

EFFECT OF CHEMICAL FERTILIZERS ON PRODUCTION OF YAMS (NYÛ) OF PASSORÉ IN FARMERS' ENVIRONMENT

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ABSTRACT

Nyû is the main morphotype of yams of Passoré. It is generally cultivated without chemical fertilizer. The study aims to determine the effect of one rate of chemical fertilizers on the yield of yams « nyû » of Passoré in farmers' environment of Burkina Faso and to collect the appreciations of the various actors about tubers in the production chain. The results reveal that chemical fertilizer involved a better expression of the agro-morphological parameters and an increase of the tubers yield which reaches 42.5 t / ha compared to the field not fertilized where tuber yield is slow (9 t / ha). However, tubers obtained of treated field have not a good organoleptic quality whereas the tubers of untreated fields have good taste. Moreover, the chemical fertilizer changed also the morphology, taste and consistency of the tubers. These results could help all actors to choose the best method of nyû production according to their objectives.

Key words : nyû, yam, mineral fertilizer, Passoré, Burkina Faso.

RESUME

EFFET DE L'ENGRAIS CHIMIQUE SUR LA PRODUCTION DE L'IGNAME (NYÛ) DU PASSORÉ DANS LE MILIEU PAYSAN

Nyû est le principal morphotype des ignames du Passoré. Il est généralement cultivé sans engrais chimique. L'étude vise à déterminer l'effet de la teneur d'un engrais chimique sur le rendement du « nyû » en milieu paysan du Burkina Faso et à recueillir les appréciations sur le tubercule des différents acteurs de la chaîne de production. Les résultats révèlent que l'engrais chimique entraîne une meilleure expression des paramètres agro-morphologiques et une augmentation du rendement des tubercules qui atteint 42,5 t / ha par rapport au champ non fertilisé où le rendement des tubercules est faible (9 t / ha). Cependant, les tubercules obtenus dans le champ fertilisé n'ont pas une bonne qualité organoleptique alors que les tubercules des champs non fertilisés ont un bon goût. De plus, une modification de la morphologie, du goût et de la consistance des tubercules à également été observée dans les champs fertilisés. Ces résultats pourraient aider les différents acteurs à choisir la méthode de production appropriée du nyû en fonction de leurs objectifs.

Mots clés : nyû, igname, fertilisant minéral, Passoré, Burkina Faso.

INTRODUCTION

Yam is a tuber plant in the tropical zone with high rainfall (800mm water / year), which is the staple food for more than 300 million people worldwide (FAO, 2008). West Africa contributes over 90 % of world production (FAO, 2013). National yields in the order of 9 to 35 t / ha in Ivory Coast (Kouakou *et al.*, 2012), 14 to 23 t / ha in Benin (Dumont *et al.*, 2010), 13 to 16 t / ha in Burkina Faso (Tiama, 2016) are still low compared to the plant potential estimated of about 60 to 70 t / ha (FAOSTAT, 2012). Global yam production is estimated in 2013 at more than 60 million tones, according to the FAO. Despite the work devoted to this plant, its cultivation remains subject to strong constraints such as the unavailability of seeds, diseases (anthracnose and virosis), the decline in yield of varieties, the decline of soil fertility and abandonment of the cultivation of yams in favor of less arduous crops. All these constraints could contribute to a genetic erosion of yams as a whole. Nevertheless, the fact remains that the work on the yield and culinary quality of these plants is deepened, and this, in relation to the current farming practices in yam production areas. In northern Burkina Faso, the cultivars «nyù», yam of Passoré represent more than 99% of cultivated areas (Tiama, 2016). However, the yield of «nyù» tubers is impaired by soil depletion in the region. In view of the drastic reduction of cultivation, it is important to extend the cultivation method by the use of chemical fertilizers to meet the new challenges of finding high-yielding technics in relation to the cultural practices of the use of these crops chemicals by producers. Hence, the interest of our study which is aims to determine the response of the nyù to chemical fertilization and the related organoleptic qualities.

MATERIAL AND METHOD

PLANT MATERIAL

The plant material consists of 41 accessions of the morphotype «nyù». The accessions were collected in 13 villages distributed in five departments of the province of Passoré. Each sample of the morphotype collected from a farmer constitutes an accession.

METHOD

Experimental site

The trials were conducted during the season 2015 - 2016 in Passoré, precisely in the village of Mia in order to allow yams to better express their agro-morphological potentialities. Mia belongs to the Arbolle department with coordinates located at 12 ° 50'29 North, 02 ° 03'48.1 West, 377 m above sea level. The annual rainfall is less than 700 mm. During the year of our test, the month of August was always the most watered (235 mm). The experimental site is characterized by shallow soil and sandy-clay. The trials were set up in January during the wind « *harmattan* » period, where the soil contains suitable moisture for storage of seed tubers before the rainy season.

Experimental design

The test was conducted according to a Fisher block device with three replications. Each repetition has been subdivided into 41 ridges. The ridges had a length of 2 m. The three replications consisted of 123 «nyù» logs per plot. In total, 246 ridges were obtained for the two plots including 123 ridges received fertilizer and 123 without fertilizer. The replications were separated by 2 m and the ridges 0.5 m. Each ridge contained five cuttings per accession spaced 50 cm a part. Chemical fertilizer at the rate of 40 g per pocket (200 g per ridge) was added during planting on one of the plots.

CHARACTERS OBSERVED

Quantitative traits

Seven quantitative traits were measured. There are stem length at emergence (LTI), stem diameter (DTI), leaf length (LLI), leaf width (LRL), tuber length (LTU), tuber diameter (DTU) and tuber weight (PTU).

Qualitative traits

Four qualitative traits relating to the tuber such as tuber morphology, tuber consistency, tuber conservation and taste of boiled tuber were noted. They were appreciated by 60 persons including 20 persons per actors group

(producers, sellers, consumers). The taste of boiled tuber was noted on a scale of 1 to 5 where 1 is the low level of the quality of the boiled tuber and 5 is the high level.

1 - very bad , 2 - bad, 3 - enough good, 4 - good ; 5 - very good

DATA ANALYSIS

The processing and analysis of the collected data were carried out using Excel 2007, Xlstat pro 752 and Statistica version 6 software. Pretreatment of data and histograms of variation of results of qualitative traits were done with Excel 2007. The analysis of variance (ANOVA)

at 5% and Newman-Keuls separation average test in order to compare the treatments were performed with Xlstat pro. 752. The others analyzes such as coefficients of variation, Mean, minima, maxima for each character were computed using statistica.

RESULTS

VARIATION OF QUANTITATIVE TRAITS

The results of analysis of variance between accessions of no fertilizer plot and fertilizer plot are recorded in Table 1.

Table 1 : Variation of agro-morphological characters under NPK fertilizer

Traits	0 NPK				200 g NPK			
	Min.	Max.	CV (%)	Pr snk	Min.	Max.	CV (%)	Pr snk
LTI (cm)	1.2	2.8	15.22	< 0.0001	1.8 cm	2.9 cm	13.21	0.005
DTI (mm)	2.2	3.8	9.38	< 0.0001	3.2	6.01	14.18	< 0.0001
LLI (cm)	11.2	13	2.53	< 0.0001	12	13	2.54	< 0.0001
LRL (cm)	7.9	9	3.35	< 0.0001	12	13	2.54	< 0.0001
LTU (cm)	31	54.6	0.36	< 0.0001	34.5	57.8	14.45	< 0.0001
DTU (mm)	36.8	61.6	12.18	< 0.0001	54.6	437.5	10.52	< 0.0001
WTU (g)	343.2	704.6	22.21	< 0.0001	351.6 g	3100.6 g	21.77	< 0.0001

Legend : length stem (LTI), stem diameter (DTI), leaf length (LLI), leaf width (LRL), tuber length (LTU), tuber diameter (DTU) and tuber weight (WTU), Min.: minimum, Max.: Maximum, CV : coefficient of variation, Pr snk :probability at the threshold from 0.05, test

Plot without NPK fertilizer

Results of analysis of variance recorded show that all traits discriminate very significantly accessions. Two weeks after emergence of the stem, the length varied from 1.2 to 2.8 m. At the flowering stage, the stem diameter varied from 2.2 to 3.8 mm, the length and the width of the leaf varied respectively from 11.2 to 13 cm and 7.9 to 9 cm. At harvest, the length of the tuber varied from 31 to 54.6, the diameter 36.8 to 61.6 mm and the weight 343.2 to 704.6 g. For this purpose, the tuber yield is 9 t/ha. Except tuber weight, the coefficient of variation of others traits are low (< 20 %).

Plot with NPK fertilizer

Results reveal that except tuber weight, the coefficient of variation of others traits is low

(< 20 %). All characters discriminate very significantly accessions. Two weeks after emergence, the length of the stem varied from 1.8 to 2.9. At the flowering stage, the diameter varied from 3.2 to 6.01, the length of the blade varied from 12 to 13 cm and the width varied from 12 to 13 cm. At harvest, the parameters of the tuber such as length, diameter and weight varied respectively from 34.5 to 57.8 cm, 54.6 to 437.5 mm and 351.2 to 3100.6. The tuber yield is 42.5 t / ha..

AGRO-MORPHOLOGICAL PERFORMANCES OF NYÛ UNDER NPK FERTILIZER TREATMENT

Results recorded in table 2 reveal that a highest value of all characters was observed under NPK fertilizer treatment. Tuber weight and tuber diameter show the largest increases in performance with respective increases of + 483 %

and 598 %. These same characters have also the highest coefficients of variation (> 30 %) while the others traits show a low coefficients of

variation. Except leaf length (LLI) and tuber length (LTU), the other characters allow to discriminate significantly the two type of plot.

Table 2 : Agro-morphological parameters of nyù accessions according of type of plots

Parameters	NPK fertilizer		CV (%)	Pr
	0 NPK	200 g NPK		
LTI (cm)	2.102b ± 0.321	2.444a ± 0.323	17.51	< 0.0001
DTI (mm)	3.132b ± 0.294	4.464a ± 0.633	21.93	< 0.0001
LLI (cm)	12.348a ± 0.312	12.346a ± 0.313	2.54	0.0983
LRL (cm)	8.415b ± 0.282	12.346a ± 0.314	19.27	< 0.0001
LTU (cm)	42.154a ± 0.153	43.276a ± 6.525	14.94	0.429
DTU (mm)	48.668b ± 5.927	339.80a ± 34.92	76.03	< 0.0001
WTU (g)	518.826b ± 115.21	3024.949a ± 65.954	71.35	< 0.0001

Legend : length stem (LTI), stem diameter (DTI), leaf length (LLI), leaf width (LRL), tuber length ((LTU), tuber diameter (DTU) and tuber weight (WTU), Min. : minimum, Max.: Maximum, CV : coefficient of variation, Pr snk : probability at the threshold level of 0.05 snk test, values followed by the same letter in the same column are not significantly different at the threshold level of 0.05 snk test

Variation of qualitative traits

The results relative of the level of appreciation of the tubers of the two types of tests are recorded

in Figure 1. Tubers of plant under NPK fertilizer treatment have the lowest organoleptic qualities.

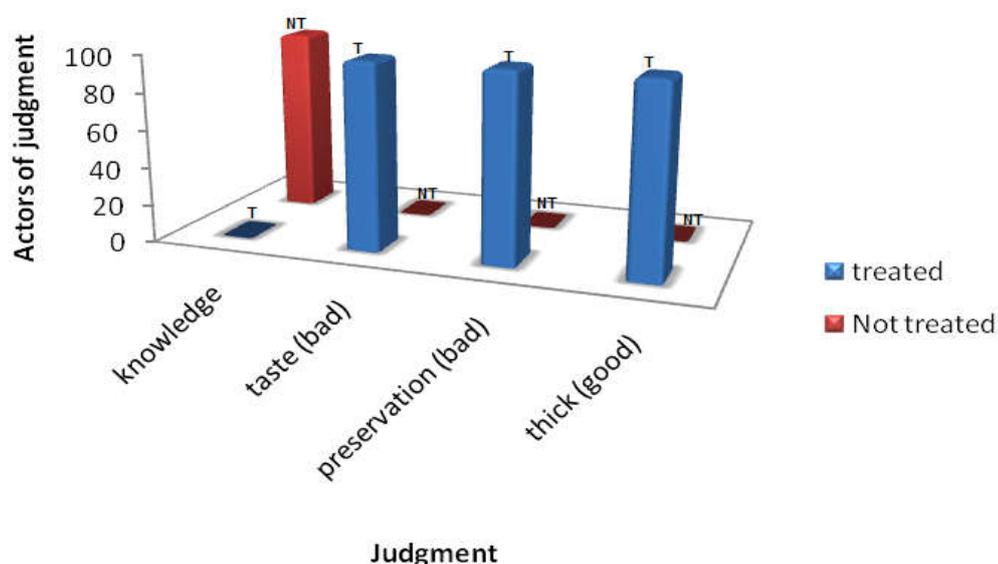


Figure 1 : Appreciation level of actors.
Legend : NT : not treated, T : treated

Untreated plant

All actors easily recognize the nyù from morphology (Figure 2) and taste. They add that the tuber becomes more fragile and difficult to keep as seed. On the morphological level, the

actors recognize the yams « nyù » by taking them by the basal part which is explain by the breakage of the yam. The tubers remain indeed filiform with a rough appearance but smooth to the touch.



Figure 2 : Picture of tubers of plant not treated with NPK

Treated plant

All actors of Mia do not systematically recognize the tubers of the treated plants (Figure 3) and do not consider them as those of the zone. They confuse them with those in the border areas of the country like Leo, which is the main area of yam production of Burkina Faso. The tubers of the treated nyù are different from the yams of

these areas by the skin. The tubers have grown and do not resemble to the usual yams of this area. The volume of the tuber reflects a high water content. Moreover, tuber does not break when taken from the base. In fact, the northern populations of tubers do not know the tubers of plants treated with manure. According to them, the exaggerated enlargement of the tubers is due to bad seeds.



Figure 3 : Picture of tubers treated with NPK

DISCUSSION

The northern zone of Burkina Faso is predominantly dominated by ferritic soils, which are generally poor in organic matter, which limits their potential to support high plant production in a sustainable manner. In view of the difficulties of supplying organic fertilizers due to the lack of government aid (Tiama, 2016), it appears necessary to use chemical or mineral fertilizers. Yam production differs from one country to another. In Burkina Faso, unlike other countries,

production is done on ridges. This practice consists in exploiting small areas, but by planting numerous seeds. The yields of 9 t/ha for tubers without mineral input and 42.5 t/ha with mineral fertilizer input are similar to Ballot (2016) in Central Africa, he obtained on fresh cassava, an increase of weight of fresh tuber per hectare which varied by 18.7 t/ha for the control treatment without fertilizer at 40.2 t/ha with treatment. These results are far superior to the Ivorian environment where National yields ranged from 8 to 15.5 t/ha for *D. cayenensis-rotundata*, 7.5 to 11.3 t/ha for *D. alata* (Soro et

al., 2002) and from 13 to 27 t / ha (Kouakou *et al.*, 2012). This difference would be due to the cultivation on billon in all areas of Burkina Faso. This practice on ridges considerably reduces the spaces between the seed boxes (Tiama, 2016). Moreover, the difference is also due to the amounts of fertilizer applied. In fact, according to Soro *et al.*, (2002), the rate used of NPK (15 15 15) in experimental site is 580 kg / ha but in the farmers' environment, the producers used on average 200 kg / ha of fertilizers. The quantity of fertilizers therefore plays a positive role in the yield. All stakeholders had a positive assessment of the size of the tubers that had undergone treatment with mineral fertilizer.

However, all actors do not recognize their yam when it is treated with the doses used by the producers. The results show that the yams subjected to the mineral fertilization are not of good organoleptic quality and also for the seed. Unlike tubers subjected to mineral inputs (Soro *et al.*, 2002, Kouakou *et al.*, 2012) the organoleptic quality was not modified. The results of the survey carried out among farmers producing and the quality assessment of raw tubers and the quality of raw tubers Cassava ball have shown that there is no effect of mineral fertilizers on the organoleptic quality of cassava after fertilization in 2016 by Ballot. This difference in results shows the lack of mastery of the use of mineral fertilizer in the peasant environment. In addition, dehydration is accelerated on these yams and there is a rapid decay of tubers in case of the slightest injury during harvest. They are therefore bad seeds, with the risk of rot very fast during storage. These rot risks have been observed with other tubers plant in Burkina Faso such as fabirama (Nanéma, 2010), and taro (Tiama, 2010). Mineral fertilizer use in yam cultivation in the province is due to poor soils and lack of organic fertilizer, and also aims to meet the increased demand of the urban population. In contrast to the producing countries, whose soils are still rich, the producers exploit large areas and without any contribution of chemical fertilizers (Yolou, 2016).

CONCLUSION

Mineral fertilization has considerably increased the yields of « *nyù* ». The yield without mineral input is 9 t / ha and 42.5 t / ha with input. However, a change in tuber morphology and degrading organoleptic quality were noted. Consumers and

producers are the main actors in the production chain. Their requirements on culinary quality and seed must be imperative. For a better precision of the effects of mineral fertilization, research could be oriented on the different optimal doses while keeping the organoleptic quality and the shape of the tubers of « *nyù* ». The results of this research could be considered as a means to fight the poor productivity of yams from the soil of the Passoré region in Burkina Faso.

For a better quality through the fertilizer, it would be interesting to carry out a study to determine the optimal doses. Also, a study with manure will bring more clarification on the different effects of fertilizer.

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