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Field Assessment of Some Agronomic Traits of Four Groundnuts (*Arachis hypogaea* L.) Varieties from the Germplasm of Gimbi Research Station

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Authors' contributions

This work was carried out in collaboration among all authors. Authors MMM and DBK designed the study and coordinated all activities. Authors VMT, RMK and JNK designed the protocol and compiled literature review. Author AKM recorded experiment data, climatic parameters and wrote the first manuscript. Authors ANN, NKK and INK carried out statistical analyzes and wrote the final manuscript. Authors AKM and MMM corrected the final manuscript. All authors read and approved the final manuscript.

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ABSTRACT

Aim: To evaluate under agro-environmental conditions of Gimbi research station, some agronomic traits of four groundnut varieties from germplasm of PNL.
Study Design: This study was conducted using a randomized complete block design with four treatments repeated three times.
Place and Duration of the Study: The study was conducted in Gimbi research station between October 2019 and January 2020 (i.e. 4 months).
Methodology: Trial was conducted using four treatments with three replications. Data collected concerned percentage of seedlings emerged, number of days between sowing and flowering 50%, dry pod weight, weight of unsorted seed, weight of sorted seeds, percentage of good seeds, shelling percentage, average weight of 1,000 seeds and grain yield per hectare. All data were submitted to analysis of variance at 5% probability level.
Results: The rate of seedlings emerged recorded on each groundnut variety was overall less than 50%. All varieties flowered 32 days after sowing. The highest average weight of dry pods (410.8g) was noted on A1408, while the lowest value of dry pod weight (310.6g) was observed on JL24. The highest weight of unsorted seeds (360.9g) was recorded on A1408, while the lowest value (260.7g) was observed on JL24. Variety A1408 presented the highest weight of stored seeds (350.5g), while the lowest value (250.8g) was noted on variety JL24. The highest percentage of good seeds (97.3) was obtained on A1408, while variety Sivi presented the lowest percentage of good seeds (93.2). The highest shelling percentage of groundnut pods (87.6) was obtained on A1408, while the lowest shelling percentage (83.5) was noted on JL24. The lowest weight of 1,000 seeds was noted on Sivi variety (484.6g), and the highest value was recorded on A1408 (522.6g). The highest grain yield (912.9Kg.ha^{-1}) was obtained on variety A1408, while the lowest grain yield was noted on JL24 (690Kg.ha^{-1}).
Conclusion: Seeds of all varieties presented a very low rate of emergence (less than 50%). Variety A1408 was more productive than other varieties, and variety JL24 used as control should be regarded as having degenerated.

Keywords: Field assessment; Arachis hypogaea; Agronomic traits; Germplasm; Gimbi research station; DR-Congo.

1. INTRODUCTION

Groundnut (*Arachis hypogea* L.) is the third largest source of vegetable oil in the world after soybean and sunflower. It is an important source of protein [1], and is cultivated mainly by small-household and resource-poor farmers [2]. This crop is therefore increasingly cultivated to satisfy a demand that is continuously increasing with a cultivated area of 28.35 million ha in 2004 to 31.17 million ha in 2014 [1]. Groundnut is a legume that ranks 4th among the oilseed crops and 13th among the food crops of the world. It provides high quality edible oil (48 to 50% used in cooking, margarines, salads), easily digestible protein (26 to 28%), about half of the 13 essential vitamins and more than a 3rd (7) of the 20 essential minerals necessary for normal human growth and maintenance [2]. It also produces high quality fodder for livestock [3]. The world average yield of groundnut is estimated at 1.66TM/ha, and United States and China obtained the highest yields (respectively 4.4T/ha and 3.58T/ha in 2014). In Africa, yield of groundnut is much lower than the average world yield [1]. This low yield observed in Africa is due to biotic and abiotic factors such as pests, diseases [4], soil nutrient deficiencies and lack of access to quality seed of improved varieties [1, 2]. In major producing countries as well as in African countries such as Nigeria and Senegal, groundnut is subject to special policies where it is widely grown.

In the Democratic Republic of Congo (DRC) groundnut occupy eighth place in national production. It is grown mainly in savannah areas where much of the production is for direct consumption as porridge, crushed or roasted. In DRC, groundnut plays a major role in the food supply, and the estimated quantity destined for consumption is 12.5 kg per person [5]. This crop plays an important role in improving farmers' incomes and in providing feed for livestock [6]. However, groundnut crop faces many biotic constraints which constituted the main factors

limiting its production [6, 7]. Leaf diseases such as cercosporioses recognizable by extensive leaf spots are considered more damaging for groundnut because they can cause yield losses of up to 50-70% [6].

In DRC, cercosporioses are constantly observed with high severity during rainy periods. Their lesions can increase rapidly under favorable conditions when several cycles occur per season [8, 9]. To control these fungal diseases, various methods have been developed and proposed. In farming environments where the incidence and severity of cercosporioses are higher, the use of resistant varieties has proven to be the most effective and economical solution compared to chemical control, which is generally very expensive [10-12]. Varietal resistance appears to be the safest and most sustainable way to effectively combat diseases [13].

In DRC, several improved varieties of groundnut have been introduced by the 'Programme National Légumineuses (PNL)'. Some of these varieties have been evaluated and characterized for their resistance to leaf diseases and their productive characteristics. However, few data relating to the plant material constituting the PNL gene pool are available. It is in this context that the present study was initiated with aim to evaluate under agro-environmental conditions of Gimbi Research Station, some agronomic traits of 4 groundnut varieties listed in the germplasm of the PNL.

2. MATERIALS AND METHODS

2.1 Presentation of Field Study

The study was conducted at the Gimbi Research Station of the National Institute for Agronomic Study and Research (INERA) located about 450Km south-east of Kinshasa, territory of Seke-Banza, Kongo Central province. The geographic coordinates of the field study recorded with GPS (Garmin 64sx) are 13°22'E longitude, 5°31'S latitude, and 339m of altitude. The experimental site was characterized by a grassy savannah whose dominant species encountered consisted of *Imperata cylindrica*, *Digitaria sanguinalis* and *Panicum maximum*. Generally, the soils of Gimbi Research Station are clayey to black sandy clay soils, and rich in humus [14]. The present study was conducted during the period from October 1st, 2019 to January 8th, 2020. According to the Köppen classification, the characteristic climate of Gimbi Research Station is AW5. It is a humid tropical climate characterized by 5 months of dry season, and 7 months of rainy season. Generally, the dry season runs from the second half of April and ends at the first half of September. As for the rainy season, it runs from the second half season of September and ends in the first half of April. The average annual rainfall is 1,185.24mm. The climatic conditions prevailed during the experimental period are presented in Table 1. Data reported in Table 1 indicate that average temperature oscillated between 25.2 to 26.4°C, relative humidity 92.3 to 93.6% and rainfall 117.6 to 183.6mm. These values demonstrate that climatic conditions that prevailed during the experimental period were favorable to the optimal production of groundnut crop.

2.2 Seed Material Used

In the present study, seed material used was from four groundnut varieties (*A. hypogaea* L.) with different vegetative cycles and levels of resistance to cercosporioses. The groundnut varieties were A1408, JL24-2, Sivi and JL24. The seeds of these varieties were obtained from the Antenna of the PNL of Mvuazi Research Centre of INERA. The main characteristics of groundnut varieties used are listed in Table 2 as described by [15]. The variety JL24 locally cultivated at the Gimbi Research Station was used as a control.

Table 1. Climatic conditions prevailed Gimbi Research Station during the experimental period

Month	Temperature (°C)			Relative humidity (%)	Rainfall (mm)
	Maximum	Minimum	Mean		
October 2019	28.8	21.6	25.2	93.6	165.8
November 2019	29.7	22.4	26.1	92.6	117.6
December 2019	30.0	22.3	26.2	92.3	140.2
January 2020	30.1	22.8	26.4	92.5	183.6

Table 2. Main characteristics of the groundnut varieties used [14]

Variety identity	Type	Origin	Integument color	Vegetative cycle (days)	Pod yield (Kg/ha)		Shelling yield (%)	Weight 1,000 grains (g)
					Research station	Real Environment		
A1408	Spanish	DRC (Bandundu)	Red	95	1,200	800	68	340
JL24-2	Spanish	DRC (Kongo Central)	Brownish pink	98	2,000	3,500	69	510
Sivi	Spanish	DRC (Kongo Central)	Brownish pink	90	2,000-2,800	1,000	60-70	514
JL24	Spanish	DRC (Kongo Central)	Cream white	90	1,200	800	70	300

2.3 Methods

2.3.1 Setting up the experiment

The experimental land was mechanically plowed and harrowed. The trial was conducted in a randomized complete block design with 3 replications. Each replication was 9m long and 3m wide. Each elementary plot was 3m long and 1.5m wide. The distance between two neighboring plots was 1m. The total area of the experimental trial was 81m² (i.e. 9m x 9m). The groundnut seeds were sown at depths of 3-4cm at the rate of 2 seeds par hole at 40cm x 20cm spacings. Each elementary plot included 5 rows seedlings of 3m in length and counted 150 plants. Weeds were regularly pullet out manually. In general, three manual weedings were carried out. The first was done two weeks after sowing, while the second and the third were respectively done two and four weeks after the first weeding.

2.3.2 Parameters observed and statistical data analysis

During the experimental period, observations mainly concerned vegetative and production parameters. The vegetative parameters concerned the percentage of seedlings having emerged, and the number of days between sowing and flowering 50%. The percentage of seedlings having emerged was evaluated 15 days after sowing. The production parameters noted were: dry pod weight, weight of unsorted seed, weight of sorted seeds, percentage of good seeds, shelling percentage, average weight of 1,000 seeds and grain yield per hectare. Data collected were submitted to analysis of variance at 5% probability level. Statistical data analysis was made using Statistix 10.0 software (free edition). Means comparison was made using the least significant difference test (LSD).

3. RESULTS AND DISCUSSION

3.1 Results

3.1.1 Vegetative parameters observed

Results relating to percentage of seedlings emerged and number days between sowing and flowering 50% are presented in Table 3.

Results in Table 3 show that the rate of seedlings emerged recorded on each groundnut variety was overall less than 50%. The highest rate of seedlings emerged (45.1%) was recorded on JL24-2 variety, while the lowest rate of seedlings emerged (39.4%) was noted on Sivi variety. The number of day between sowing and flowering 50% was the same for all varieties used, which corresponded to 32 days.

3.1.2 Parameters of production recorded

In Table 4a are presented results on dry pod weight, weight of unsorted seeds, weight of sorted seeds and percentage of good seeds. Table 4b reports results on shelling percentage, weight of 1,000 seeds and estimated yield recorded during the experiment.

Results of Table 4a indicate that the highest average weight of dry pods (410.8g) was recorded on A1408 variety, while the lowest average dry pod weight (310.6g) was noted on JL24 variety (control). The highest weight of unsorted seeds (360.9g) was observed on A1408 variety, while JL24 variety presented the lowest average weight of unsorted seeds (260.7g). The highest weight of sorted seeds (350.5g) was enregistered on A1408 variety, and the lowest value of weight of sorted seeds (250.8g) was obtained with JL24 variety. It was observed that the highest percentage of good seeds (97.3) was obtained with variety A1408, while variety Sivi had the lowest value of percentage of good seeds (93.2). The highest shelling percentage of groundnut pods (87.6) was obtained on A1408 variety, while the lowest shelling percentage of groundnut pods (83.5) was noted on JL24 variety. The lowest weight of 1,000 seeds was noted on Sivi variety (484.6g), while the highest value was recorded on A1408 variety (522.6g). The highest estimated yield (912.9Kg/ha) was obtained from A1408, while JL24 gave the lowest estimated yield (690Kg/ha).

3.2 Discussion

The study carried out on field evaluation of 4 varieties of groundnuts recently introduced in the germplasm of Gimbi research station revealed that, theses varieties react differently under agro-ecological conditions where they have been placed in competition. In general, the average percentage of seed emergence was equal to 42.6, which is much less than 50%. The low emergence rate recorded is thought to be due to the loss of viability of seeds as a result of the long storage of seeds in the warehouse without the use of pesticides that can help prevent attacks by pests. The number of day to 50%

flowering recorded equal to 32 days for all varieties. Present results show that all varieties used in this study flowered on 3 – 4 days later compared to data reported by Ngoy *et al.* [14] which demonstrated during two growing seasons, that varieties A1408 and JL24 flowered on average on 28 – 29th day after sowing, and variety JL24-2 flowered on 29th day after sowing. The extension of the flowering period could be due to the low quantity of water received by groundnut plants during their vegetative cycle. Agro-environmental conditions of experiment site can also influence the timing of flowering plants. Indeed, in India, Kumar and Abbo [16] reported that sites where plants grow have an influence on the time of initiation of flowering.

Data reported in Table 4a indicate that dry pod weight varied from 310.6 to 410.8g, that of unsorted seeds from 260.7 to 360.9g. The weight of sorted grains varied from 250.8 to 350.5g and the percentage of good grains varied from 93.2 to 97.3g. Results recorded in Table 4b show that shelling percentage varied from 83.5 to 87.6, while the weight of 1,000 grains varied from 484.6 to 522.6g and the grain yield from 690.2 to 912Kg.ha^{-1}. Data reported in Table 4b demonstrate that shelling percentage obtained are greater than those reported in Table 2 relating to main characteristics of varieties used. In general, it was observed that apart from the percentage of good grains and weight of 1,000 grains, the variety JL24 (used as control) presented the lowest values relating to the various parameters considered. In contrast to the control, it was noted that the variety A1408 performed better compared to other two varieties. Results reported in the present are inferior to those obtained by other authors. In fact, results obtained by Ngoy *et al.* [14] indicate, for two cropping seasons, an average yield of 1.1t/ha for variety A1408, 1.3t/ha for JL24 and 0.95t/ha for JL24-2. These differences can be explained by interactions which took place between genotypic factors of each variety and environmental factors of the experimental site. These interactions therefore influence the phenotypic factors of plants obtained. According to Li and Nelson [17], phenotypic factors are highly influenced by environmental conditions of sites where plants are grown. In view of results of present study, it should be noted that the low

Table 3. percentage of seedlings emerged and number of days between sowing and flowering 50%

Variety	Percentage of seedlings emerged	Number of days to 50% flowering
A1408	44.4a	32a
JL24	41.6b	32a
JL24-2	45.1a	32a
Sivi	39.4b	32a

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

Table 4a. Dry weight, weight of unsorted seeds, weight of sorted seeds, and percentage of good seeds

Variety	Dry pod weight (g)	Weight of unsorted grains (g)	Weight of sorted grains (g)	Percentage of good grains
A1408	410.8a	360.9a	350.5a	97.3a
JL24	310.6b	260.7b	250.8b	95.8a
JL24-2	342.2ab	292.6ab	283.4ab	96.9a
Sivi	363.5ab	313.7ab	291.7ab	93.2a

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

Table 4b. Shelling percentage, weight of 1,000 seeds and estimated yield

Variety	Shelling percentage	Weight of 1,000 grains (g)	Grain yield (Kg.ha^{-1})
A1408	87.6a	522.6a	912.9a
JL24	83.5b	501.3b	690.2b
JL24-2	85.4ab	508.3b	760.5ab
Sivi	86.2ab	484.6c	807.9ab

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

productivity of variety JL24 is mainly due to its degeneration. Indeed, this variety highly appreciated for more than 20 years by agricultural producers is no longer the subject of improvement work. Actually, the rare works carried out with this variety are oriented towards varietal maintenance without focusing on its best characteristics for which it was developed.

5. CONCLUSION

The results of the present study revealed that all varieties presented a very low rate of emergence (less than 50%) due to long storage leading to loss of viability. The variety JL24 used as control gave low values, while variety A1408 was more productive than other varieties. Future studies are carried out on the varietal resistance of groundnut accessions listed in PNL germplasm to main diseases prevalent in the Gimbi Research Station.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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