JOURNAL OF ADVANCED
BOTANY AND ZOOLOGY

Journal homepage: http://scienceq.org/Journals/JABZ.php

Research Article Open Access

Effects of some legumes in crops associated on the growth and production of Corn (Zea mays var. QPM) in eco-climatic conditions of Kinshasa (DR Congo).

Bangata B.M.[1], Kazanga K.[1], Mufwaya U.P.[1], Koto-te-Nyiwa Ngbolua[2,*], Minengu M.[1], Mobambo K.N.[1]

[1] Department of Crop Science, Faculty of Agricultural Sciences, University of Kinshasa, Democratic Republic of the Congo.

[2] Department of Biology, Faculty of Science, University of Kinshasa, Democratic Republic of the Congo.

*Corresponding author: Professor Koto-te-Nyiwa Ngbolua, Tel: (00243) 81 68 79 527 E-mail: jpngbolua@unikin.ac.cd

Received: November 29, 2015, Accepted: January 2, 2016, Published: January 2, 2016.

ABSTRACT

Among the foodstuffs having a nutritional value in Democratic Republic of Congo (DRC), there is the corn crop. It is the second food crop after cassava with a high energetic value in calories and proteins. However, its production remains low in Kinshasa because of the poor quality of soil and less appropriate techniques for its production. It is therefore essential to define new more appropriate strategies in order to increase its availability locally. It is in this context that a study was conducted at the N'djili-Brasserie station for the purpose of assessing the effect of different legumes in crops associated with maize, and implementing technique of simple and adaptable production notably the QPM maize based association system and other food legumes that can play a key role in the soil fertility improvement. According to a randomized complete block system with four repetitions, the data collected were analyzed using the method of analysis of variance (ANOVA) with 5% likelihood point completed by the test of the least significant difference (LSD) to compare the different observed parameters. The findings indicate that T_1 (QPMCorn + Peanut) and T_2 (QPMCorn + Soybean) respectively influenced more vegetative parameters positively than the others. As for the estimated yields, the highest values were recorded in T_1 (7.33 tons/ha) followed by T_2 (7.03 tons/ha) and T_3 (2.95 tons/ha) gave the lowest yield. To that end, T_1 (QPM Maize + Groundnut) and T_2 (QPM Maize + Soybean) can be kept and recommended to farmers in Kinshasa as varieties of associated crops focusing particularly on T_1 (Peanut) for its effectiveness in nodulation and its relatively high yield.

Key words: Yield, legume, association, diet, Democratic Republic of the Congo

INTRODUCTION

Agriculture in tropical African countries is characterized by its low productivity. In Democratic Republic of Congo (DRC), low crop yields are often explained by the natural poverty of soil in nutrients of which the most important is nitrogen and the low use of fertilizers [1, 2]

In the current context of global food shortage, the value enhancement of food crops proves to be essential. Indeed, the high population growth of recent years leads to a high pressure on resources in cultivable lands and causes a sudden increase in demand for plant products useful to man [3]. This high pressure on the plant canopy decreases the capacity of soil to produce the biomass appropriate to the needs of an increasingly numerous population. In such a context, the fallow which was the traditional way of restoring soil fertility is less used because of the high demand for cultivable lands[4]. Among the food stuff shaving a nutritional value, there is the corn crop. It is currently the second food crop in DRC after cassava with a high energetic value in calories and proteins [5].

It is therefore essential to define new more appropriate strategies in order to increase the availability of this foodstuff locally for the well-being of the poor population like that of Africa. Given this situation, it is urgent to develop rational, efficient and accessible fertilization techniques to the producers at lower costs and which would help increase the production perarea unit by maintaining long-term soil fertility [6].

In Sub-Saharan Africa, the most used method for agricultural production in the traditional system for a better value enhancement of land is "the combination of crops". However, the production balance turns out to be less. This technique inefficiency is mainly due to its bad application [7].

Moreover, legume crop is known for its residual effects that are advantageous for associated crops, like soybean, which, known for its richness of proteins, brings to soil more than 300 kg of nitrogen per hectare, 60 Kg of *Vigna unguiculata* and 60-70 Kg of *Arachis hypogaea* [8].

Consequently, the productivity growth of these soils requires an integrated fertility management with a system improving and maintaining this fertility. The QPM maize based association system and other food legumes could to that end play a key role in improving soil fertility and increasing the richness of proteins of this foodstuff.

In this work we compared the three food legumes (*Vigna unguiculata*, *Arachis hypogaea* and *Wisteria max*) in order to identify the best combination that can help the farmers of this country increase their production of the QPM maize in associated crops.

MATERIAL AND METHODS

Geographical location of the site

The experimentation was carried out at the crop scientific station of N'djili-Brasserie, located about 30 km from Kinshasa downtown (4° 29' South latitude and 15° 23' East longitude, 471.31 m of altitude) in DRC. The previous farming consisted of a fallow land dominated by *Cyperus rotundus* and *Cynodon dactylon*. Kinshasa soils are mainly sandy soil texture accompanied by a few coarse elements. The low water retention capacity of these soils gives them a marginal use for agriculture [9]. However, the soil presents a clay texture in the low swampy ground. This soil presents a particular texture with an acid pH (i.e. 4.72). The major minerals are a low proportion or 0.49% for nitrogen; 0.039% for potassium and 0.48% for calcium [10].

The test was conducted from April 20 to August12, 2013 (against growing season A/2013) for the first test and from October 2, 2013 to January 12, 2014 (growing season A/2013) for the second test. The temperature during the period of the test varied between 25.2 and 26.9°C. The crop scientific station of N'djili-Brasserie is bounded in the Eastby the N'djili River, South-East by the Mati River and North by the Mitindi River. The Marubakambaka River rises inside the station, crosses it from west to east and then flows into the N'djili River [11].

The experimental site belongs to climateAw_4according to Koppen's classification. It is a hot and humid tropical climate with four months of dry season. The rainy season ranges from mid-September to mid-May, with two extreme months of maximum precipitation, November and April. It is quite frequently interrupted by a short dry season fluctuating between December end and February. The average temperature ranges from 21 to 26°C in the dry season and from 26 to 32 ° C in the rainy season [3].

Plant Material

The plant material used during this experimentation consisted of a variety of the QPMcorn and three varieties of legumes (Peanut, soybean and Niébé) from the National Institute for Agronomic Study and Research (INERA) Mvuazi/Bas-Congo.

The QPM maize with white grains has high quality of proteins, popularized since 2000 in Ghana under the name of Obatampa and was introduced in Ivory Coast to meet the needs of farmers. This corn rich in proteins has a high rate of lysine and tryptophan compared to normal maize. Its agronomic characteristics are the following: good growth, sowing cycle of maturity from 95 to 106 days, with a period of 50 to 53 days for female blossom. The maximum height of QPM varieties is noticeably more reduced and the insertion levelof the cob significantly lower (<1 m from the ground) compared to local varieties. It is widely grown in West Africa and Central Africa, and in some countries of East Africa and Southern Africa [12, 13].

Methods

The test was conducted according to a randomized complete block system with 4 repetitions. Each block representing a repetition consisted of 4 treatments corresponding to the studied treatments, i.e. a total of 16 plots.

The experimental field had a total area of 155.1 m^2 or 14.1 m long and 11 m wide. The blocks were separated by a distance of 1.5 m and 1 m between two plots. Each experimental plot had an area of 4.8 m^2, or 2.4 m long and 2 m wide and each of them had 24 corn plants. Sowing was performed at the spaces of 80 cm x 50 cm with 3 seeds per seed hole. The three legumes (Groundnut, Soybean and Niébé) together, were installed in processing parcelspacesusing the following spaces: 20 cm x 20 cm for Peanut, 40 cm x 20 cm for Soybean and 50 cm x 25 cm for Niébé.

Ground preparation had consisted of clearing, followed by medium labor (15-25 cm), harrowing and delimitation of the blocks and plots. A week after ground preparation, we proceeded to direct seeding with three seeds per seed hole at a depth of about 3 cm for four species set under study. The shoot took place five days after sowing for maize, four days for soybean and Niébé and six days for groundnuts. The no-marriage was performed 14 days after sowing simultaneously with the emptiness refilling; this consisted of keeping the number of plants to two per seed whole. Next, three series of weeding were done: the first two weeks after the no-marriage and emptiness refilling, the second before blossom and the third before the full maturity of corn. Yet mounding (40 days after sowing that is after the release of adventitious roots) had consisted of collecting soil around plants to enable adventitious roots to grow under the effect of root formation that improves the stability and the nutrition of plants. The data on vegetative parameters and production parameters were recorded from a sample of 10 randomly selected plants per experimental plot.

Statistical analysis

For each studied treatment, the collected data were analyzed using the method of analysis of variance, ANOVA with5% likelihood level. The test for the least significant difference (LSD) was used to compare the results of the different treatments applied. All these tests are carried out using the STATISTIX 8.0 software.

RESULTS AND DISCUSSION

Vegetative parameters

Vegetative parameters observed during the experimentation are shown in Table 2.

Table 2. Results related to the shoot rate (in %), the node diameter (in mm), the average height (in cm) per corn plant on trial.

Varieties	Shoot rate (%)	Node diameter (cm)	Plants height (m)
T_0	96.25a	2.97b	1.36ab
T_1	98.437a	3.17a	1.43a
T_2	96.250a	3.06ab	1.26b
T_3	97.500a	2.83c	1.07c
Average	97.109	3.01	1.28
CV(%)	1.46	4.47	3.77

***Legend**: **T_0**: QPM maize in pure crop; **T_1**: QPM Maize + Peanut; **T_2**: QPM Corn + Soybean and T_3: QPM corn + Niébé. The numbers in the columns followed by the same letters are not significantly different according to the test of the Least Significant Difference (LSD) with 5% likelihood.*

It is clear from Table 2 that statistical analysis with a 5% likelihood point revealed no significant difference between the treatments. The plant shoot had occurred four days after sowing and was spread up to seven days. Assessed 7 days after sowing, the shoot rate was over 96% for all the treatments.

As far as the node diameter is concerned, Table 2 shows us that all the treatments significantly influenced growth in diameter with a noticeable stalk extremity for T_1, which gave an average diameter to the node superior to the others (3.17 cm) and T_3 closing ranks (2.83 cm). Statistical analysis with 5% likelihood level gave the differences between the treatments as for growth in diameter of these different treatments. This can be justified by better adapting QPM associated with groundnut. Finally, the plant height data collected in blossom by means of a tape measure indicate that T_1, T_0 and T_2 present a higher thanT$_3$ (1.43, 1.36 and 1.26 m) while the lowest height was observed in T_3 (1.07 m). Statistical analysis reveals a significant difference between the treatments with 5% threshold (LSD = 1.55). Our findings on the height are almost similar to those found by [10], with an average of 1.4 m.

Production parameters

The results relating to the weight of cobs with rachisper plot, the average weight of dry grains per plot, the weight of 1000 grains and the estimated yield (T/ha) are presented in Table 3.

Table 3. Results related to production parameters

Varieties	Weight of cobs with rachis per plot(kg)	Weight of corn grains per plot(kg)	Weight of 1000 grains(g)	Estimated yield (T/ha)
T_0	2.99c	1.94b	308.75b	3.97b
T_1	5.32a	4.03a	312.75ab	7.33a
T_2	4.71b	3.87a	319.75a	7.03a
T_3	2.37c	1.46c	314.75ab	2.95c
Average	3.85	2.83	314	5.32
CV (%)	8.91	7.67	1.69	7.62

***Legend**: **T_0**: QPM Maize in pure crop; **T_1**: QPM Maize + Peanut; **T_2**: QPM Maize + Soybean and **T_3**: QPM Maize + Niébé. The numbers in the columns followed by the same letters are not significantly different according to the test of the Least Significant Difference (LSD) with 5% likelihood.*

It is apparent from this table that the weight of cobs with rachisper plot indicates that the treatments T_1, T_2 and T_0 respectively present a high weight. Furthermore, T_3 presented the lowest weight of cobs with rachis. Statistical analysis with 5% likelihood level indicates that there is a significant difference between the treatments. As far as the average weight of maize grains per plot is concerned, statistical analysis with 5% likelihood threshold indicates significant differences between the treatments. The highest weight was observed in T_1 (4.03Kg per plot) followed by T_2 (3.87 Kg per plot). T_0 and T_3 presented the lowest average weight of corn grains per plot respectively 1.94 Kg per plot and 1.46 Kg per plot. With regard to the weight of 1000 grains, it is apparent from Table 3 that the weight of 1000 grains ranged between 308.75 and 319.75 grams. The numerical data showed a clear difference between the treatments of which the plants of T_2 gave the higher weight compared to the other treatments (319.75 g). Statistical analysis showed the significant differences between the treatments. As a matter of fact, this result allows considering this parameter as a selection criterion of these treatments for their spread. Finally, the results on the estimated yield in ton per hectare in our test ranged from 2.95 to 7.33 tons. Statistical analyses show the significant differences between the treatments.

The conditions that prevailed during the experimental period were satisfactory for the corn crop. For temperature, the conditions are normal during the test period because the normal development of corn occurs under the conditions of the average temperature between 21 and 32 °C. As far as rainfall is concerned, rains were less abundant during the first three months of the test that constitute the vegetative period of the crop. The average rainfall was 161.55 mm, less than 200 mm while the optimum for corn is from 450 to 600 mm[14]. The best yields are recorded with 600 to 900 mm of rain in the tropics [5]. Rainfall is more and more reduced in January and February, which was unfavorable during the period when many grains are in doughy form [15, 16]. T_3 gave the lowest yield due to the nutrient competition and especially in light that was very strong. Niébé plants through their marked vegetative development practically covered all the corn plants. These being sun-loving, they could not grow well. We can therefore say that legumes contribute to the improvement of the crop yields associated only if there is a better complementary nature between the associated components and without competition between them. While comparing our findings to those presented by [17], whose test was installed on the site of the University of Kinshasa at Mont-Amba Plateau, we notice that this one was able to obtain the lowest values. There emerges a clear difference between our findings and those he found under the different doses of the fertilizers like 5.1 tons of corn per ha against 7.33 tons for our test at the Ndjili-Brasserie crop scientific Station. These differences could be due either to soil richness.

CONCLUSION

The objective of this study was to investigate the influence of the different legumes (peanut, soybean and niébé) on the QPM corn production in crops associated in eco-climatic conditions of Ndjili-Brasserie station. The findings showed that with regard to vegetative parameters T_1 (QPM + Peanut) showed a better evolution to the height and node diameter compared to the others. The best height was observed in T_1 (QPM + Peanut) followed by T_2. As for the estimated yield per hectare, the overall production results obtained after the comparative evaluation of the nodulation characteristics and performance of the three legumes highlighted the performance maintenance of T_1 (QPM + Peanut) followed by T_2 (QPM + Soybean). From all that precedes, considering the importance that must be given to the plan of productivity as well as to that of the soil durability, we suggest that this study can be pursued indifferent areas taking into account the evaluation of other parameters, namely symbiotic efficiency, the nodulation sign, as well as the amount of nitrogen determined by each associated variety.

ACKNOWLEDGMENTS

The authors are indebted to "Académie de Recherche et d'Enseignement supérieur (ARES, Belgium)" for the research grant PAH-2015 ARES/UNIKIN offered to Bangata B.M.

REFERENCES

1. N. Ahamadi, J. Chanterau, L.C. Hekimian, J.L. Marchand, G. Quendeba, 2002. Les céréales, maïs en Agriculture d'Afrique Tropicale. In mémento de l'agronome, Ministère des affaires étrangères et du commerce extérieur et de la coopération Internationale, Bruxelles, 780-794.
2. J. Wey et M.Obaton, 1978. Incidence de quelques techniques culturales sur l'activité fixatrice d'azote et le rendement de l'arachide. Agronomie tropicale 33(2): 129-135.
3. B.M. Bangata, K.N. Ngbolua, M. Minengu, K.N. Mobambo, 2013. Etude comparative de la nodulation et du rendement de quelques variétés d'arachide (Arachishypogaea L., Fabaceae) cultivées en conditions éco-climatiques de Kinshasa, République Démocratique du Congo. Int. J. Biol. Chem. Sci., 7(3): 1034-1040.
4. P. Dugué, E. Vall, P. Lecomte, H.D. Klein,D.Rollin, 2004.Evolution des relations entre l'agriculture et l'élevage dans les savanes d'Afrique de l'Ouest et du Centre.Oléagineux., 11(4):268-276.
5. K.N. Mobambo, 2012. Phytotechnie spéciale, Cours inédit, premier grade Phytotechnie, Faculté des Sciences Agronomiques, Université de Kinshasa.
6. F. Papy et A. Torre, 2003. Quelles organisations territoriales pour concilier production agricole et gestion des ressources naturelles? (à partir de questions d'agronomie et d'économie).Études et Recherches sur les systèmes agraires et le développement.,1(33): 151-169.
7. D. Ristanovic, 2001. Maïs in Agriculture tropicale, Belgique, éd. Raemaekers, R.H. DGCI, Rue des petits carmers, 15- karmelietenstraat 15- B-1000 Bruxelles, 44-61.
8. S. Frontier, D. Pichod–Viale, A. Le Prete, D. Davoult, C. Luczak, 2004. Ecosystèmes : structure, fonctionnement, évolution. 3ème édition Dunod, Agronomie tropicale. 16(3): 93-102.
9. Anonyme, 1998. Ministère de l'agriculture pèche et élevage,recommandation sur l'utilisation d'engrais, SENAFIC- PNE, FAO Kinshasa, 16-17.
10. L. Ndembo, W.R. Masozera, M. Kabwika, M.N. Makumbi, 1987. Evolution des sesquioxydes de fer et d'Aluminium dans un sol de Kimwenza. Rev. Zar. Sci. Nucl., 8(1): 96-107.
11. M. Botula, 2003. Cartographie et zonage de la station phytotechnique de N'djili Brasserie par le système d'information géographique. Mémoire inédit, Faculté des Sciences Agronomiques, UNIKIN, 35p.
12. M. Brink, G. Belay, 2006. Ressources végétales de l'Afrique tropicale1. Céréales et légumes secs, Fondation Prota, Wageningen, Pays- Bas, 328 p.
13. J. Demol, 2001. Amélioration des plantes : application aux principales espèces cultivées en régions tropicales. Presses agronomiques de Gembloux.
14. C. Pieri, 1989. Fertilité des terres de savanes, bilan de trente ans de recherche et de développement Agricole au sud du Sahara, Ministère de la coopération Française et CIRAD- IRAT, p. 31.
15. J. Katanga, 2013. Ecologie végétale appliquée, Cours inédit, deuxième grade Phytotechnie, Faculté des Sciences Agronomiques, Université de Kinshasa.
16. J.L. Marchand, M. Peterschmitt, B. Reynaud, 1994. Les viroses de la striure du strippe et de la mosaïque sur le maïs en région tropicale. Agriculture et développement, 4 (1):1–6.
17. Lumpungu, 2012. Evaluation de rendement de 4 variétés de maïs (Zea mays L.var. QPM,Samaru – Lovo et Locale)dans les conditions écologiques de Kinshasa (Mont-Amba). Mémoire, Inédit, Faculté des Sciences Agronomiques, Université de Kinshasa, 18 p.

Citation: Koto-te-Nyiwa Ngbolua *et al* (2016). Effects of some legumes in crops associated on the growth and production of Corn (Zea mays var. QPM) in eco-climatic conditions of Kinshasa(DR Congo). J. of Advanced Botany and Zoology, V4I1. DOI: 10.15297/JABZ.V4I1.01.