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RESEARCH ARTICLE

AGRONOMIC EVALUATION OF 12 CULTIVARS OF COWPEA (*VIGNA UNGUICULATA* (L.) WALP) IN KABINDA ZONE, LOMAMI PROVINCE IN DR CONGO

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ABSTRACT

In the present investigtion, twelve cowpea (*Vigna unguiculata* L. Walp) germoplasms were evaluate in Kabinda zone during the first growing season A 2015-2016. The main purpose of the investigation was to estimate the growth and yield performance of twelve cowpea germoplasms for improving selection in cowpea. The study was conducted using a randomized block design with for replications. The results showed that varieties CNGKASC2-1, CNGKASC5-2-0-T and CNGKASB6-1A gave higher seeds yields, whereas CNGKASB7B-1, CNGKAS C6-1-1, CNGKAS A7-0-L and CNGKAS C5-1-1-R had lower seed yields. They observed high positive significant correlations for vegetative and reproductive traits. Therefore, in the present study with cowpea, a high impact of direct effects of correlation suggested that going for plant height, number of leaves per plant, number of branches, number pod per peduncle, number of pod per plant; pod long and seed weight would be effective for improving seed yield in cowpea.

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INTRODUCTION

The Democratic Republic of Congo is a country in Central Africa with 80 million hectares (ha) of arable land, of which only 9 to 10% is currently being used. With this availability of land, it is possible to practice a varied range of plant speculations in proportions that could cover domestic demand and stimulate exports (FAO, 2007). It is also pointed out that almost all of the country benefits from a cropping season of more or less eight months in the year for practicing rain fed agriculture. In front of these assets that possesses DR Congo, the promotion of agricultural activities can constitute in all considerations an interesting opportunity to diversify crops but also to fight against poverty and food insecurity in Sub-Saharan Africa. Referring to the economic activities of the country, more than two thirds of the population work in agriculture (INS, 2014). This activity ensures the subsistence life and constitutes the base of the Congolese economy. Its part in national income reached as much as 50% in the 1990s, partly as a result of the collapse of other sectors of the economy (mining sector in particular). It still provides 40.3% of GDP (against about 13% for the mining sector) World Bank (2010). Seasonal speculations in the DR Congo include cereals (with particular emphasis on maize, rice, millet, wheat and sorghum), roots and tubers (mainly cassava, but also including sweet potato, Yams, potatoes and taro), grain legumes (peanut, common bean, soybeans, cowpeas, voandzou), which have an annual growth

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Table 1. Vegetative parameters

Varieties	Height (cm)	Dc (mm)	NbreFL	LGFL (cm)	LgFL (cm)	LPDc (cm)	NbrRM
CNGKASC5-2-0-T	24.1a	3.5a	8.0a	10.1a	3.6ab	23.6a	2a
CNGKASC6-1-1	20.4a	2.7a	5.2a	6.8a	4.9a	24.7a	1a
DIAMANT	20.9a	3.1a	5.5a	7.8a	4.0a	22.6a	1a
CNGKASB4-2-0	21.0a	3.2a	8.5a	8.5a	3.9a	27.5a	2a
CNGKASC5-1-1-R	21.1a	2.6a	6.5a	6.1a	1.3c	18.3a	2a
CNGKASB6-1A	23.4a	2.4a	5.5a	8.5a	3.2abc	24.2a	1a
CNGKASD1-0	21.1a	2.4a	5.2a	9.0a	3.9a	22.5a	1a
CNGKASA7-0-L	22.9a	2.5a	4.7a	7.7a	4.3a	21.2a	1a
CNGKASC2-1	22.9a	3.1a	6.0a	8.6a	4.5a	21.7a	1a
CNGKASC5-2	22.9a	3.1a	7.7a	8.6a	3.2abc	27.3a	1a
CNGKASB7B-1	20.7a	2.5a	5.7a	6.4a	3.7ab	19.0a	1a
CNGKASA8-2	23.4a	2.9a	7.7a	8.7a	1.5bc	20.3a	2a
CV %	16.3	26.3	28.4	46.3	24	24.2	32

Ht: height of plant; Dc: collar diameter; NbreFL: number of leaves, LGFL: length of leaves; LgFL: wide of leaves, LPDc: length of peduncle, NbrRM: number of ramification,

Table 2. Production components of cowpea varieties understudy

Treatments	Pod/pedoncule	Pod/plant	Length pod (cm)	grain/pod	Weight of 100 grains (g)
CNGKASC5-2-0-T	2a	5.7a	16.7a	11a	12.0a
CNGKASC6-1-1	2a	4.5a	15.1a	11a	8.2de
DIAMANT	2a	4.5a	17.0a	12a	9.0bcd
CNGKASB4-2-0	2a	4.0a	15.1a	13a	8.0e
CNGKASC5-1-1-R	2a	4.0a	16.5a	13a	7.5e
CNGKASB6-1A	2a	3.7a	17.7a	13a	10.5abc
CNGKASD1-0	2a	3.7a	16.2a	13a	11.2ab
CNGKASA7-0-L	2a	3.5a	16.2a	14a	8.5de
CNGKASC2-1	2a	3.5a	17.7a	14a	9.0cde
CNGKASC5-2	1a	3.2a	17.5a	13a	11.7a
CNGKASB7B-1	2a	3.2a	15.8a	12a	9.7bcd
CNGKASA8-2	2a	3.0a	15.7a	14a	12.0a
CV (%)	16.8	48	8.7	34	6.5

Table 3. Correlation coefficients among yield components and yield of some cowpea genotypes

	HP	NFL	NRM	PPCL	PPL	LPD	WG100	YDG
HP	1.0							
NFL	0.9221**	1.0						
NRM	0.6897**	0.6202**	1.0					
PPCL	0.9562**	0.9277**	0.5872**	1.0				
PPL	0.8960**	0.8047**	0.8104**	0.8488**	1.0			
LPD	0.9819**	0.9316**	0.6445**	0.9761**	0.8784**	1.0		
WG100	0.9744**	0.9368**	0.6279**	0.9658**	0.8584**	0.9849**	1.0	
YDG	0.9550**	0.9263**	0.6366**	0.9485**	0.8482**	0.9678**	0.9688**	1.0

*significant at 1%

HP: Plant height; NFL: Number of leaves; NRM: Number of branches; PPCL: Number pod per pedoncule; PPL: Number of pod per Plant; LPD: Pod long; WG100: 100 Seed weight YDG: Seed yield

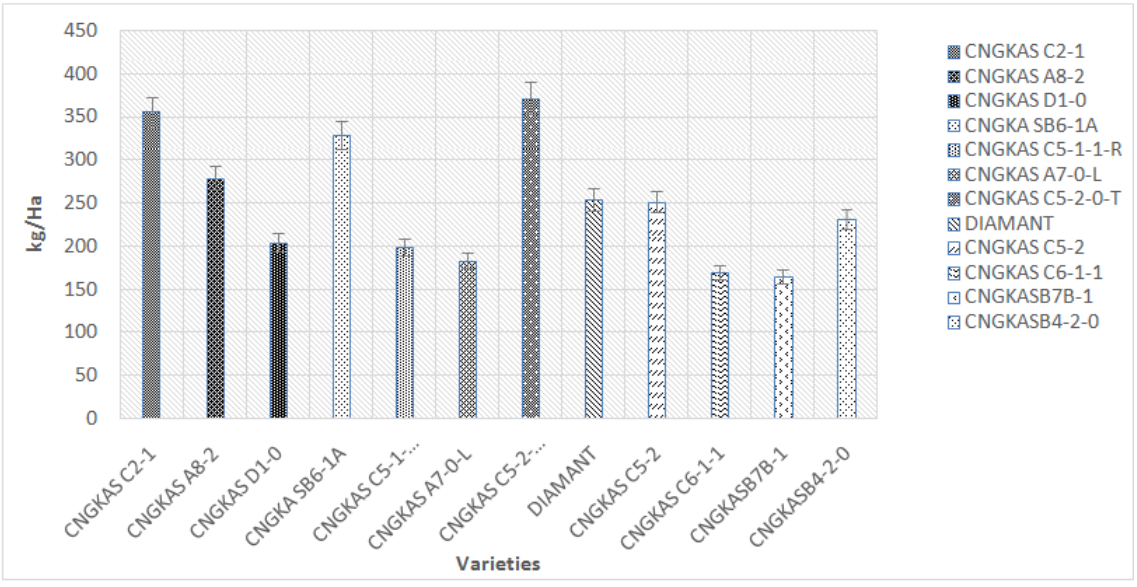

Figure 1. Yield in dry grains of cowpea

rate lower than that of demography, except cassava and vegetables, and are unable to cover the needs of population. It is in this context that this study focuses on a grain legume, mainly cowpea, which is now regaining interest in sub-Saharan Africa in general and particulary in DR Congo because of its nutritive richness in alimentation and the economic opportunities it offers. Native from Africa, Cowpea, *Vignaunguiculata* (L.) Walp, is an annual herbaceous legume from the genus *Vigna* belonging to the Leguminosae family. It is currently one of the most important grain legumes growing in tropical and subtropical regions and is used in human nutrition as well as forage for animal alimentation. It is the second legume produced in DR Congo after the common bean, with a production level seven times more greater than the voandzou. Total current production at the national level is estimated at 70.042 tons. This production shows a marked increase comparing it to the years from 1995 to 2013 (41.549 – 68.094 tons) INS (2014). The average yields in the Congolese peasantry are between 250 and 350 kg/ha (Mukendi *et al*., 2014; Munyuli, 2007; Nwofia *et al.*, 2014).

This production is very low at local and even African level. It is practiced in small - scale family farms with less than two hectares annually, that practice is poorly performing, rudimentary in its equipment's and materials, and with limited access to modern agricultural inputs (safe seeds, fertilizers and pesticides), to technologies and financial possibilities on the one hand and on the other hand because of its susceptibility to the numerous attacks of insect pests and disease vectors, to the use of traditional varieties with low productivity which are also susceptible to diseases and insects but also coupled with abiotic constraints which are the main problems of cowpea producers. Cowpea is very widespread in the DRC, particularly in Katanga, in the three Kasai, Bandundu, Lomami and northern Ecuador. Yields vary from one region to another, but the national average remains low due to biotic and abiotic constraints affecting yields in grains. However, cowpea is rich in protein, iron, starch, calcium, phosphorus and vitamin B. It is an excellent food even consumed in small quantities. Young green leaves and immature pods are eaten as a vegetable (Egbe *et al*., 2010; Ali *et al*., 2004; Ayoade, 2010).

Apart from the nutritional value of this crop, it is of great importance in agriculture, where it has the capacity to fix atmospheric nitrogen (Ayoola and Makinde, 2008) in the soil by these nodules whose accumulation is estimated to be 9 to 240 kgN / ha / year and the leaves fix 60 to 70 kg / ha of this nitrogen. (Aikins and Afuakwa, 2008; Yukubu *et al.,* 2010). It plays an important role in crop rotations (Baudoin, 2001).

These hawks are incorporated into the soil during seed-bed preparation but are also used in livestock feeding (Shiringani, 2007) in countries that have developed intensive livestock production. It is a relatively drought resistant crop. Any cowpea production in this area will have to overcome the various biotic and abiotic constraints and respond to local peasant demand in order to improve the nutritional status of consumers, contributing to food security, raising the income of producers and improve the stock of nitrogen nutrient in the soil. It is in this perspective that this study proposes to evaluate some germoplasm of cowpea in the agro-ecological and environmental conditions of Lomami with a vision to select the most productive varieties and to make them available to producers.

MATERIALS AND METHODS

The study was carried out at the experimental garden of the Notre Dame de Lomami University, located in Kimulo, Kabinda area, Lomami province in the Democratic Republic of Congo. The geographical coordinates of the experimental site are 24° 33' E, 6° 06' S and 792 m of altitude. The characteristic climate of the experimental site is of type Aw3 according to the classification of Koppen. It is a humid tropical climate characterized by the alternance of 2 seasons: a rainy one that lasts 9 months (from August to April), and a dry season of 3 months (from May to July). The average annual rainfall is 1600 mm, and the average annual temperature is around 25 °C. Almost all the soil on the site has an acid character, generally belonging to the group of Ferralsols according to the classification of the INEAC of 1961 (Ministere of plan, 2005). The soil is light, easily drained and leached, with a very low water retention capacity (poor soils with low agricultural value). The vegetal materiel used consisted in varieties of cowpea obtained from INERA Gandajika, DR Congo such as: CNGKASC2-1, CNGKASC5-2-0-T, CNGKASB6-1A, CNGKASC6-1-1, CNGKASB7B-1, CNGKASA7-0-L, CNGKASC5-2, CNGKASD1-0, CNGKASA8-2, CNGKASC5-1-1-R, CNGKASB4-2-0 and Diamant.

Cowpea varieties were evaluated during the first growing season A 2015-2016, which begins in August until mid-January. The seedbed was prepared manually with the hoe whose depth of plow is estimated at 15 cm. The trial was based on the experimental setup consisting of completely randomized blocks with twelve treatments and four repetitions for each treatment. All the trial counted 48 elementary plots of 7.2 m² each one. The differences between the plots were 1.0 m. Each plot was 3 m long and 2.4 m wide and had 5 rows. Seeding was done at intervals of 0.20 m within the rows and 0.6 m between the rows. These seeds had been preserved with a chemical preservative Momtaz at the research center. Three seeds per hole were seeded at sowing moment, and two weeks later, only two plants have been maintained per hole as it was proceeded to the leaving out of one plant per hole. Agronomic practices include control of the weeds by weeding with the hoe when necessary. The parameters observed during the experiment were the growth and production variables. Growth variables were observed during a period of 45 days at the 14 days interval from sowing, while production observations were evaluated at harvest. The parameters measured were: collar diameter of plants, height of the main stem, number of leaves per plant, number of branches, length and wide of leaflet, length of stalk, number of pods per plant , pod length, seed number per pod, number of pods per peduncle, weight of one hundred seeds and yield extrapolated per hectare. The data collected on the central row of the experimental plot during the vegetative phase after the emergence plants and production phase were calculated using the descriptive statistical method in the Excel spreadsheet. Then all the averages of the parameters measured were analyzed using ANOVA with STATISTIX 8.0 software. The averages were compared a posteriori using the Tukey HSD test at the 5% probability threshold.

RESULTS AND DISCUSSION

Vegetative evolution of cowpea varieties at pre-flowering phase are illustrated in the table below:

The results of agronomic performance in growth phase of cowpea are presented in the Table 1. Analysis of variance showed that there were no significant differences at the 5% threshold for cowpea plant height at pre-flowering ($p > 0.05$) in all 12 varieties tested. The height varies between 20.4 cm and 24.1 cm. The same trend was observed with collar diameter variables, leaf number, peduncle length and the number of ramifications following the Tukey HSD means separation test. All averages of these variables showed non-significant differences ($p > 0.05$) between the genotypes tested. However, the wide of leaf parameter in this study showed that the means are significant ($p < 0.05$). The CNGKAS C6-1-1 variety showed a longer width whereas the CNGKASR1-1-R variety appears to be the one with the smallest width of the group. Results for the yield performance are shown in the table below.

The essential components of yield, such as number of pods per stalk, number of pods per plant, pod length, number of seeds per pod and weight of one hundred seeds are shown in Table 2. The analysis of the variance for the number of pods per peduncle showed that there was no difference between the 12 varieties of cowpea tested ($p > 0.05$). Similarly, the number of pods per plant, pod length, and seed count per pod showed average values that did not have differences between varieties in the study as shown in Table 2 ($p > 0.05$). However, the weight of one hundred seeds undistinguishably of the varieties exhibit the means value significantly different between them according to the 5% Tukey HSD test. The variety that had a greater weight value of one hundred seeds had got 12 grams as well as for CNGKASC5-2-0-T and CNGKASA8-2 and the variety that had the low weight of one hundred seeds weighed 7.5 grams (CNGKASR1 -1-R) as demonstrated in Table 2. For the yield in dry grains of these twelve materials, the result is shown in the graphic below. It emerges from the results of the yield of 12 varieties of cowpea shown in Fig. 1 that the weight of dry grains showed significant differences ($p < 0.05$) between them. The average yield of twelve varieties of cowpea varies between 370 kg/ha and 160 kg/ha. The highest mean was obtained with the CNGKA C5-2-0-T variety (371.05 kg/ha) and the lowest average yield of the group was observed with the variety CNGKASB7B-1 (163, 8kg/ha).

The correlation matrix (Table 3) between vegetative and reproductive traits showed that all are significantly and positively correlated. For example, we noted that the height of the plants has a positive and significant correlation ($r = 0.95$) with the yield. That is to say, a high-range variety is useful for solar reception and induces a good yield in it. This is quite justified by the best yields obtained by the varieties CNGKASC5-2-0-T, CNGKASB6-1A, CNGKASC2-1. The same goes for the rest of this variables. The strongest correlations are remarkable with the yield linked to the six variables in this study, apart from the number of branches per plant with a coefficient equal to 0,6366.

DISCUSSION

The evaluation of the agronomic performance of 12 improved varieties of cowpea in terms of plant height, collar diameter, and number of leaves, leaf length and width, number of ramifications as described in Table-1 shown no varietal differences during the vegetative phase in this study. This observation is a direct consequence of field condition, with soils and climatic factors affect the growth and development of these new varieties in order to interpret the observed yields under this environment. Agyeman *et al.* (2014) suggested that the cowpea varieties respond differently to the prevailing soil in climatic conditions. Addo-Quaye *et al*. (2011) have also underlined it in their study on cowpea grain yield component. But with regard to yield and its components shown in Table-2 and Figure-1 respectively, there is once again no differences between the varieties understudy in the Kabinda area. The variables observed in the varietal performance assessment contributing directly and indirectly to the grain yield of this crop, Kwaga (2014), confirms that the contribution to the ultimate yield of any crop even on the production of biomass, grain and root is directly related to the different parts of the plant. The plant height; number of leaves; number pod per peduncle; number of pod per plant; pod long and seed weight contribute significantly to the yield of cowpea. This is entirely justified by the positive and significant correlation between the variables and the results obtained. Mukendi *et al*. (2017) was observed this in our study. These variables are an emanation of varietal genetics as observed for each variety. The study by Kwaga (2014), confirms that 31.85% of cowpea yield is directly related to the number of pods per plant. In this study, it appeared that this parameter gave non-significant results between all the varieties because the number of pod per plant was low. The low average yield of cowpea and its components has been attributed to heavy pest and disease infestation apart from other production constraints. These present results are consistent with previous study on cowpea by Yadav, (2013); Singh, (2013), who reported that 30 and 60 % yield loss or depression due to pests and diseases and in extreme cases, there could be total loss. It might be thought in view of the results of this study that the weight of one hundred grains had influenced the grain yield of 12 varieties under study. The varieties with a higher weight on the weight of one hundred grains give higher yield of the group and can be chosen as good material for a preliminary varietal selection in the Kabinda area.

Conclusion

The study of yield and its components has allowed to bring out the production performance of the twelve varieties of cowpea in the Kabinda area. It also identified the variables that contribute more to realize yield in cowpea varieties. Knowing that the level of production capacity in terms of plant height, number of leaves, length of pod, number of pods per plant, number of peduncles per plant, number of grains per pod, and weight of 100 grains are the determinants parameters for the cowpea yields prediction, the observations in this study highlight the weight of 100 seeds that contributed significantly to the yield of cowpea. However, this prediction can only be correct if the damage caused by the parasites and pests of this crop is reduced. At the end of this study, the cowpea varieties identified as the most productive areCNGKASC2-1, CNGKASC5-2-0-T and CNGKASB6-1A. In effect, these varieties have performed well on some essential variables.

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