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Field Evaluation of Six Newly Introduced Soybean Varieties in the National Pulses Program Germplasm, Kongo Central Province

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AKDM and KKK designed the study and coordinated field activities. Authors FNK and JMM, compiled literature review, collected experiment data and wrote the first manuscript. Authors ANN and LTL carried out statistical analyzes and corrected the first manuscript. Authors MMM and AKM corrected the final manuscript. All authors have read and approved the final version of manuscript.

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ABSTRACT

Aim: To evaluate the behavior of soybean varieties recently introduced in germplasm of National Pulses Program of National Institute for Agricultural Study and Research.
Study Design: The study was conducted using a randomized complete block design (RCBD) with six treatments replicated three times.
Place and Duration of the Study: The experiment was carried out at the Lieutenant-Colonel EBEYA Military Camp, precisely in the POUDRIERE site in LOMA district from April 14 to June 17, 2023.
Methodology: The study was conducted with six soybean varieties replicated three times. Data collected concerned percentage of seedlings emerged, vegetative development and production parameters.
Results: The emerged plants rate varies from 82.6 to 90%, collar diameter from 4.3 to 6.4mm, and plant height from 27.9 to 51.3 cm. The leaflet number per plant varies from 18.3 to 32, while their length and width varied from 6 to 9.4cm, and from 10.5 to 17.7cm, respectively. On each plant, the number of branches bearing pods varied from 3.6 to 5. The number of pods and seed per plant varied from 18 to 37, and from 34.3 to 68, respectively. Overall, soybean varieties flowered on 34.4 to 68 DAS. The 100-seed weight varied from 8 to 15.3g, and yield obtained from 572.9 to 2,203kg/ha.
Conclusion: Overall, the results of this study indicate that vegetative development and production parameters vary among varieties. This variability in behavior results from the interactions between intrinsic properties of each soybean variety and agroenvironmental conditions of experimental field. The yields obtained were lower than the global average. However, variety TGM 0169 considered late, had high emerged plants rate (90%), and yielded more than 2t/ha, which is far higher than the average recorded in the majority of Sub-Saharan African countries. Ultimately, TGM 0162 appeared as elite variety whatever parameter considered.

Keywords: Soybean; morphologic; agronomic; performance; assessment; mbanza-ngungu; Kongo central province.

1. INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] is a multifunctional oil-protein plant that has many qualities. It is currently the most important source of vegetable oil in the world and the most excellent source of protein for human and animal nutrition [1,2]. On an industrial level, the processing of soy lends itself to multiple uses such as oilcake, flour, milk, yogurt, creams and derived products [3]. Soybean is also known to improve the physical, chemical and biological soil properties [4]. The protein content of its seeds can reach 50% in certain varieties, while black beans have 25 to 28%. It is also rich in oil, vitamins and mineral elements [5-7].

Soybean production is estimated at over 330 million tons per year with an increase of almost 5% each year. The United States and China alone produce 92% of global soybean production, Europe (2%), Oceania (0.02%), and Africa (less than 1%) [8]. The soybean yield varies depending on region and variety [9]. For example, in Madagascar, the yield is 539.5 kg/ha, while it can reach 1.1 t/ha in Nigeria. In the Democratic Republic of Congo (DRC), soybean yield can vary from 780 to 1,000 kg/ha.

According to Karaboneye [9], in Africa, soybean remained a marginal crop for a long time, and it was not until 1967 that International Institute of Tropical Agriculture (IITA) made soybean research and the popularization of knowledge of this crop a priority. At IITA, African soybean lines improvement began in 1970, which led to an increase in production of this crop in some African countries. This is the case of Nigeria where production increased from 60,000 tons in 1985 to 285,050 tons in 2010 [8]. Research work carried out at IITA has developed several varieties, some of which have been the subject of multi-local trials, while others have not yet been tested.

It is in this context that the present study takes place, which pits six soybean varieties recently introduced in National Pulses Program germplasm at Institut National pour l'Etude et la Recherche Agronomiques (INERA), Mvuazi research station. This study aims to analyze the morphologic and agronomic parameters of these soybean varieties under agroecological conditions of Mbanza-Ngungu region. Specifically, it involves evaluating the behavior of these recently introduced soybean varieties, and multiplying in a certain way the quantity of their seeds that can be distributed to small agricultural producers.

2. MATERIALS AND METHODS

2.1 Presentation of Experimental Site

Experimental site was located within the Lieutenant-Colonel EBEYA Military Camp, precisely in the POUDRIERE site in LOMA district. The geographic coordinates of the experimental recorded using a Garmin GPS indicated 14°52'56" East longitude, 5°14'55" South latitude, and 591m of altitude. Generally, Mbanza-Ngungu region is dominated by savannah; the experimental field was characterized by grasses dominated by *Imperata cylindrica*. According to Köppen classification, the climate of MBANZA-NGUNGU is Aw4 type. It is a humid tropical climate characterized by the alternation of two seasons: a rainy season of 8 months, and a dry season of 4 months. The daily temperature varies between 15.4 to 20.8°C during the dry season, and between 24.6 to 25.7°C during the rainy season. The average rainfall varies from 1,300 to 1,500 mm. In general, MBANZA-NGUNGU soils have quite variable textures, ranging from coarse (silty sands) to fine (clays), and are acidic and deficient in nitrogen because of their low level of organic matter. Our experimental field soil was characterized by a sandy-clayey texture.

2.2 Plant Material Used

In this study, six soybean (*Glycine max*) varieties were used. These include: VUANGI, TGM0454-1, TGM0260, TGM0169, TGM0376, and TGM0776. The VUANGI variety served as control. Seeds of all varieties were obtained at National Pulses Program of INERA/Mvuazi Research Center. Main characteristics of soybean varieties used are presented in Table 2.

2.3 Setting Up the Experiment

The trial was conducted from April 14th to June 17th, 2023 using a randomized complete bloc design (RCBD) with six treatments replicated tree times. The experimental field measured 13.5m in length and 7m in width, which correspond to an area of 94.5m^2. The distance between two blocks was 50cm, and each elementary plot had 2m in length and 2m in width. In the block, the distance between two neighboring plots was 30cm. Sowing was done manually at a depth of ± 2-3cm with 2 seeds per pocket, at spacings of 40cm x 20cm. Each experimental plot contained 5 lines of 10 pockets. During experimental period, two weedings were carried out. The first was carried out 24 days after sowing (DAS), and the second was carried out 41 DAS.

2.4 Parameters Observed and Statistical Data Analysis

In this study, parameters observed concerned morphologic and agronomic traits. After noting the seed emergence rate, morphological parameters observed were collar diameter, plant height, number of leaves per plant, leaflet length and width, and number of branches per plant. Agronomic parameters concerned number of days to flowering 50%, number of pods per plant, number of seeds per plant, weight of 100 seeds, and seed yield. All observations were made on fifteen plants located in three central lines in the useful plot according to Naab et al. [10]. Data collected were submitted to analysis of variance (ANOVA) to compare means between soybean varieties. When a significant difference was revealed between varieties, the ANOVA was completed by the least significant difference text

at the 5% of probability threshold. Statistical analysis was carried out using Statistix (version 8.0).

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Plant parameters

The results relating to the plants emerged, collar diameter and plant height are presented in Table 1. Analysis of the results in Table 1 indicates that the highest emergence rate was recorded in the variety TGM 0169 (90%), while the lowest emergence rate (82.6%) was recorded in the TGM 0260 variety. The highest collar diameter (6.4mm) was noted in the TGM 0169 variety, while the lowest collar diameter (4.3mm) was observed in the TGM 0260 variety. The highest average plant height (51.3 cm) was recorded in the TGM 0169 variety, while the variety TGM 0260 had the lowest height (27.9cm) unlike the other varieties. Analysis of variance revealed significant differences between varieties only for plant height parameter.

3.1.2 Vegetative parameters

The results relating to the vegetative parameters recorded on the six soybean varieties are presented in Table 2. The results in Table 2 indicate significant differences between groundnut varieties for number of leaves per plant. The highest number of leaves par plant (32) was recorded on the TGM 0169 variety, while the lowest number of leaves par plant (18.3) was counted on the TGM 0260 variety. The highest leaflet length (9.4cm) was observed on the variety TGM 0169, while the lowest (6cm) was observed on the variety TGM 0260. The variety TGM 0260 presented the lowest leaflet width (10.5cm), while the highest (17.7cm) was recorded on the variety TGM 0169. The highest number of branches bearing pods (5) was recorded in the variety TGM 0169, while the lowest number of branches bearing pods (3.6) was noted on the variety TGM 0260.

3.1.3 Production parameters

Table 3 shows the results relating to the production parameters recorded on the 6 soybean varieties put into competition. The results relating to the production parameters reveal that there are significant differences between the treatments. The highest number of seeds per plant (68 gains per plant) was observed in the variety TGM 0169, while the lowest number of seeds (34.3 seeds per plant

Table 1. Plants emerged rate, collar diameter, and plant height recorded on the 6 soybean varieties

Variety	Emerged plants rate (%)	Collard diameter (mm)	Plant height (cm)
TGM 0169	90a	6.4a	51.3a
MVUANGI	89.3a	6.1a	48.5ab
TGM 0776	86a	6a	41ab
TGM 0376	84.6a	5.8a	36.8ab
TGM 0454-1	84a	4.6a	34.7ab
TGM 0260	82.6a	4.3a	27.9b

In each column, the means followed by the same alphabetical letter are not significantly different at the 5% probability level

Table 2. Number of leaves per plant, leaflet length, leaflet width, and number of branches per plant recorded on the 6 soybean varieties

Variety	Number of leaves per plant	Leaflet length (cm)	Leaflet width (mm)	Number of branches per plant
TGM 0169	32a	9.4a	17.7 a	5a
MVUANGI	27ab	8.4a	15.9a	4.6a
TGM 0776	26.3ab	6.7a	12.5a	4.3a
TGM 0376	21.3ab	6.7a	12.2a	4.3a
TGM 0454-1	20.3ab	6.4a	11.5a	4a
TGM 0260	18.3b	6a	10.5a	3.6a

In each column, the means followed by the same alphabetical letter are not significantly different at the 5% probability level

Table 3. Production parameters recorded on the 6 soybean varieties entered into competition

Variety	Number of seeds per plant	Number of pods per plant	Weight of 100 seeds per plant (g)	Number of days to 50% flowering	Yield (kg/ha)
TGM 0169	68a	37a	15.3c	68a	2,203.1b
MVUANGI	49a	34.3a	12c	49a	968.8b
TGM 0776	45.6a	26.6a	11.7c	45.6a	911.5b
TGM 0376	39.6a	22.6a	9b	39.6a	895.8b
TGM 0454-1	36.6a	20.3a	8a	36.6a	713.5a
TGM 0260	34.3a	18a	8b	34.3a	572.9b

In each column, the means followed by the same alphabetical letter are not significantly different at the 5% probability level

was recorded in the variety TGM 0260. The variety TGM 0260 had the lowest number of pods per plant (18), while variety TGM 0169 had the highest number of pods per plant (37). The variety TGM 0169 gave the greatest weight of 100 seeds (15.3 g), while the lowest weight of 100 seeds (8 g) was noted in the variety TGM 0260. The number of days to flowering high (68) was observed in the TGM 0169 variety, while the lowest (34.3) was noted in the TGM 0260 variety. The highest yield (2,203kg/ha) recorded was in the TGM 0169 variety, while the lowest yield (572.9 kg/ha) was noted in the TGM 0260 variety.

3.2 Discussion

The results of this study made it possible to note behavioral variability within the soybean varieties studied. The emergence rate varied from 82.6 to 90%, the diameter at the collar varied from 4.3 to 6.4mm, and the height from 27.9 to 51.3cm (Table 1). Our results are higher than those of Sané [11] who observed an emergence rate of less than 80% for the majority of soybean varieties in Senegal. According to this author, the low emergence rate can be explained by the excess water in the soil, the nature of the soil, and the attacks of pests which attack the sown seeds. In addition, Thomas et al. [12] point that excess water particularly affects soybean emergence. In this study, results obtained plant height varied among varieties. This corroborated data reported by Doré et al. [13] who observed that soybean plants can reached 30 to 150cm due to interaction between varieties used and fields conditions. The results on production parameters (Table 3) revealed that the majority of soybean varieties flower between 34.3 and 68 DAS. This demonstrates that there is variability in flowering time among soybean varieties. Our observation is similar to that of Sané [11] who noted in the Ziguinchor region significant differences regarding the flowering time of soybean varieties. Varieties that flower at 34 days are considered early, while those that flower after 45 days are late. In the present study, the TGM 0169 variety flowered 68 DAS, which makes it a later variety. This variability would be due to the inherent characteristics of the varieties and the environmental factors of the experimental plot [12,14].

The weight of 100 grains varied from 8 to 15.3g, and the yield varied from 572.9 to 2,203.1kg/ha (Table 3). Significant differences were observed between the soybean varieties studied. Our results are lower than those obtained by Nzoue et al. [3] who obtained weights of 100 seeds varying from 17 to 22.5g. Furthermore, in the Bukavu region, it was reported that the weight of 100 seeds varied from 14.5 to 27.9g. The differences observed in production parameters can be explained by low rainfall conditions that may occur at the start of the pod filling phase [11], which also impacts the quality of the seeds. The yields obtained in the present study revealed to be far lower than the world average which is 3,000kg/ha as indicated by IAEA [15]. In the absence of any pest attack, as well as drought, the low yields observed in this study can be explained by the genotypic qualities of the varieties used. For Vidal et al. [16] the low yields observed in soybeans may be due to pod abortions that occur periodically during the pod establishment and filling phase.

4. CONCLUSION

Overall, the results of this study indicate that vegetative development and production parameters vary among varieties. This variability in behavior results from the interactions between intrinsic properties of each soybean variety and

agroenvironmental conditions of experimental field. The yields obtained were lower than the global average. However, variety TGM 0169 considered late, had high emerged plants rate (90%), and yielded more than 2t/ha, which is far higher than the average recorded in the majority of sub-Saharan African countries. The soybean varieties used in this study have not yet been included in the DRC national catalog of crop varieties. It is therefore important that similar studies are carried out in different agroenvironmental field conditions and cultural seasons in order to compare their potential production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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