



Agro-Morphological Performances of Common Bean Varieties (*Phaseolus vulgaris. L*) Introduced in the Central African Republic

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2021/v33i2330712

Editor(s):

(1) Dr. Sangita Sahni, Dr. Rajendra Prasad Central Agricultural University, India.

Reviewers:

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(3) Harish G. Entomology, ICAR-Directorate of Groundnut Research, India.

Complete Peer review History: <https://www.sdiarticle4.com/review-history/74524>

Original Research Article

Received 01 August 2021
Accepted 11 October 2021
Published 09 November 2021

ABSTRACT

The common bean (*Phaseolus vulgaris* L.) is one of the main legumes produced and consumed in the Central African Republic (CAR). But in CAR, the common bean production is constrained by certain biotic and abiotic stress which severely impacts the quantity and quality available in the value chain. To compensate this loss of the production, the Central African Institute for Agronomic Research (ICRA) had introduced in CAR ten varieties of common bean from Rwanda and Cameroon. A four-repeat randomized full-block device was used for testing the performances of these ten varieties of common bean. The measured variables were the vegetative growth, the

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production, and the sensibility to plant diseases. Overall, the different varieties exhibited a high germination rate (88.6%). The highest rate is observed in variety RWR2245 from Rwanda (100%). Varieties from Rwanda, RWR3194 with 1000 kg ha⁻¹ and BOA5M1-6 with 916.66 kg ha⁻¹ gave better yields followed by varieties Ecapan 025 from Cameroon with 833.33 kg ha⁻¹ and RWR2245 with 833.33 kg ha⁻¹. The yields obtained are roughly referred to the agronomical standard. The varieties NITOU and NUA566 from Rwanda were more susceptible to disease incidence and pest attacks compared to those from Cameroon.

Keywords: Agro-morphological; performances; Common bean; Central African Republic.

1. INTRODUCTION

The Common bean (*Phaseolus vulgaris* L.) is legume crop native to Central and South America [1]. It provides essential micronutrients lacking in the diets of millions of persons in Sub-Sahara region, where populations are generally poor [2,3].

The Common bean is important source of inexpensive vitamins and proteins in the diet of many people in tropical countries, pulses are a good complement to food rich in carbohydrates such as grains, tubers and roots [4,5]. Its high protein content [6,7] places it among the most important food crops for the populations of the various southern countries dominated by high altitude lands with little breeding potential [8]. Its production contributes to improving food security and farmers' incomes in certain southern countries and constitute food for domestic animals but also when they are buried in the soil allows fertilization [9,10].

In the CAR, the Common bean is cultivated, but it contributes to food security and income generation among the subsistence and semi-commercial farmers. However, among the factors limiting its production, there are abiotic constraints (climate, soil salinity and acidity) and biotic constraints (diseases and pests). These latter constraints, to which beans are very sensitive, are an important cause of low crop yields [11,12,13]. The use of good quality of seeds (resistant or tolerant to major diseases improves the productivity of the crop and contributes to the improvement of agricultural systems [14,15,16]. To compensate this loss of the production caused by biotic and abiotic stress in the common bean, the Central African Institute for Agronomic Research (ICRA) has signed the agreements for collaboration with research centers from Cameroon and Rwanda to introduce in CAR the varieties of common bean whose characteristics are shown in Table 1. Thus, the general objective of this work was to

assess the agro-morphological performances of the common bean varieties imported from Cameroon and Rwanda and cultivated in ICRA to improve the food security in the CAR.

2. MATERIAL AND METHODS

2.1 Experimental Site

The study was carried out on the site of ICRA in Begoua located northwest of Bangui the Capital country of CAR (altitude: 400 m, North latitude: 4 ° 26'30 " and East longitude: 18 ° 32'568 "). Begoua enjoys a Sudanese- Guinean climate with high rainfall observed during the months of July, August and September with an amplitude of 1,600 to 1,800 mm of water per year. Begoua is located shrub savannah with a forest gallery all along the watercourses, precisely towards the north-west of the said municipality [17]. The soil of Begoua is reddish with laterite of the ferralitic type and a blackish part. The nature of the soil is sandy clay of the ferralitic type, moderately or strongly denatured, and lithosols whose structures favor certain crops such as peanuts, maize and cassava, highly prized by the population [18].

The General Direction of ICRA is located in Begoua and own the plots for adaptability tests of imported varieties before extension to local producers.

2.2 Experimental Material

The test of agro-morphological performance is carried out on ten (10) varieties of common bean from Cameroon (04 varieties) and Rwanda (06 varieties). The Characteristics of varieties of common bean are shown in Table 1.

2.3 Experimental Layout

The trial was done during the second period of season of crop (June-July 2019). Four randomized complete block design (RCBD) was

deployed for this research trial with 4 replications [19]. The elementary plot had an area of 6m² or (3 m X 2 m). Each block was separated from the next by a distance of 1m and in each block, each sub-plot was separated by 0.5m from the next. The seeds were sown at spacings of 0.40 m X 0.20 m with two seeds per pocket (density: 150 plants / plot) on a site which has not received the cultivation of a legume during the last five years.

In order to control weeds, two ridging were carried out on the plots. The second ridging was followed by the application of Cypercal 12 insecticide (rate: 50 ml /16 liters). The application of NPK 20-10-10 fertilizer was made during the first flowering.

The observation was carried out every week on 30 plants for each variety in the each randomized complete block design. The measured parameters were:

- The germination rate (ER) and the number of seed (NS) were estimated by counting;
- The height of the plants (HP), and the leaf dimensions (blade length and width) were measured in the working plot on 30 plants at 14, 28, 42, and 60 days after sowing using a tape measure. Measurements are estimated in cm and

height was measured from the plant collar to the last bud.

- The diameter at collet (Diam) was measured on ten/30 feet of beans per variety using a caliper;
- The weight of the pods and seeds was evaluated in g and then converted into Kg after the harvest through the weighing of 100 seeds with an electronic scale;
- The yield / vine (kg/hectare) was calculated for each variety after harvest;
- Disease incidence was determined by the following formula [20]

$$I(\%) = \frac{\text{Number of diseased Plants}}{\text{Number of Total Plants}} \times 100$$

2.4 Data Analysis

Data analysis (germination rate; number of seeds; height of the plants; diameter at collet; yield / vine) was carried out one-way analysis of variance (ANOVA) using R software version 3.1.3. The Shapiro-Wilk test was used to verify the normality of the data and the various tests are validated at the 5% threshold. The graphics were generated using Excel software.

Table 1. Characteristics of the different varieties of common bean imported from Cameroon and Rwanda

Varieties	Port	Cycle	Yield (kg/ha)	Seed color	Seed form	Origin
COTONOU	Erect	60-80 days	600-800	Red speckled with white	Spherical	Cameroon
ECAPAN 025	Erect	60-80 days	600-800	Red speckled with white	Spherical	Cameroon
GLP 190	Erect	60-80 days	800-1000	Brown	Oval	Cameroon
NITOU	Erect	60-80 days	600-800	Red speckled with white	Spherical	Cameroon
RWR3194	Erect	75-90 days	800-1200	Red speckled with white	Oval	Rwanda
RWR2245	Erect	75-90 days	800-1200	Red speckled with white	Oval	Rwanda
RWR2154	Erect	75-90 days	800-1500	Beige speckled with white	Oval	Rwanda
KAB 06 F2-8-27	Erect	75-90 days	800-1200	Red speckled with white	Oval	Rwanda
BOA 5-1M6	intermediate	90-120days	800-1200	Light red	Oval	Rwanda
NUA566	Erect	75-90days	800-1500	Red	Ovale	Rwanda

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Germination rate

The results of analysis of variance (ANOVA) of the germination rate show that there is significant difference (P-value = 0.00163) between the different varieties common bean. The RWR2245 variety from Rwanda has the best emergence rate (100%) while the lowest rate is observed in the NITOU variety from Cameroon with 59%. The other varieties have emergence rates between 77% to 97% (Fig. 1).

3.1.2 The height of the plants diameter at collet

The variety NUA566 has the largest diameter (1.9 mm) while the variety GLP190 variety from Cameroon has the smallest diameter (1.3 mm). According to statistical analysis, there is

significant difference (p-value = 5.125e-10) on diameter of varieties of common bean.

The significant difference (P-value = 2.260e-9) is observed on height of plants. The variety GLP190 with 62 cm has a high height, followed by RWRW2154 (60 cm) and RWR3194 with 55 cm. The varieties KAB06F2-8-27, ECAPAN 025 and RWR3194 with 55 cm, show the same height while the lowest heights (10 cm) are observed on the varieties RWRW2154, BOAS-1M6 and ECAPAN 025 (Fig. 2).

3.1.3 Number and size of sheets

Analysis of Fig. 3 reveals that the variety KAB06 F2-8-27 develops a large number of leaves, 36 on average, followed by NITOU (30), and GLP190 with 30 leaves. The varieties BOA5-1M6 and RW3194 with 11 and 10 leaves respectively have fewer leaves (Fig. 3). The analysis of variance reveals a significant difference between the number of leaves of each variety (P = 0.0000).

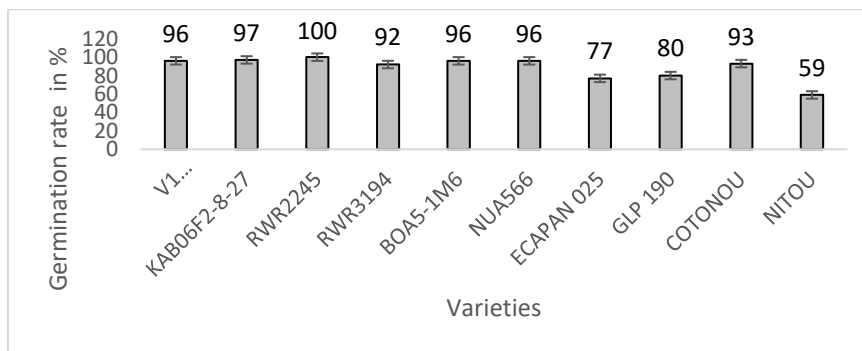


Fig. 1. The germination rates of the varieties

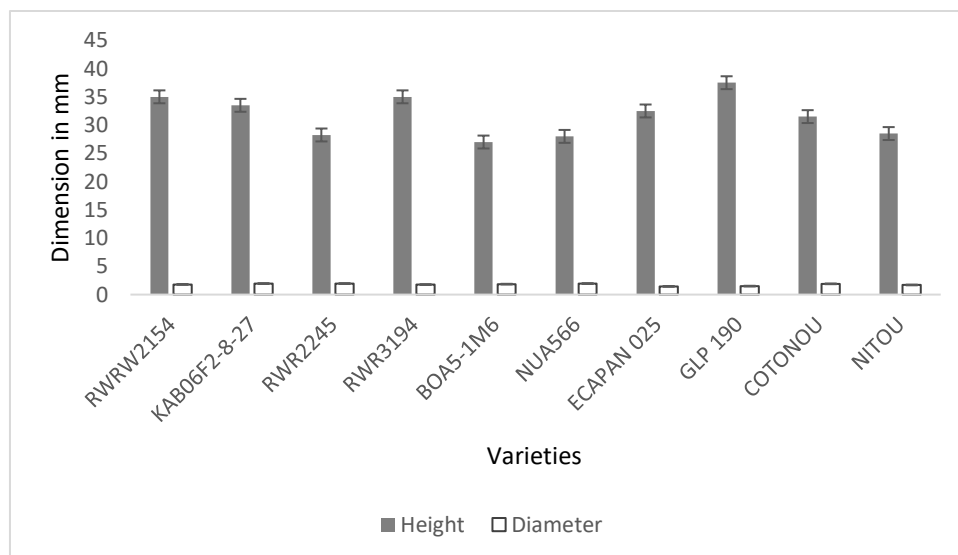


Fig. 2. Height and diameter of the different varieties of bean

Regarding the width of the leaf blade, the varieties ECAPAN025 (9 cm), BOA5-1M6 (8.8 cm) and COTONOU (8.6 cm) have wider leaf blades, while the varieties RWR2245 and RWR3194 with 6.9 cm have narrower blades. The statistical analysis carried out with regard to the width of the leaves reveals a significant difference between the different varieties ($P= 0.00000$).

The figure below shows that the variety RWRW2154 (11.51 cm) has longer leaf blades, followed by KABO6F2-8-27 with 10.75 cm. The variety NITOU with 10.5 cm has the lowest blade length. The difference observed between the different varieties is significant ($P=0.00000$).

3.1.4 Pod and seed weight

According to the performed analysis of variance, the observed difference is in general significant ($P\text{-value} = 0.03847$). For the 100 seeds from the different varieties of common bean, the RWR3194 (0.08 kg), BOA5-1M6 (0.06 g) and RWR2245 (0.05 g) have heavier seeds (Fig. 4).

For the 10 pods of the different tested varieties, the BOA5-1M6 variety with 0.018 kg weighs more than the others. It is followed by RWR3194 (0.017kg), RWR2245 (0.016 kg) and NUA 566 (0.016 kg). The COTONOU, RWR 2154 and NITU varieties have intermediate values, while the lowest weights are seen from ECAPAN025, GLP190 and BOAF2-8-27 varieties. The analysis

of variance carried out on the weight of pod attests that there is a significant difference according to the different varieties on common bean ($P\text{-value} = 2.768 e^{-9}$).

3.1.5 Seed yield

The obtained yields (kg / ha) from ten varieties of common beans showed that there is variability between the different values. The variety RWR3194 (1000 kg / ha) has the best yield, following by the varieties BOA5M1-6 (916.66 kg / ha), Ecapan 025 (833.33 kg / ha) and RWR2245 (833.33 kg / ha). The lowest yield is observed in variety RWR2154 (650 kg / ha). The yields from five varieties (KAB 06F2-8-27, NUA566, GLP190, NITOU and COTONOU) were less than 800 kg / ha (Fig. 5). The observed difference is significant ($P\text{-value} = 0.02447$).

3.1.6 Incidence of diseases on common bean introduced from Rwanda and Cameroon

The Fig. 6 shows the proportions of diseased on the experimented plants. The highest incidence is observed in the variety KAB 06F2-8-27 followed by NITOU and NUA566. The difference is significant ($P\text{-value} = 0.01479$). Variety RWR3194 from Rwanda and Cotonou from Cameroon were not influenced by pests and disease (Anthracnose, damping off, bean rust and gray rot). Varieties from Rwanda are the most susceptible to disease compared to those from Cameroon (Fig. 6).

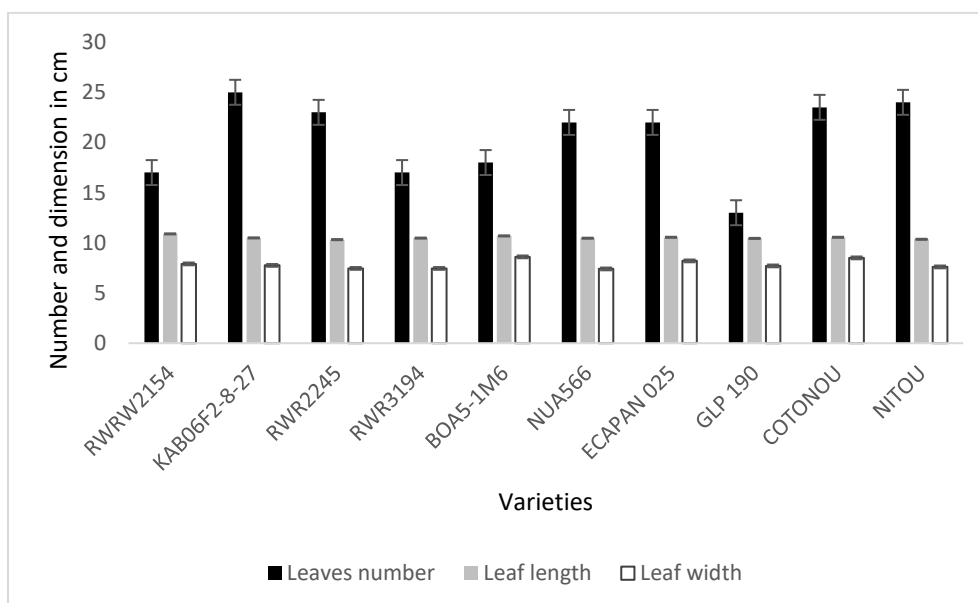


Fig. 3. Number and size of leaves of the different varieties of common bean

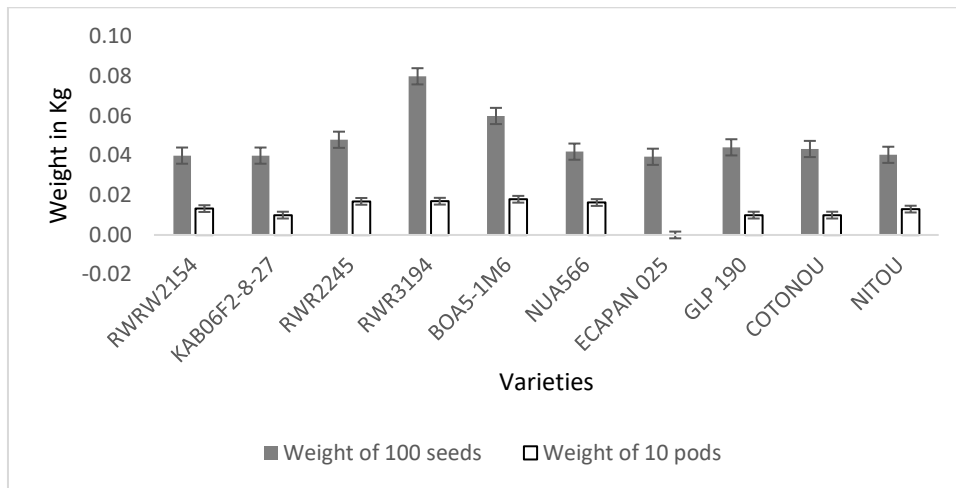


Fig. 4. Weight of 100 seeds of the different varieties of common bean

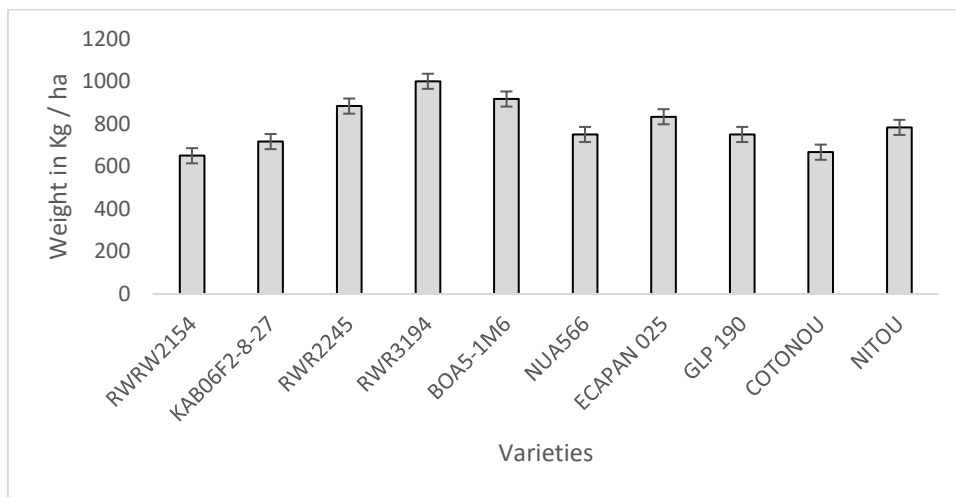


Fig. 5. Seed yield kg / ha of the different varieties of common bean

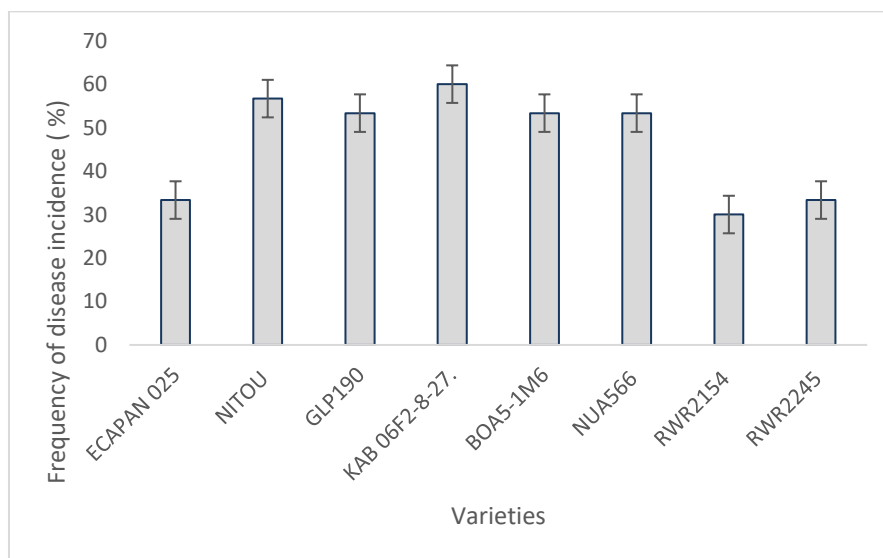


Fig. 6. Frequency of disease incidence

3.2 Discussion

The results of the germination test show that the different varieties of imported common bean overall exhibited a high germination rate (88.6%). The highest rate is obtained with the variety RWR2245 from Rwanda with a percentage of 100. The results obtained on the germination test in the Democratic Republic of Congo and Madagascar by Mufind et al. and Allen, [8,21] show the germination rate between 64% to 81%. The difference between the seed germination rate is very strongly linked to the individual performance of the different varieties, but also to the seed storage conditions as well as to the conditions of the study environment Casinga et al. [1], INERA, [22]. Also, differences in germination power may be related to differences in germination energy and physiological maturity Tayeb [23].

There is a variability on the measured growth parameters according to the different varieties. The variety NUA566 from Rwanda has a better diameter at the crown. The variety BOA5-1M6 (10.53 cm) which has wider leaves with the largest dimensions. The variety KAB 06F2-8-27 (25) has a greater number of leaves. The statistical analysis carried out on this parameter shows that there is a significant difference between the different varieties ($P = 0.00000$). The results are similar to those obtained by Nyabyenda et al. [24] with an average number of 26 leaves.

The evaluation of yield parameters (the weight of 100 seeds, the weight of 10 pods, the weight of seeds in kg, the weight of seeds in kg / ha) shows a highly significant difference between the different values. Rwanda variety RWR3194 (1000 kg.ha⁻¹) and BOA5M1-6 (916.66kg / ha) gave better yields followed by the varieties Ecapan 025 (833.33 kg / ha) and RWR2245 (833.33 kg / ha). The lowest yield is observed from the variety RWR2154 (650 kg / ha). The four more productive varieties (RWR3194, BOA5M1-6, RWR 2245 and Ecapan025) show average yields comparable to those cited by Carburet et Hekimian [25]. The other five varieties (KAB 06F2-8-27, NUA566, GLP190, NITOU and COTONOU) gave a yield of less than 800kg / ha. These values are slightly higher than those obtained by Mufind et al. [8], et Baudoin et al. [9]. According to Ravelombola [26], yield results from all the growth and development processes are influenced by different pedoclimatic and biological factors. The variation

in yield observed would be due to the genetic heritage of the different varieties by favoring or disadvantaging one or the other variety in the pedoclimatic conditions of the environment. This observation was also made by Casinga et al. [1], who not only demonstrated that different genotypes could induce highly significant differences in yield but also, the yield of the same genotype was significantly influenced by the environment and even the different sowing dates.

Some symptoms (Anthracnose, damping off, bean rust and grey rot) were observed during a cycle of development (vegetative growth, flowering, fruiting, and maturity). The varieties of common bean from Rwanda were susceptible to attack of natural pests than the varieties from Cameroon. The variety NUA566 was very susceptible to anthracnose, grey rot and pest attack. Similar results were obtained by Schafer et al. [15] in Cameroon who also attests that the disease infestation becomes more and more important to the maturity of common bean.

4. CONCLUSION

The test of agro-morphological performance was carried on ten (10) varieties of common bean from Cameroon (04 varieties) and Rwanda (06 varieties). The different parameters were measured (germination rate; number of sheets; height of the plants; diameter at collet; yield / vine). The RWR2245 variety from Rwanda had the best emergence rate (100%) while the lowest rate was observed in the NITOU variety from Cameroon with 59%. The variety NUA566 from Rwanda had the largest diameter (1.9 mm) than GLP190 variety from Cameroon with the smallest diameter (1.3 mm). The GLP190 variety exhibited a significant height, followed by RWR2154 and RWR2245. The variety KAB06 F2-8-27 developed a large number of leaves (9), followed by NITOU (8), COTONOU, GLP190 and RWR2245. Varieties NUA566, ECAPAN 025 and RWR2154 had more leaves than variety RWR3154 with a very low number. The RWR3194 (0.08 kg), BOA5-1M6 (0.06 g) and RWR2245 (0.05 g) had heavier seeds. The variety RWR3194 (1000 kg / ha) had the best yield, followed by the varieties BOA5M1-6 (916.66 kg / ha), Ecapan 025 (833.33 kg / ha) and RWR2245 (833.33 kg / ha). The lowest yield was observed in variety RWR2154 (650 kg / ha).

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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