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## RESEARCH ARTICLE

# RESULTS OF AGRO-ECOLOGICAL TRIALS ON PHASEOLUS VULGARIS BEAN (L.) IN THE REPUBLIC OF CONGO

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### ABSTRACT

The objective of this work is to determine the appropriateness of the effect of agroecology in bean plantations to increase bean grain yield and increase the protein content in the grain. Eleven varieties (local and imported) were tested on the agro-ecology of the Republic of Congo, the random block system with three (3) replicates, each block was made up of 11 experimental plots. The results of the agro-ecological trials on beans were carried out by comparing the average rates of the plants. Protein content in grains, protein collection and bean yield at mineral rates were compared to unfertilized plants. The field study with eleven varieties of beans shows that to replace the Nkayi variety, which is a local variety, the VSB variety 1132128 from Germany and the red variety from Cameroon can be introduced into the Republic of Congo.

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## INTRODUCTION

In Congo, vegetable cultivation plays an important role in food production. This is the case for the cultivation of beans (*Phaseolus vulgaris* L.) grown in the Bouenza and Plateaux regions respectively in the localities of Mfouati, Boko-Songho and Lékana (Ntingo and Mandimba, 1994), where farmers have always cultivated a diversity of cultivars. For example, beans, as part of the legumes, are widely cultivated and represent one of the most important components of the diet in Latin America and Africa, due to their high protein content and micronutrients such as iron and folic acid (Salcedo, 2008). Legumes play a crucial role in meeting the growing need for plant proteins in the national economy (Ngbesso et al, 2013). Legumes, as nitrogen accumulators, enrich the soil with nitrogen thanks to the nodular bacteria that grow on their roots, which helps to increase the yield of the crops that follow them. For legume production to continue to grow, it is necessary to significantly increase yields by gradually increasing crops and introducing new high-yielding varieties. According to (Scheider et al, 2015) and (Allen 1996), pulses, including beans, had an estimated average global production of 334 million tonnes per year between 2008 and 2012 and ranked second only to cereals in the world. It is also important to note that beans adapt well to abiotic (drought, phosphorus and nitrogen deficiencies, soil acidity) and biotic (diseases and pests) (Bressani, 1997) constraints, making them a year-round crop when others become scarce.

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Beans contribute to the restoration or maintenance of soil fertility (Borget, 1989). In addition, it can be used as a cover crop and green manure for soil protection against water erosion (Tohill, 1986). Most of the cultivated land is in West Africa (Quin, 1997) and together with Central Africa covers 80% of the cultivated land (Abdou, 1987). In terms of agricultural policy, beans are included in the national agricultural development programme (Anonymous, 2008). In order to contribute to broadening the focus of knowledge on this crop, this study proposes to focus on cultural practices. For example, it targets the agro-ecological effects of the eleven cultivars of bean (*Phaseolus vulgaris* L.) in the Republic of Congo.

## MATERIALS AND METHODS

**Plant material:** The study was carried out on the 11 varieties of beans, the local and imported varieties were purchased at the Total market in Bacongo, Brazzaville.

**Experimental site:** The experimental site was the National Agency for the Valorisation of Research Results (ANVAR) is located in the scientific city of Brazzaville, formerly ORSTOM, it is a reserve of the Goose Paw Forest. It is located on a plateau of 309 m above sea level southwest of Brazzaville (15° 14' of longitude East and 4° 16' of latitude South). It owes its name to the installation in 1947 of the Office of Scientific and Technical Research Overseas (ORSTOM) within it. This forest has an area of 22.48 hectares. The scientific city from the phytogeographical point of view belongs to the flora district of the Léfini according to the phytogeographical subdivision, Kimpouni et al (1992) integrated into the system of White (1979).

The scientific city benefits from a humid tropical climate, of the low Congolese type, which reigns over the south-west of the Congo (Samba-Kimbata, 1978). Evaporation has a relative maximum from February to March and an absolute maximum from August to September (Vennetier, 1977). The average insolation is 140 hours, with two maximums in April-May and November-December and a minimum in July (Koechlin, 1961).

**Trial set-up, experimental set-up and fertilisation:** Experience is a single, lesser factor. The test was set up on a plot of land with a north-south slope. The system of random complete blocks, with three (3) repetitions has been adopted. Each block consisted of 11 experimental plots oriented perpendicular to the direction of the slope to receive the 11 randomly distributed bean varieties. This corresponds to 33 experimental plots. Each experimental plot is 3 m long and 2 m wide. The experimental plots of the same block have a distance of 0.5 m from each other. A replicate corresponds to an experimental plot containing 3 rows of 24 plants with a density of 1 m between the rows and 0.5 m between the plants.

**Fertilization:** The soil of the experimental site is medium black. The agrochemical characteristics of the site are as follows:

- Humus according to Tourina - 6.47%
- PH of salt extraction - 5.0
- P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O, respectively - 29.0 and 26.2 mg/100 g soil
- Sum of bases absorbed (according to Kappen-Gilkowitz) - 29.8 mg\*EQ/100 g soil
- Hydrolytic acidity (according to Daikouhara) - 6.49 mg\*EQ/100 g
- Mobile nitrogen content (according to Tourina) - 6.5 mg/100g soil

Soil treatment included disc clearing and ploughing the land to a depth of 20-25 cm. The treatment of the soil consists of harrowing. The beans were sown at a depth of 1.5 cm. After sowing, the site was rolled into a ring of spur rolls. To control weeds, Bazagran (3 kg/ha) was used, with the massive appearance of aphids, all varieties of beans were treated with the product "Aktar" – the standard of which is 60 g/ha. Yields have been converted to 14% moisture and 100% purity.

observed: the germination rate and the emergence rate of the varieties; This parameter is carried out, taking into account the number of seeds sown out of the total number of emergence. The plant habit was observed on the stems and ramifications of the different varieties during the flowering phase. The development cycle was counted from sowing to harvest and yield was assessed by production per hectare. All data were statistically analyzed using XLSTAT software version 7.5.3. The results of the agro-ecological trials on beans were carried out by comparing the average rates of the plants. The comparison between the means of all variables was made by the Student Newman-Keuls test at the 5% threshold.

## RESULTS

### **Growth and development variables for the eleven bean varieties:**

The 11 bean varieties growth trial was evaluated in the field, three days after planting, emerged plants were counted one by one, for each elementary plot, a emergence rate was calculated based on the number of seeds planted (Table 2). Sowing was manual with spacings of 1m between rows and 0.3m between plants, i.e. a density of 126 plants/m<sup>2</sup>. The bean was sown in pockets with three seeds per pocket, for a total of 24 pockets per elementary plot. Plant height was measured six times a week during the reproductive cycle, using a tape measure to the centimetre (cm) from the sixth days after sowing on a sample of 10 plants randomly selected per elementary plot. The measurements were made on the plants on the intermediate lines. This height is considered the distance between the crown and the terminal bud of a plant. Table 2 shows the emergence rate, emergence rates of 97.3%, 94.4% and 90% were observed respectively on the Cameroon red variety, the Flamingo variety and the VSB 1132128 variety, and the low emergence rates were observed on the Cameroonian white variety and the Kazanets variety. During the flowering phase, observations made on the stems and ramifications of the different varieties showed that the white variety of Djambala, variety VSB11, white variety of Nkayi, variety Tan and white variety of Cameroon are twining, while the yellow variety of Kindamba, yellow variety of Mouyondzi, flamingo variety, white variety of Bouansa, Kazanets variety and red variety from Cameroon are dwarf (Table 3). In Table 3, these observations have shown whether the variety is dwarf or twining.

**Table 1. Bean varieties included in the trial design**

1. White Variety of Nkayi	Congo	7. Cameroon White Variety	Cameroon
2. VSB 1132128	Germany	8. Flamingo	Russia
3. Red variety from Cameroon	Cameroon	9. Bouansa White Variety	Congo
4. White variety of Djambala	Congo	10. Kazanets	Tatarstan
5. White variety of Kindamba	Congo	11. Tan	Tatarstan
6. White variety of Mouyondzi	Congo		

**Table 2. Germination rate by variety based on total number of plants emerged**

Varieties	Number of seeds sown	Total number of tricks	Lift Rate (%)
White variety of Nkayi (standard)	72	70	97,2
VSB 1132128	72	65	90,3
Red variety from Cameroon	72	70	97,2
White variety of Djambala	72	62	86,1
Kindamba Yellow Variety	72	58	80,5
White variety of Mouyondzi	72	58	80,5
White variety from Cameroon	72	56	77,7
Flamingo	72	68	94,4
White variety of Bouansa	72	50	69,4
Kazanets	72		70,8
Tan	72	63	87,5

**Measured Variables and Data Analysis:** During the experiment, data collection was done during observations and by measurements. The variables studied focused on agronomic performance: growth and development variables, yield and crude variables (fat and protein content). During the vegetative phase, five (5) variables were measured: emergence rate, plant habit, development cycle, yield, and gross (fat and protein content). Two growth parameters were

The parameters that have been considered for the habit are the stem and its ramifications. The growth mode was determined at the growth stage. Despite the plant habits and growth pattern observed on the eleven varieties, VSB 1132128 gave a good yield compared to the other varieties due to its higher pod production. From sowing to flowering, the number varies from 32 days for the yellow varieties of Kindamba and Mouyondzi.

**Table 3. Plant growth habit of the eleven varieties used in the trial**

Varieties	Plant Habit	Growth Mode
White variety of Nkayi	voluble	undetermined
VSB 1132128	voluble	undetermined
Red variety of Cameroon	dwarf	determined
White variety of Djambala	voluble	undetermined
White variety of Kindamba	dwarf	determined
White variety of Mouyondzi	dwarf	determined
White variety from Cameroon	voluble	undetermined
Flamingo	dwarf	determined
White variety of Bouansa	dwarf	determined
Kazanets	dwarf	determined
Tan	voluble	indeterminate

**Table 4. Productivity of the different varieties of beans**

Variety	Growing period, days	Performance per year T/ha				Gross	
		2021	2022	2023	Average	Fat	Protein
White variety of Nkayi (standard)	78	3,03	2,83	4,08	3,31	2,21	18,37
VSB 1132128	90	2,96	2,84	4,14	3,31	2,13	18,39
Red variety from Cameroon	76	2,94	2,62	3,85	3,14	2,32	16,62
White variety of Djambala	78	3,01	2,76	3,94	3,24	2,40	18,38
Kindamba Yellow Variety	76	2,16	2,85	3,44	2,82	2,30	17,36
White variety of Mouyondzi	76	2,68	2,75	3,74	3,06	2,80	18,12
White variety from Cameroon	80	2,39	2,45	3,74	2,86	2,58	18,20
Flamingo	88	2,71	2,70	3,61	3,01	2,12	18,43
White variety of Bouansa	78	2,05	2,46	2,99	2,50	2,22	18,62
Kazanets	78	1,87	2,42	3,54	2,61	2,62	18,90
Tan	86	1,94	2,47	3,69	2,70	2,20	18,64
HCP <sub>0.05</sub> t/ha		0,290	0,322	0,328			

The 34-day delay was observed with the white varieties of Nkayi and red varieties of Cameroon. The period between sowing and flowering was 36 and 38 days respectively for the white varieties of Djambala, Kazanets variety and white variety, Bouansa, as well as the white variety from Cameroon. On the other hand, the time between sowing and maturity of the pods was 76 days for the yellow varieties of Mouyondzi, yellow of Kindamba, red of Cameroon. This period was 78 days for the white varieties of Nkayi, Djambala, Bouansa and the Kazanets variety. While the late varieties were observed, for the white variety of Cameroon 80 days, the Tan variety 86 days, Flamingo 88 days and the VSB variety 1132128 with 90 days, and the values of fat and protein content are in the table below. Table 4 shows that none of the varieties tested exceeded the standard in terms of yield. The yield obtained from the VSB variety 1132128 on average for 3 years is equal to the standard. Similar yield data were obtained for the white varieties of Djambala (3.24 t/ha) and the red variety of Cameroon (3.14 t/ha), with the yield of the white variety of Mouyondzi (3.31 t/ha). The latest varieties were found to be Rayonnantes: VSB 1132128 (90 days), Flamingo (88 days) and Tan (86 days). The growing period of the other varieties tested averaged 77 to 80 days. In terms of fat content, the white variety of Mouyondzi has a high rate of 2.80g; and the Kazanets variety, high in fat and protein. Biochemical analysis of the grain revealed no significant differences in its composition depending on the variety.

## DISCUSSIONS

The observations made during this study highlighted the effects of eleven varieties of the bean on the agro-ecology of the Republic of Congo. Emergence was observed between the third and sixth days for all eleven varieties. Our results coincide with those of (Kouanga, 1997) who observed emergence between the third and ninth day after sowing ;(Mahoungou, 2001) also observed emergence from the third day and then it was staggered at different rates. The spread of the emergence could be due to the low soil moisture level in relation to the quantities of water that fell during the period. (Hudson et al. 1997) found a strong relationship between soil moisture and percent emergence. Similarly (Ndaeyo and Aiyelari, 1993) obtain for different treatments such as tillage, emergence percentages of

between 90.6% and 97.4%. They believe that tillage has not had a significant impact on emergence and attribute excellent results to good soil moisture. (Bikindou, 1997) observed for groundnut cultivars; heterogeneous emergence and attributes this to the lack of water that prevailed during the first days after sowing. The rapid growth of the main stem observed in varieties with an indeterminate growth pattern at two months after sowing is explained by the fact that this period with the flowering time during which the rate of photosynthesis would be high in order to be able to satisfy the plant's needs for elaborate substances necessary at the time of flower initiation (Heller, 1995). For the parameter number of pods per<sup>m2</sup>, we observed a significant difference in the effects of the cultivation of the varieties studied in the Republic of Congo.

## CONCLUSION

This agro-ecology study of eleven local and imported varieties of beans (*Phaseolus vulgaris* L.) was conducted within the walls of the Scientific City (formerly ORSTOM) under the supervision of the National Agency for the Promotion of Research Results (ANVAR), for three years. The methods used have allowed us to achieve our objectives, namely to identify the different local and imported varieties that can give yields on the eleven varieties chosen, four variables of these varieties: Germination rate, plant habit, yield and gross (fat and protein content). Thus, the field study with eleven varieties of beans shows that to replace the Nkayi variety, which is a local variety, the VSB variety 1132128 from Germany and the red variety from Cameroon can be introduced into the Republic of Congo.

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