, plant height and seed weight per pod and also had a low negative relationship with weight per 100 seed. Seed weight has negative relationship to all components of beans (Table3).

DISCUSSION

Significant differences were obtained in bean yield, number of seed per pod, weight per 100 seeds and plant height among the bean cultivars grown (Table 1). This indicated that the processes taking place within the plants of different bean cultivars differed resulting in the varying contribution to yield components. There was a wide variation from very high contribution to very low contribution made by each of the four yield components. The difference is attributed to bean genotypes since they were grown under the same environmental conditions receiving the same treatment. Yield is a polygenic trait conferred by many genes, which is in turn directly or indirectly influenced by the above-mentioned components. The results are consistent with the findings of other researchers who obtained significant difference among bean cultivars for yield, number of seed per pod, weight per 100 seeds and plant height (Nduwarugira, 2016). Similarly, Singh *et al*., (1991) studied genetics of seed yield and its components in common beans of Andeans origin and found the components varying among genotypes with some making large contributions while others showed very low contributions. Szilagyi (2003) conducted a study on yield and yield components using Bulgarian common bean and discovered a wide variation among bean cultivars for different yield components.

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Number of pods per plant showed a positive relationship between number of seed per pod, plant height and seed weight per pod and these implied that when number of pods increased, the number of seed per pod, plant height and seed weight per pod also increased. But the correlation matrix does not show which one causes increase to the other. These findings concurred with the results of Duarte and Adams (1972) who also used correlation analysis on beans and found that the number of pods per plant, seed weight per pod was positively and highly correlated. Similarly, Chung and Goulden (1970) reported high correlation between seed per pod and high number of pods per plant is of interest to breeder because this character is relatively easy to determine yield. Nonetheless, it had low negative relationship with weight per 100 seed indicating that when number of pods per plant increased weight per 100 seed decreased. Seed weight had negative relationship to all components of beans. The negative correlations among the components of yield may make difficult the combining of desirable levels of these characters for high yield (Chung and Goulden, 1970). Such inverse association arise primarily from developmentally indirect relationships as stressed by (Adams, 1967).

CONCLUSION

There was a significant difference among bean genotypes for three components namely; number of seed per pod, weight per 100 seed and plant height while number of seed per plant and seed weight per pod revealed non-significant differences. Number of pod per plant showed a weak positive relationship between number of seed per pod, plant height and seed weight per pod but it has weak negative relationship with weight per 100 seed. Seed weight has negative relationship to all components of beans.

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Table 1: Analysis of variance for yield components of beans

		Mean square					
Source of variation	d.f	No. of pods per plant	Plant height	No. of seed per plant	Weight per 100 seed	Seed weight/pod	Yield
Replication	3	105.312	443.68	1.500	35.17	0.4588	14684566
Treatment	21	252.222**	2474.45**	2.380	174.74*	0.4823	21041666**
Error	55	4.742	93.36	1.024	16.77	0.1964	2039100
Total	79						
Mean		20.116	61.878	5.225	29.79	1.52	5184.1
CV (%)		9.99	15.37	19.46	29.34	13.74	26.78
LSD		3.357	14.90	1.560	0.6832	6.312	2201

**highly significant (P<0.01)

*significant (P<0.05)

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Table 2: Means of different parameters influencing yield

Name of cultivars	No. of pods per plant	Plant height	No. of seeds per pod	Weight per 100 seeds	Seed weight per pod	Yield
1-MR 13905-6	12	44	4.5	29.99	1.19	2822.5
2-CIM-NAV 02-12-1	35.3	59	5.5	20.50	1.08	6845
3-RCB 265	23.25	47.8	6.5	28.55	1.89	7037.5
4-CIM-PINK 02-1	16.25	44.75	4.8	24.64	1.20	3211.3
5-NUA 45	26.25	35.5	4	50.79	1.95	7150
6-PINTO- NODAK	27.25	117	5.8	29.49	1.88	7450
7-RCB 233	23	105	6.3	23.59	1.37	5913.8
8-RCB 261	20	58.3	5.3	26.56	1.39	4575
9-RCB 266	15	53.5	4.5	25.49	1.20	2873.8
10-SER 83	15.75	35.3	5.3	26.93	1.41	3791.3
11-SER 124	21.75	48	5.3	24.18	1.40	4120
12-SER 45	14.75	63	3.8	23.90	0.83	2200
13-BF 13607-9	26	50.5	6.3	31.38	1.85	7837.5
14-AFR 703	15.5	49.8	4	35.52	1.28	3185
15-VTTT 925/9-1-2	21	113.5	5	33.06	1.74	4695
16-VTTT 923/10-3	16	83.3	4.8	33.75	1.52	4125
17-CAL 143	40.75	54.3	5.8	30.84	1.83	11452.5
18-PAN 148	12.75	31.5	6	25.0	1.63	3342.5
19-PAN 9249	13.75	76.5	6	41.41	2.33	5237.5
20-SUGAR 131	32.75	67	5	30.32	1.32	5817.5
GRAND MEANS	20.116	61.878	5.225	29.79	1.52	5184.1

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Table 3: Correlation coefficient among yield components

	No of pods per plant	No of seed per pod	Plant height	Seed weight per pod
No. of seed per pod	0.3130			
Plant height	0.1556	0.1998		
Seed weight per pod	0.1813	0.5297	0.1840	
Weight per 100 seed	- 0.0014	-0.2430	-0.0117	0.6425

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