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Research Article

EFFECT OF THE GROWING AREA ON THE AGRONOMIC PARAMETERS OF THREE VARIETIES OF COWPEA [*VIGNA UNGUICULATA (L.) WALP, FABACEAE*] CULTIVATED IN CÔTE D'IVOIRE

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A B S T R A C T

This work was carried out to assess the effect of the growing area on the agronomic parameters of three cowpea varieties (N5BBr, N6BR and N9BN) grown in Côte d'Ivoire. This took place in the Haut Sassandra (Daloa) and Nawa (Soubré) regions. A completely randomized block experiment was adopted. The parameters measured concerned the height, the wingspan, the number of leaves, the number of pods, the weight of pods, the dry biomass, the number of seeds, the weight of seeds, the harvest index and the rate of filling. The results showed that the cultivation area had a significant impact on the parameters measured due to the different soil and climatic conditions. It therefore emerges from this study that the N9BN varieties produced a large quantity of seeds and biomass in the locality of Soubré.

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INTRODUCTION

Cowpea, *Vignaunguiculata (L.) Walp*., Is the most important legume in tropical Africa (Koko *et al.,* 2016). Its culture plays a very important role in the nutritional balance and in the economy of rural populations. It occupies a special place because it is an important source of protein and energy for humans and animals in developing countries (Kouassi *et al.,* 2016). In Africa, cowpeas are cultivated above all for their seeds, cooked in the most diverse forms. In many regions, its young leaves, fresh or dried, and its immature pods are also eaten (Pasquet & Baudoin, 1997). Thanks to its symbiotic fixing capacity of atmospheric nitrogen, the insertion of cowpea in crop rotations makes it possible to meet the nitrogen fertilizer needs of subsequent crops (Kouassi *et al.,* 2019). According to Coulibaly & Lowenberg-Deboer (2002), West Africa is currently far from covering its cowpea needs with its own production. These yields rarely exceed 400 to 500 kg of seeds per hectare in traditional cultivation (Langyuntuo *et al.,* 2003). Several major difficulties including the absence of improved varieties really adapted to local growing conditions and the presence in the environment of many very active parasites during the various stages of plant development are the basis of these low yields. (Boyé *et al.,* 2016a). In Côte d'Ivoire, although much consumed for its nutritional and cultural contribution, cowpea remains a marginal crop (N'gbesso *et al.,* 2013) and very little data exists on its agronomic composition.

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Its production is around 36,310 tonnes / year, which represents less than 2% of African production. Given its importance, due to its relatively high protein content, cowpeas should be valued in Côte d'Ivoire. It is therefore essential to characterize certain local cultivars to assess their production potential according to Ayolié *et al.* (2016), improving local cultivars requires controlling certain endogenous factors such as growth characteristics and yield components of cultivated varieties. Although studies have been undertaken to increase national cowpea production, they have been conducted only in the Haut Sassandra region (Boyé *et al.,* 2016a; Ayolié *et al.,* 2016; Kouassi *et al.,* 2017). Few studies have been carried out on cowpeas in other regions to assess the effect of the growing area on the production of cowpea varieties. A study devoted to the influence of the shrub area on the agronomic parameters of cowpea was also carried out by Kouassi *et al.* (2018). And yet, the regions of Côte d'Ivoire are characterized by different climatic factors that influence vegetation. In addition, the high soil pressure exerted on the different types of soil could impact the yields of cowpea crops. The overall objective of this study is therefore to assess the effect of the growing area on the agronomic parameters of three local varieties of cowpea.

MATERIAL AND METHODS

Study site

The Soubré region is characterized by two dry seasons (July to August and December to March) and two rainy seasons (April to June and September to November). Average temperatures range from 26 °C to 28 °C and can reach up to 30 °C during

the dry season. The average rainfall is between 1,300 and 1,600 mm / year of rain.

The climate in the Daloa region also includes four seasons. The long rainy season runs from April to mid-July, the short dry season from mid-July to mid-September, the short rainy season from mid-September to mid-November and the long dry season from December to March. The average rainfall, temperature and atmospheric humidity characterizing the study site in the test period from May to August corresponding to the major rainy seasons are respectively: 142.81 mm; 26.42 °C and 83.7 %.

Plant Material

The plant material used in this study consisted of seeds of three varieties of Cowpea (Vigna unguiculata). These varieties come from the collection of the Jean Lorougnon Guédé University in Daloa (Côte d´Ivoire). These are the following accessions: N5BBr (Niébé 5 Biankouma Read White), N6BR (Niébé 6 Biankouma red) and N9BN (Niébé 9 Biankouma black).

Experimental method

The experimental device used is that of completely randomized blocks with three repetitions. The tests were carried out on an area of 336 m^2. Then, the installation of the nine boards (9) was carried out by block. Each of the boards has an average length of 3m and 2m wide. All of these nine (9) plates represent a block repeated twice at random. Sowing was carried out on 26/01/2019 at the rate of 3 seeds per pocket, at a depth of 3 cm in each locality. Ten days after sowing, the pairing was done in order to keep only the best plant per pocket. The maintenance of the plots consisted of cleaning the different plots three times during the vegetative cycle. The first interview took place two weeks after sowing in order to eliminate weeds and allow a harmonious development of the shoots of interest. The insecticide treatment was done twenty-one (21) days after sowing with Lambdacyhathrine (25EC) in one treatment.

Collection of data

Eight weeks after sowing, data collection began with the collection of morphological parameters from 10 plants taken at random by variety. Leaf counting was done from the first two leaves from the base of the main stem at the collar to the last leaves at the tip. Wingspan data was collected using a tape measure by determining the distance from each branch of the two most extreme leaves. The height measurement consisted of measuring the distance from the main stem from the collar to the most extreme leaf. Only the measurement of dry biomass was determined in the laboratory by weighing the unearthed plants and then after drying in the sun until constant weights were obtained. The pods are harvested by block and by elementary plot. After harvest, the number of mature pods per plant was counted. The dry weight of the pods was determined after drying in the sun. The pods were then peeled to count the number of seeds per plant. The weight of the seeds per plant was determined. The harvest index as well as the filling rate were also determined according to the methods of Ayolié *et al.* (2016). The measured parameters and measurement methods are recorded in the Table 1.

Table 1 Parameters studied and the different measurement methods.

Parameters studied	Measurement methods and samples
Biomass : DBm (t/ha)	Average weight measurement of the Dry plant per hectare
Span of the plant : Sp (cm)	Distance measurement of each ramification of the two most extreme leaves.
Height of the plant : Hpl (cm)	Distance measurement of the main stem from the collar to the most extreme leaf.
Number of Leaves : NLe	Size of all leaves of each plant.
Number of pods per plant : NPo	Size of all pods of each plant.
Number of Seeds per plant : NbS	Size of all seeds after pods have dried for each plant.
Weight of Dry Pods : WDP (g)	Mass of pods harvested and dried on each plant.
Weight of Seeds : WSe (g)	Seed mass per plant.
Harvest Index: HI	Total mass ratio of Dry seeds from a plant to the weight of the plant.
Filling Rate: FR	Total mass ratio of dry seeds from a plant to the weight of pods from the same plant.

Statistical data analysis

The data collected for each of the ten (10) variables were entered using the Excel spreadsheet version 97-2003. This data is processed taking into account the locality and the variety of cowpeas using STATISTICA version 7.1 software through the analysis of variance (ANOVA). The significance of the test was determined by comparing the probability (P) associated with the statistic at the threshold P = 0.05. When a significant difference was observed between the characters, the ANOVA was supplemented by the Smallest Significant Difference test (SSD). SSD allows you to see the homogeneous groups, since it locates where the significant difference is. This analysis of variance makes it possible to identify the significant differences between the varieties, localities and sowing densities considered.

RESULTS

Comparaison of agronomic parameters according to the growing area

Table II shows the comparison of the means of the agronomic characteristics measured in the localities of Soubré and Daloa. Analysis of this table shows that variables such as height, wingspan, seed weight, harvest index and filling rate were influenced by the growing area. Thus, the highest height and wingspan were obtained in Daloa with 56.49 ± 28.90 cm and 58.80 ± 40.25 cm respectively. On the other hand, at the level of parameters such as the number of seeds, the weight of the seeds, the harvest index and the filling rate the highest values were observed in Soubré. The number of pods, the weight of the pods of the plant and the dry biomass per plant do not give a significant difference between the localities of Daloa and Soubré (P> 0.05).

Table 2 Average (± standard deviation) of the agronomic characteristics measured in the localities of Soubré and Daloa.

Variables	Average (±standard deviation)		Statistics	
	SOUBRE	DALOA	F	P
Hpl(cm)	45.52±10.70[a]	56.49±28.90[b]	23.77	0.00
Sp(cm)	51.94±17.89[a]	58.80±40.25[b]	4.61	0.03
Nle	24.09±10.35[b]	19.46±10.70[a]	20.79	0.00
NPo	6.40±3.90[a]	6.32±3.85[a]	0.04	0.83
WPo(g)	8.66±5.75[a]	8.30±5.87[a]	0.42	0.51
DBm (g)	17.62±8.53[a]	16.06±12.15[a]	2.21	0.14
NbS	69.22±54.55[b]	60.91±43.80[a]	4.84	0.04
WSe(g)	6.57±4.57[b]	5.40±4.23[a]	7.82	0.00
HI	0.37±0.20[b]	0.32±0.10[a]	8.21	0.00
FR	1.35±0.41[b]	0.61±0.11[a]	781.41	0.00

* For each character, the values bearing the same letters in lines are statistically equal. Hpl: height of the plant; Sp: Span of the plant; Nle: Number of leaves of the plant; DBm: Dry biomass; NPo: Number of pods in the plant; WPo: Weight of plant pods; NbS: Number of seeds per plant; WSe: Weight of seeds per plant; HI: Harvest index; FR: Fill rate.

Comparaison of agronomic parameters according to the variety

Table 3 presents the comparison of the means of the agronomic variables of the three varieties of cowpea. Analysis of this table shows that in terms of pod weight per plant and filling rate, there is no significant difference between the varieties N5BBr, N6BR and N9BN (P> 0.05). Variables such as plant height and number of plant leaves show significant differences in the three cowpea varieties (P = 0.00). For the size, the number of pods, the weight of the seeds of the plant and the dry biomass, the varieties N5BBr and N6BR do not show any significant difference thus giving a partial difference between the three varieties. However, they are significantly different from the variety N9BN. As for the number of seeds per plant, there is a significant difference between the variety N5BBr and the other two varieties. The greatest height was obtained with the variety N6BR. The largest span is that of the variety N9BN. The highest number of leaves is obtained with the variety N9BN.

Table 3 Average (± standard deviation) of the agronomic variables measured on the three (3) cowpea varieties

Variables	Average (±standard deviation)			Statistics	
	N5BBr	N6BR	N9BN	F	P
Hpl(cm)	39.00±12.05[a]	64.07±20.71[c]	53.23±28.97[b]	50.31	0.00
Sp(cm)	45.46±16.14[a]	47.56±14.73[a]	75.14±48.09[b]	44.22	0.00
Nle	17.27±9.25[a]	20.86±9.76[b]	25.81±11.53[c]	26.38	0.00
Npo	5.40±3.20[a]	6.23±4.17[a]	7.43±3.92[b]	10.85	0.00
Wpo(g)	7.67±4.91[a]	8.45±5.37[a]	9.21±6.91[a]	2.64	0.07
DBm(g)	13.40±7.02[a]	15.54±7.91[a]	21.12±14.55[b]	22.06	0.00
NbS	53.07±37.97[a]	67.74±53.09[b]	75.48±50.45[b]	8.56	0.00
WSe(g)	5.33±3.84[a]	5.53±4.13[a]	6.34±5.11[b]	4.00	0.03
HI	0.37±0.14[b]	0.36±0.18[b]	0.29±0.11[a]	13.34	0.00
FR	0.87±0.45[a]	0.90±0.45[a]	0.94±0.44[a]	0.86	0.42

* For each character, the values bearing the same letters in lines are statistically equal. Hpl: height of the plant; Sp: Span of the plant; Nle: Number of leaves of the plant; DBm: Dry biomass; NPo: Number of pods in the plant; WPo: Weight of plant pods; NbS: Number of seeds per plant; WSe: Weight of seeds per plant; HI: Harvest index; FR: Fill rate.

Interaction localities-varieties on the agronomic parameters studied

The results of the analyzes in Table 4 showed that the height of the plant, the extent, the number of leaves, the number of pods, the weight of the pods, the dry biomass per plant, the number of seeds and the weight of seeds present significant differences at the level of varieties and localities (P <0.05). Thus, the highest height, wingspan, number of leaves, pod weight, dry biomass per plant were obtained with the variety N9BN in the locality of Daloa. On the other hand, the highest number and weight of seeds were observed with the same variety but in the locality of Soubré. For the harvest index and the filling rate, there is no significant difference between the locality and the variety (P> 0.05).

DISCUSSION

The present study has made it possible to identify the varieties producing seeds as well as varieties likely to produce a significant quantity of biomass. The study of the variability of cowpea varieties revealed a great diversity of the agronomic characters studied according to the growing area. For example, the Daloa area had the lowest values for traits such as number of seeds and seed weight, harvest index and fill rate. This demonstrates the influence of agro-ecological factors on agro-morphological characters in cowpea. Indeed, according to Kouassi *et al.* (2018), the accumulation of seed reserves depends on climatic factors. The Soubré area in the south of Côte d'Ivoire has higher rainfall than that of Daloa. These results are consistent with those obtained by Boyé *et al.* (2016a) during their studies on the diversity of cowpea varieties in Côte d'Ivoire. According to these authors, there is a reduction in the agromorphological characteristics of cowpea due to the low rainfall and the short rainy season as well as the high temperatures and the intensity of the long dry season that characterize the northern area of Côte d 'Ivoire . These results are similar to those of Ayolié *et al.* (2016) and Boyé *et al.* (2016b).

For these researchers, the capacity to fill the seeds would be more important in the plants of the Soubré area. This result thus confirms the hypothesis of a difference in the efficiency of mobilization of assimilas and therefore of the capacity of plants to ensure the filling of seeds. The capacity to fill the seeds would be greater in the plants of Soubré which expressed the highest weights of dry seeds. The low weight of seeds obtained in Daloa would probably be explained by the poverty of its cultivation soil, its unfavorable environmental conditions. Finally, the low seed weights observed in the two crop areas could be explained in part by attacks of all kinds suffered by the plants during the vegetative and reproductive phases. This confirms the results of Craufurd *et al.* (2013) according to which, in its ecology the cowpea plant is faced with many constraints such as, diseases, climate pests.The present study made it possible to assess the performance of the cowpea varieties N5BBr, N6BR and N9BN. Analysis of agronomic characteristics such as height, wingspan, number of leaves, number of pods, weight of pods, dry biomass per plant, number of seeds, weight of seeds, index of harvest and the filling rate showed great variability within the varieties studied. The variety N9BN gave the highest averages in terms of size, number of leaves, number of pods, dry biomass per plant and number of seeds. The variety N6BR has obtained the greatest height. These results are contrary to those obtained by Kouassi *et al.* (2017). Indeed, these authors showed during a study on the influence of the seeding density that the variety N6BR obtained the highest values of the parameters mentioned. These results show that the evolution of agronomic parameters depends on varieties, years and seasons. This indicates that the accumulation of reserves in seeds depends on the type of genotype (Khan *et al.,* 2010).

Table 4 Average (± standard deviation) of the agronomic characteristics measured at the level of the localities-varieties interaction.

Variables	Average (±standard deviation)						Statistics	
	SOUBRE			DALOA				
	N5BBr	N6BR	N9BN	N5BBr	N6BR	N9BN	F	P
Hpl(cm)	42.93±10.36 [b]	51.67±8.37 [c]	41.95±10.56 [b]	36.38±12.43 [a]	72.34±22.34 [e]	60.74±34.47 [d]	20.43	0.00
Sp(cm)	51.10±20.76 [b]	46.38±13.35 [b]	58.33±16.96 [c]	41.70±10.72 [a]	48.34±15.60 [b]	86.34±58.01 [d]	15.30	0.00
Nle	23.37±10.82 [c]	22.08±10.12 [c]	26.83±9.67 [d]	13.20±4.91 [a]	20.04±9.49 [b]	25.13±12.63 [d]	8.58	0.00
Npo	6.73±3.94 [d]	6.30±4.30 [c]	6.17±3.45 [b]	4.51±2.20 [a]	8.18±3.93 [e]	6.27±4.23 [c]	11.06	0.00
Wpo(g)	9.40±5.76 [c]	7.25±5.19 [b]	9.33±6.08 [c]	6.52±3.88 [a]	9.24±5.37 [c]	9.13±7.45 [c]	6.52	0.00
DBm(g)	16.77±7.85 [d]	14.25±7.12 [b]	21.83±8.83 [f]	11.15±5.39 [a]	16.39±8.33 [c]	20.64±17.38 [e]	5.16	0.00
NbS	66.47±48.40 [c]	59.23±61.93 [b]	75.95±53.25 [d]	44.14±25.68 [a]	68.64±46.20 [c]	64.93±48.61 [c]	4.33	0.01
WSe(g)	6.27±4.47 [c]	5.55±4.29 [b]	7.88±4.85 [e]	4.04±2.69 [a]	6.17±4.02 [c]	6.98±5.28 [d]	7.22	0.00
HI	0.41±0.17 [a]	0.38±0.27 [a]	0.28±0.15 [a]	0.34±0.11 [a]	0.35±0.10 [a]	0.28±0.08 [a]	1.84	0.16
FR	1.30±0.44 [a]	1.33±0.45 [a]	1.42±0.33 [a]	0.59±0.13 [a]	0.63±0.11 [a]	0.62±0.09 [a]	1.52	0.22

Thus, the variety N9BN stood out for its high averages in terms of wingspan, number of leaves, number of pods, and dry biomass during our study.

These results are contrary to those obtained by Ayolié *et al.* (2016) who worked on the agronomic quality of the same cowpea varieties in the Daloa region. For these authors, there is no significant difference between the varieties N5BBr, N6BR and N9BN in terms of variables such as the number of leaves and the number of pods. Such a difference in result could be explained by the difference in density in the different studies.

CONCLUSION

The objective of this study was to assess the effect of the growing area on the agronomic parameters of three varieties of cowpea (N5BBr, N6BR and N9BN) cultivated in Côte d'Ivoire. To achieve this objective, experiments took place in the area of Daloa and Soubré. It emerges from this study that the cultivation area has a significant influence on the agronomic parameters measured. Also, the variety N9BN gives better production compared to the other two varieties.

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