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DEVELOPMENT OF A VARIETY OF VULGAR BEANS (PHASEOLUS VULGARIS L.), IN THE RIO LIMPOPO VALLEY, IN THE LOCALITY OF MANIQUENIQUE, IN THE DISTRICT OF CHIBUTO, PROVINCE OF GAZA

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Abstract: The objective of this work was to develop a variety of common bean (*Phaseolus vulgaris L.)* performance and excellent characteristics for the Limpopo valley, in the town of Maniquenique, in the district of Chibuto, province of Gaza. To elucidate these assumptions, a total of 105 Genotypes were evaluated from August to October 2016, of which 96 germinated and Harvest was made, in only 42 Genotypes that produced grain and, later, 9 promising Genotypes were pre-selected that were evaluated in the advanced trial from March to May 2017. A complete randomized block design with 9 treatments and 3 replications was used. The parameters Emergence, Flowering, Harvest, Cycle, number of Green beans per plant, number of grains per Green beans, weight of 100 grains and Performance were evaluated. Quantitative variables were submitted to analysis of variance, using the SISVAR software version 5.6. Based on Performance, bela negra and semoc 1 were the Genotypes identified as promising, with 4,292kg*ha-1 and 4,250 kg*ha-1, respectively. Diacol calima was the Genotype that registered the lowest performance with 1,639 kg*ha-1. The Green beans per plant variable was the one that most contributed to the increase in Performance, due to its strong correlation (0.96880). The number of Green beans per bean plant (*Phaseolus vulgaris L.*) is one of the main components of grain yield.

Keywords: *Phaseolus vulgaris L*, variety, genotype, selection, Performance.

INTRODUCTION

Beans (Phaseolus vulgaris L.) is a legume widely consumed in the world and contributes substantially as a source of protein to a large part of the world population, especially where the consumption of animal protein is relatively low (AFONSO, 2010). It is a culture native to the high regions of Central America, namely Mexico, Guatemala and Costa Rica (MINISTRY OF AGRICULTURE, 1987). This legume has nutritional advantages that include protein content, dietary fiber, high content of complex carbohydrates and the presence of B vitamins (DEPARTMENT OF STUDIES AND STATISTICS, 2016).

The five largest world producers of beans are Brazil, China, India, Burma and Mexico, representing more than 65% of world production (AFONSO, 2010). It is estimated that the area occupied by the common bean crop in Mozambique until 1990 was 40 000 hectares (30 to 50% of the total area of legume production) (CANDA, 1998) and until 2010, the area of exploitation for the culture of butter beans was 100 087 hectares, 12 269 hectares in large farms, 2 665 hectares in medium farms and 85 153 in small farms (INSTITUTO NACIONAL DE STATÍSTICA, 2011). In terms of production levels, Niassa province is the largest producer at the national level, followed by Tete, Manica, Sofala and Zambézia (DEE, 2016).

The low use of improved varieties, low soil fertility, lack of good quality seed, low use of agricultural inputs (fertilizers and pesticides), pests and diseases, low schooling, lack of rainfall, lack of financial resources, are pointed out by small producers and agrarian technicians, as points that compromise the performance of the culture and its exploitation. The same, without many alternatives, use grains from previous campaigns or acquired in fairs and informal markets, such as seeds and the government, to overcome this deficiency, buys seeds in other provinces not adapted to agro-climatic conditions and, often not accepted in the market. (ROCHA et al, 2008).

Despite the success of breeding programs, the objective of promoting the cultivation of improved varieties is sometimes not achieved, mainly due to the resistance of some producers who insist on cultivating traditional varieties, due to the fact that new varieties are often not adapted to the climatic and edaphic conditions of the region. For this reason, in addition to developing new varieties, efforts have been made to improve materials that are stable to local conditions and used by producers.

In Mozambique, this crop, despite its great food importance and its socio-economic contribution, the average performance of the bean crop is low, around 300 kg*ha-1 due to low adoption of improved varieties, continuous use of low seed quality (CANDA, 1998). According to Freitas (2015), if the variety has low genetic potential for production, even using good quality seed, the Performance will be low. Although Mozambique is rich in traditional local varieties, as a result of successive crops, there is a cluster of variability in these varieties, in addition, they are increasingly mixed because of the marketing process, in which the merchant, when purchasing the product, mixes the grains, thus using materials from various sources or from other provinces acquired through government programs in an attempt to overcome this deficiency.

The mixture of varieties has brought effects such as: loss of genetic identity and unevenness in cultivation and production, which makes crop management and product commercialization difficult (ROCHA et al, 2008). The Limpopo valley has fertile soils (decomposed organic matter), with good ability to retain moisture, conditions that favor the development of common bean cultivation under rainfed conditions. is widely practiced, mostly by small farmers. The objective of this work was to develop a variety of common bean (Phaseolus vulgaris L.), for the Limpopo valley, in the town of Maniquenique, in the district of Chibuto, province of Gaza.

MATERIALS AND METHODS

To carry out the experiment, the following materials were used, ropes and stakes, seed sample of common bean Genotypes, scale, moisture meter, hoes, tubes and drums, hoe, glyphosate herbicide 360g/l, pesticides (cypermethrin, mancozeb, metamidofus 585g/l, fortis k 5% EC- Cyhalothrin 50g/l and triazole 250g/l), plastic boxes, seasonal labor, motor pump, urea mineral fertilizer, tape measure, labels, sprayer, bags and saucers. This research presents a quantitative approach, according to Fonseca (2002) cited by Gerhardt & Silveira (2009), the results are quantified and uses mathematical language to describe the relationships between variables.

As for nature, it is an applied research (GERHARDT & SILVEIRA, 2009), since it generated knowledge for practical application, aimed at solving specific problems and involving local truths and interests (Limpopo river valley region). Regarding the objectives, the research is descriptive (GIL 2008). As for the procedures, the research is experimental (GERHARDT & SILVEIRA, 2009), since it selects groups of coincident subjects, submits them to different treatments, checking for extraneous variables and observes if the differences in the answers are statistically significant and the observed effects are related to variations in stimuli, as the purpose of experimental research is to apprehend cause and effect relationships by eliminating conflicting explanations of the findings made.

LOCATION OF THE STUDY AREA

The experiment was carried out in the province of Gaza, district of Chibuto, locality of Maniquenique, in one of the research fields of the Centro de Formação Agraria de Maniquenique (IIAM). Maniquenique is 14 km from the district headquarters of Chibuto, located between coordinates 24°44'S and 33°32'E. The district's climate is generally dry tropical, with average annual temperatures above 25°C. A small portion in the south

(Administrative Post of Malehice) shows a moderately warm climate, with average annual temperatures below 25°C. The annual rainfall varies on average between 400 and 600 mm in most of the district, being greater than 700 mm south of the city of Chibuto, in the Administrative Post of Malehice. In the hot season the relative humidity between 60 to 80%. The district has 2 types of soils, namely clayey and sandy loam, rich in organic matter, capable of retaining moisture (PEDDC, 2008).

CHARACTERIZATION OF TREATMENTS

The experimental material in the preliminary phase consisted of 105 treatments (Genotypes), of which three controls (Catarina, diacol calima and semoc 1: chosen because they are varieties released by the breeding program and cultivated locally), resulting from the Harvest of individual plants whose seed was acquired in the local market of Chibuto. In the advanced test, the material consisted of nine treatments (Genotypes).

The Genotypes in Figure 1 are arranged horizontally from left to right in the following sequence: Flattened, Bela negra, Catarina, Gray Bonus, Round, Round 1, Round 2, semoc 1 and diacol calima. Genotypes, Flattened, gray bonus, Round 2 have similar characteristics, such as larger grain size, oval shape with light red spots, determined growth, and precocious. The Genotypes, Round, Round 1, determined growth, short Cycle, light red stained grains, small size and oval in shape. Bela Negra, presents semi-determined growth, Cycle slightly late, long grain, semoc 1 is slightly late, semi-determined, long grain with no stains and very popular in the Chibuto market, Catarina is precocious and determined, long grain and with a shine and the Calima diacol, presents a grain size with uniform characteristics, and seeds of dark red background with cream spots.

EXPERIMENTAL DESIGN

For the preliminary test, a simple scheme was used in which each furrow comprised an area of 4.96 m2 in which 6.2 m corresponded to the length. The furrows were spaced at a distance of 80 cm and 20 cm between plants in the same furrow. A randomized block design with nine treatments (Genotypes) and three replications was used. The plots consisted of four furrows, each furrow 6m long and 80 cm wide, in a total area of 192 m2. The treatments were randomized within each block, using the statistical package SISVAR version 5.6. In the preliminary test, sowing was carried out in furrows, in a measure of 80x20 cm, and each furrow a Genotype, each ten Genotypes was interspersed by three controls. In the advanced test, sowing was done in furrows, one seed in every 20 cm in the plots.

DATA COLLECT

For the emergence variable, in each Genotype, days were counted from sowing until the day when 50% of plants emerged in the furrow and in the plot was reached. At Flowering, in each Genotype, days were counted from emergence to the day when 50% of plants with open flowers were reached in the furrow and in the plot. Harvest was made when the plants had 90% of the green beans mature and dry. At the end of the Cycle, five sample plants were harvested in each plot and their Green beans were counted and recorded to obtain the number of Green beans per plant.

The average total number of Green beans per plant was determined from the average number of Green beans from sample plants collected from each plot. The number of grains per Green beans was obtained by the ratio between the average total number of grains and the average total number of Green beans obtained. For the weight of 100 grains, the

100 grains were determined at 13% moisture, using a precision balance and moisture meter. Performance was obtained based on the relationship between the components, using the following expression: R=plant/m2*Green beans/plant*grains/Green beans*grain weight. Where R is Performance and m2 is square meter.

STATISTICAL ANALYSIS

The data obtained from all variables were submitted to analysis of variance to show significance at 5% probability and the comparison of médays was carried out using Tukey's test at 5%.

RESULTS AND DISCUSSION

PRELIMINARY TEST

Of the 105 Genotypes seeded, Harvest was made in only 42 that produced. The result referring to the number of Green beans/plant presented a variation range of 3-11 Green beans/plant, after calculating the standard deviation added to the average, it was possible to identify 11 (eleven) Genotypes. It was found that during the Flowering period (August 25 onwards) temperatures were rising, which compromised Flowering. In the case of those that flowered, some Green beans formed were flat, the reason for some Genotypes with higher Green beans/plant number but lower grain/plant and weight.

According to Júnior et al, (2007), high air temperature has probably been the environmental factor that exerts the greatest influence on the abscission of flowers and green beans, the inadequate filling of grains, the setting and the final retention of seeds. Green beans in beans, being also responsible for the reduction in the number of seeds per Green beans and for the lower seed mass. Based on the evaluation of the number of grains/Green beans, the variation range was 1-16, and 8 (eight) Genotypes were identified, adding one more unit above the mean, around the standard deviation. The result referring to P100 grains presented a variation range of 11-48g, after calculating the standard deviation added to the average, it was possible to identify 6 (six) Genotypes.

IDENTIFICATION OF PROMISING GENOTYPES

In Performance, the variation range was 44-1133 kg*ha-1 and from these data 9% of 105 Genotypes were identified as promising for the advanced assay, that is, those that showed the highest Performance in kg*ha-1, as it was shown in Table (01). An obvious reason for the low performance was sowing out of season and according to Pereira et al, (1998), beans are sown at the end of the rainy season and that it is not too dry. For the southern region of Mozambique, it is sown in the second half of March to the first half of May (MINAG, 1987). On the other hand, it was possible, under stress conditions, to identify some Genotypes harvested that stood out better by some tolerance mechanism and adapted to unfavorable conditions, bringing the possibility of their production in the dry season. The Genotypes used as witnesses were not on the identified list.

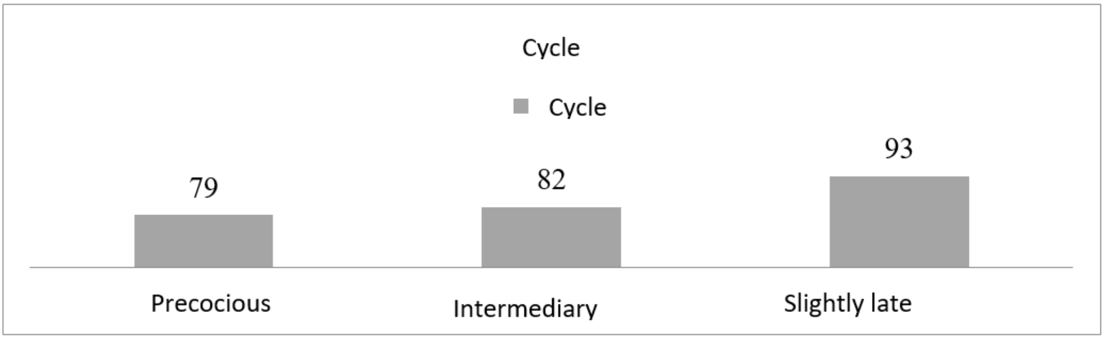
There are no genes for area productivity.

Most of the variables that breeders work with are controlled by many genes, productivity is greatly influenced by the environment (SILVA, 2009). Which means that it must be controlled and monitored, from implantation, even to create favorable conditions for the development of the culture in order to increase the productivity of the grains. As the results in Table 01 show, the promising Genotypes (Flattened, bela negra, gray bónus, Round, Round 1, Round 2) stand out with high data in relation to the controls (Catarina, diacol calima, semoc 1) in all variables described above. In general,

Figure 1: Seed samples (material used in the advanced assay).

Genotype	Green beans/plant	Grains/Green beans	P100 grains (g)	Performance (kg*há$^{-1}$)
Flattened	8	4	41	868
Bela Negra	9	4	34	693
Gray bonus	7	4	44	789
Round	7	2	31	296
Round 1	6	3	34	388
Round 2	7	4	42	633
Semoc 1	5	3	27	229
Catarina	5	3	37	312
Diacol calima	5	2	30	205

Table 1: Performance and its components, of the promising Genotypes identified in the preliminary trial.



Graph 1: Graph of Genotypes as a function of Cycle.

the preliminary test aimed to identify the best promising Genotypes in the period from August to October 2016 for further selection in the advanced Performance test from March to May 2017.

ADVANCED TEST

In the second phase of the trial established in the period March - May 2017, nine Genotypes were sown. As for emergence and Flowering, there were no significant differences between the Genotypes (Pr=0.7317) and Flowering (Pr=0.2424), with an average of 7 and 31 days, respectively. There was a significant effect for Harvest (Pr=0.0191) and a highly significant effect for Cycle (P=0.0003), with an average of 54 and 82 days, respectively. Gray Bonus, Round, Round 1, Round 2, Flattened and catarina were the early Genotypes and bela negra, semoc 1 and diacol calima, slightly late, as shown in Graph 1.

Breeding programs have given emphasis to varieties with a short and slightly late cycle: around 80 to 90 days (BERTOLDO, 2011), which reduces production costs. The reduction of costs favors small producers, since beans are cultivated, mainly for subsistence in a rainfed regime, hence short Cycle varieties can be recommended for sowing in the months of February, March and April, which is the period of maximum rainfall (according to rainfall data from IIAM-Maniquenique).

STATISTICAL ANALYSIS OF PERFORMANCE COMPONENTS INTERPRETATION OF RESULTS

Table 3 below shows the analysis of variance, mean squares for Performance and its components.

The experimental results showed that there was a highly significant effect between the genotypes regarding the number of Green beans/plant (Pr=0.0011), grains/Green beans (Pr=0.0000), P100 grains (Pr=0.0062) and significant regarding the Performance (Pr= 0.0170), by the F test. The coefficients of variation are considered low, when less than 10%, medium, when from 10 to 20%, high, when from 20 to 30%, very high, when greater than 30% (Gomes, nineteen ninety). In this experiment, the coefficient of variation was low for the variable grains/Green beans, medium for the variable mass of 100 grains and high for the number of Green beans/plant and Performance (Table 3).

The coefficient of variation of Green beans/plant was high possibly due to the genetic diversity of the genotypes tested (treatments), that is, genotypes such as bela negra and semoc, have an average of 44 Green beans/plant while genotypes such as Flattened, diacol calima and Round 2, have about 20 Green beans/plant (almost half).

EVALUATION OF THE NUMBER OF GREEN BEANS/PLANT IN THE TWO EXPERIMENTAL PHASES

In the advanced assay, there was a highly significant difference between the genotypes in terms of the number of Green beans/plant, with the genotypes bela negra and semoc 1 being the ones with the highest number of Green beans/plant (44 Green beans), figure 3. Sowing in the Marco period favored greater number of Green beans/plant. According to Freitas (2015), the Green beans/plant variable positively influences yield. Hence, higher grain yield is expected in the genotypes bela negra and semoc 1. Martins (2017), states that the number of Green beans is greatly influenced by the environment and is also dependent on the number of flowers produced by the plant and the floral setting, or that is, the proportion of flowers that give rise to Green beans.

The results showed that, under unfavorable conditions, the number of Green beans/plant of the genotypes is greatly affected by the

Genotype	Emergency (days)	Flowering (days)	Harvest (days)	Cycle (days)
Flattened	7a	31a	54ab	78ab
Round	6a	30a	54ab	77a
Round 1	7a	33a	53ab	79ab
Round 2	7a	30a	55b	78ab
Gray bonus	7a	30a	55b	78ab
Bela negra	6a	30a	56b	93bc
Catarina	6a	30a	55b	78ab
Diacol calima	8a	33a	50a	90c
Semoc 1	8a	29a	54ab	90c
Average	**7**	**31**	**54**	**82**

Means followed by the same letter in the column do not differ statistically from each other, using the Tukey test at a 5% significance level. Means followed by different letters in the column differ statistically from each other, using the Tukey test at a 5% significance level. Higher averages are represented by letters in descending order.

Table 2: mean values (days) of emergence, Flowering, Harvest and Cycle of the promising Genotypes

		QM			
FV	**GL**	Green beans/plant	Grains/Green beans	P100 (Kg)	Performance (kg*há$^{-1}$)
Block	2	26.70	0.04	0.0002	9709.26
Genotype	8	268.45**	0.84**	0.0003* *	2201982.49*
Mistake	16	43.71	0.08	0.00001	640785.77
CV (%)		23.05	8.81	15.93	26.26
General average		28.70	3.19	0.05	3047.83

* Significant at the 5% probability level by the F test, **highly significant at the 1% probability level by the F test, CV% - coefficient of variation, GL - degrees of freedom, FV - source of variation, QM - mean squares.

Table 3: Analysis of Variance: mean squares for Performance and its components.

Genotype	Green beans/plant	Grains/Green beans	P100 grains (Kg)	Performance (kg*há$^{-1}$)
Flattened	22ª	3bc	0.05abc	2417ab
Round	30ab	4c	0.04ª	3333ab
Round 1	26ab	4c	0.05ab	2958ab
Round 2	21ª	3ab	0.07bc	2500ab
Gray bonus	24ª	3ab	0.06abc	2792ab
Bela negra	44b	3ab	0.06abc	4292b
Catarina	30ab	2a	0.07c	3250ab
Diacol calima	18ª	3ab	0.05abc	1639ª
Semoc 1	44b	3ab	0.05abc	4250b
Average	28	3	0.06	3047.8

Means followed by the same letter in the column do not differ statistically from each other, using the Tukey test at a 5% significance level. Means followed by different letters in the column differ statistically from each other, using the Tukey test at a 5% significance level. Higher averages are represented by letters in descending order.

Table 4: Average performance values and their components, of different common bean genotypes

environment, especially the control varieties (Catarina, diacol calima and semoc 1). Bela Negra and Semoc 1 were the genotypes that reacted very positively to the environment, under favorable conditions.

EVALUATION OF THE NUMBER OF GRAINS/GREEN BEANS IN THE TWO EXPERIMENTAL PHASES

In general, there were an average of 3 grains/Green beans, and the genotypes, round, round 1 and bela negra were the ones that registered the highest number of grains (4 grains/Green beans) Graph 3. In relation to 2016, there was no great variation in the number of grain/Green beans, which is assumed that this component was little affected by the environment. On the other hand, the diacol calima, round and round 1 genotypes responded positively to favorable conditions, unlike the remaining genotypes. The variables number of Green beans per plant and number of grains per Green beans are not positively correlated (FREITAS, 2015). Bela negra and semoc 1 that showed a positive reaction in the fresh season, for the number of Green beans, showed a lower number of grains per Green beans, it can be said that the greater the number of Green beans, the lower the number of seeds/Green beans.

EVALUATION OF THE WEIGHT OF 100 GRAINS (G) IN THE TWO EXPERIMENTAL PHASES

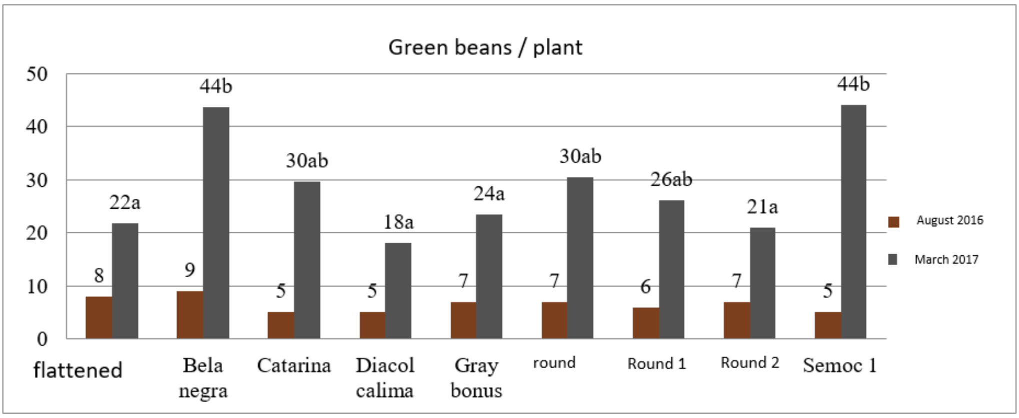
On average, the weight of 100 seeds was 60 grams, the genotypes, catarina and ronda 2, presented higher grain weight, Graph 4. The results showed that favorable environments result in higher grain weight. Catarina and Round 2 obtained almost twice the grain weight in favorable environments. Small-grain genotypes in this set were less affected by environmental fluctuations, as was the case with Round.

PERFORMANCE (KG*HÁ$^{-1}$) IN THE TWO EXPERIMENTAL PHASES

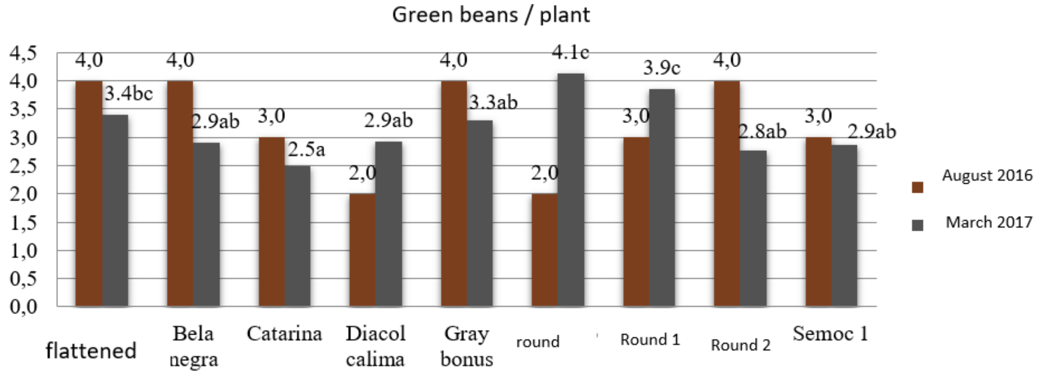
The average yield of the trial was 3047 kg*ha-1, much higher than the national yield of the common bean crop in Mozambique, which demonstrates the enormous potential of this crop in this study region. Bela negra and semoc 1 were identified as the best genotypes with a yield of 4292 and 4250 kg*ha-1, respectively (Graph 5). The sowing time of the advanced test favored better productivity results, as was the case of the positive response of the genotypes tested. Bela Negra and Semoc 1 that reacted very positively in terms of productivity under favorable conditions. But under adverse conditions, that is, in the period of the preliminary test, Semoc 1 decreased, while Bela negra shows a certain mechanism of survival to adverse conditions. This means that in late sowings it will be better to use the bela negra genotype.

Higher productivity is the main objective of virtually all plant breeding programs, where a new variety is only launched on the market when it has higher productivity than those already being used by farmers (BERTOLDO, 2011). However, there are other factors in determining the choice of a genotype. Bela Negra and Semoc 1 showed an indeterminate growth habit – climber, hence the intercropping and family sector can be indicated for these genotypes. The genotypes, round, round 1, round 2, flattened, catarina, gray bonus showed the determined type of growth.

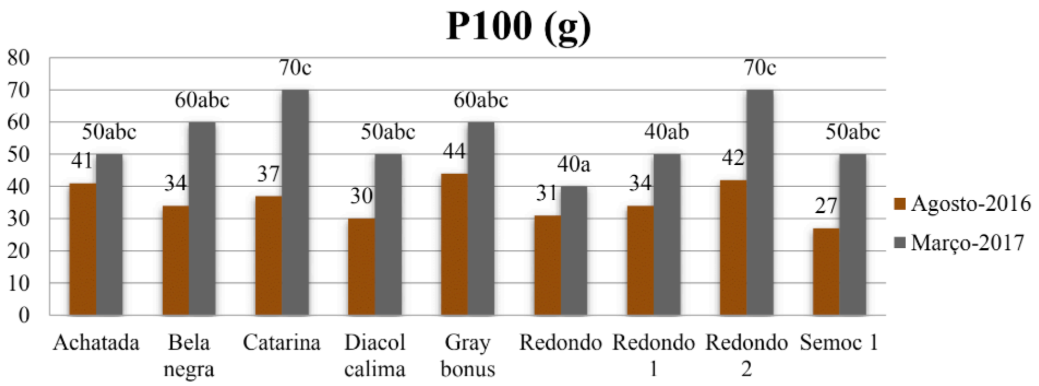
The genotypes, round, round 1, round 2, flat and gray bonus show uniform maturation, senescence and fall of all leaves after maturation, characteristic that facilitates mechanized harvesting and threshing, hence they can be recommended for commercial agriculture. They have thick Green beans that prevent soil moisture from coming into contact with the grain at maturation, thus



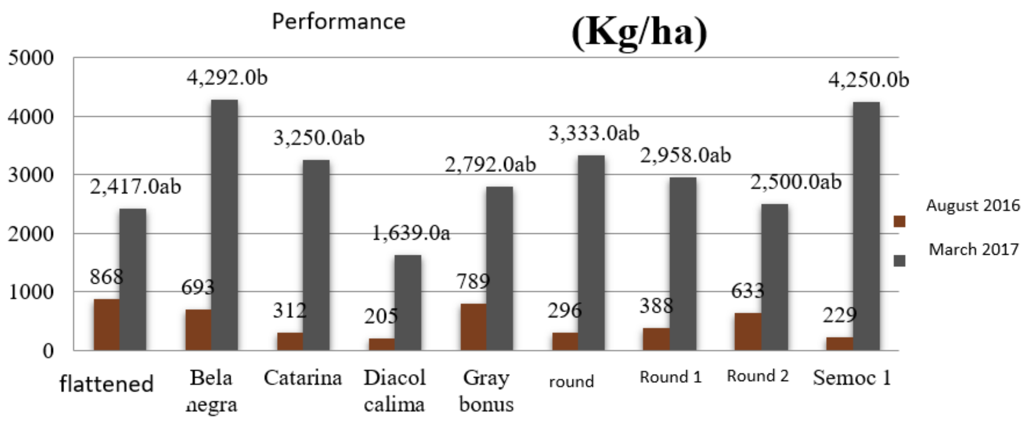
Graph 2: Graph evaluation of the number of Green beans/plant in the two experimental phases.



Graph 3: Graph of the evaluation of the number of beans/Green beans in the two experimental phases.



Graph 4: Graph of the evaluation of the Weight of 100 grains (g) in the two experimental phases.



Graph 5: Graph of income (kg*há$^{-1}$) in the two experimental phases.

Variables	Green beans/plant	Grain/Green beans	**P100 grains**	**Performance**
Green beans/plant		-0.14525	-0.07388	0.96880
Bean/Green beans			-0.76488	-0.06697
P100 grains				0.00166
Performance				

Table 5: Correlation between Yield and its Components.

preventing stains on the grain. Although semoc 1 presented higher yield, the grains after harvest showed a lot of impurity: deformed grains and after separation clean grain the yield decreases. For traders, a greater quantity of impurity implies lowering the price of the same, constituting breaks.

CORRELATION BETWEEN YIELD AND ITS COMPONENTS

Correlation analysis is an important tool in plant genetic improvement, since some traits can be selected indirectly, by selecting a trait positively or negatively correlated with it (BERTOLDO, 2011). Table 5 shows that the number of Green beans/plant showed a high positive correlation with the yield, the weight of 100 grains showed a high negative correlation with the number of grains/Green beans. It was observed by Bertoldo (2011), the grain yield that was positively correlated with the number of Green beans/plant, with significant values. In studies by Freitas (2015), grain yield was significantly associated with the number of Green beans/plant and it is understood with this result that the increase in grain yield is a consequence of the increase in the number of Green beans/plant.

The genotypes identified as promising in this study were bela negra and semoc 1, out of a total of 9. As can be seen in graphs 2 and 5, these two genotypes are the ones with the highest number of Green beans/plant and yield/hectare, confirming once again the strong correlation between these two variables.

CONCLUSIONS

Based on the analysis of yield and its components, from research conducted in the Limpopo valley, which aimed to develop common bean varieties (*Phaseolus vulgaris L.*) from local genotypes, the null hypothesis is rejected at a significance level of 5%, since the genotypes are genetically different, so it can be concluded that: the number of Green beans per bean plant (*Phaseolus vulgaris L.)* was one of the main components of grain yield with a significant contribution. The promising genotypes identified for the advanced assay were: flat, round, round 1, round 2, bela negra, gray bónus, Catarina, diacol calima and semoc 1. The promising genotypes selected for the region were bela negra and semoc 1 for cultivation. in the family sector, round 2 for cultivation commercial agriculture.

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