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Characterization Agromorphological of five cultivars of eggplant (*Solanum aethiopicum*) grown in Ivory coast

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Abstract

To select eggplant high yielding cultivars and adapted to ecological conditions of Côte d'Ivoire, a trial was carried out at Anguededou Station of CNRA, between June and December 2008. It consisted to assess the agronomic performances of 5 eggplant cultivars (*Solanum aethiopicum*) collected from diverse ecological areas of the country. The experimental design was a Randomised Block Completed Design with 4 replications. Observations and measures were recorded on cultivars vegetative behaviour at field, dates of phenologic stages, fructification rate and yield components. Results showed that cultivars were vegetative well developed at the all observations dates. Concerning the days to flowering, all the cultivars flowered between 90 (Aub1N/06Dk) and 108 Days after sowing (Aub42K/06Ti). Aub42K/06Ti and Aub21N/06Du cultivars recorded the highest fructification rate with 87.3 % and 72.7 %, against 43.6 % for the local witness. The Aub1N/06Dk cultivar was the most productive with 10.3 t/ha of net yield. The local witness obtained 2.8 t/ha. To pursue these cultivars eggplant selecting, it would be indicated to undertake multilocal trials in order to appreciate their agronomic aptitude in other agro-ecological environments of Côte d'Ivoire

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Introduction

The eggplant, a vegetable grown for its leaves and/or fruit, is much appreciated in West and Central Africa. She indeed occupies fifth place behind the tomato, onion, pepper and gumbo (SCHIPPERS 2000). Eggplant belongs to Solanaceae family and genus Solanum which includes many crop species, the best known in Ivory Coast are *Solanum melongena* L., *Solanum aethiopicum* L. and *Solanum macrocarpon* L. The species *Solanum melongena* was the subject of more research. Indeed, global production was estimated in 2004 to almost 23 million tons and an area of 1.4 million hectares. China (56 %) and India (28 %) are the main producers in the world (Ihtizaz *et al.*, 2015). Africa represents less than 4 % of world production for this species. Regarding S*olanum aethiopicum* and S*olanum macrocarpon*, their productions were estimated in 2004 to 60 000 tons in Ivory Coast, 45 000 tons in Senegal and 8000 tons in Burkina Faso (Lester and Seck, 2004). In Ivory Coast, eggplant has an important place in people's diet. It is grown throughout the territory. However, large production sites are located in forest areas. Otherwise, the production and supply of large eggplant markets are now an income generating activity in Côte d'Ivoire (Bationo-Kando *et al.*, 2015). However, production of eggplant is facing many constraints that limit the productivity of this crop in Ivory Coast. Indeed, eggplant is grown in traditional cropping systems characterized by improved lack of cultivation technique. The needs of nutrients, their doses and application frequency in eggplant cultivation are not controlled by the producers (Fondio *et al.,* 2003). Effective techniques of crop protection against diseases and pests are not available on-farm. The cultivated accessions are usually traditional, less productive and responsive to biotic factors. To make available to producers of improved varieties, the former Institute of Savan (IDESSA) had undertaken a plant breeding program of vegetable crops since 1990. The program, which was taken over in 1999 by the National Center Agronomic Research (CNRA) had identified local cultivars of eggplant high performance *Solanum aethiopicum* and *Solanum macrocarpon*.

Unfortunately, the program was interrupted by the political and military events triggered in September 2002, which resulted in total destruction of eggplant collection CNRA in Bouaké. In 2003, CNRA, took over the plant breeding program by the reconstruction of a collection of 54 local eggplant cultivars from various agro-ecological zones of Ivory Coast. The first agro-morphological characterization activities on six cultivars of this collection have identified four quite productive accessions (N'Tamon, 2007; Fondio *et al.,* 2004). Therefore, this study aims to confirm agronomic performance of these four eggplant cultivars observed for selection for pre-extension-farm studies. Specifically, it is to determine the main agronomic traits of these four cultivars (Phenological stages, yield components, vegetative development) compared to a control cultivar.

Materials and methods

Study site

The work was conducted at the experimenting and Productions Station of CNRA to Anguédédou. This station is located in the town of Songon, 30 km southwest of Abidjan, on the road Abidjan-Dabou. Its geographical coordinates are: 5 ° 22 North latitude, 4 ° 08 West longitude and at an altitude 95 m. The climate is hot and humid with an average monthly temperature of 26 ° C, an annual rainfall of 2000 mm and a monthly humidity constantly around 80%. The soil, ferralitique type is sandy clay texture with a high proportion of sand (70%) dominated coarse matter (50%). It is permeable and has good drainage.

Planting materials

The plant material consists of five cultivars belonging to two different groups of species *Solanum aethiopicum* (Figure 1). Accessions studied belong to collection of CNRA. But they come from different regions of Ivory Coast and are designated by codes:

-Aub1N/06Dk comes Dimbokro (Centre);
-Aub21N/06Du comes from Duékoué (west);
-Aub33K/06Gn comes from Gagnoa (south-west);
-Aub42K/06Ti comes Tiassalé (South);
-Aub T Grown Anguédédou (South) where applicable our internship served as a control.

The collection of accessions is based on the shape of fruit (Figure 1).

Technical materials

For plants cultivation and maintenance, several working tools were used: mineral fertilizers (NPK 10-18-18, sulfate of potash), systemic insecticides Callidium (Dimethoate at 400 g/l) and Stork (Cypermethrin 50 g/l), Ivory80 WP fungicide (Mancozeb to 800 g/l), water and atomizer. Observations and measurements required the use of a measuring tape, digital camera, balance of 30 kg range, pairs of scissors, thread, rubber bowls and clear jars.

Experimental design

The test was arranged Fischer completely randomized blocks with four repetitions which factor is the cultivar. There are 24 elementary plots. Each elementary parcel, dimension 5 m x 3 m or 15 m², consists of three ridges measuring 5 m × 0.5 m or 2.5 m². The distance between ridges is 0.75 m. On the ridges, the plants are equally spaced 0.5m, or 10 plants per ridges, 30 plants per elementary parcel, 120 feet by cultivars, 480 feet for testing. The spacing between two elementary contiguous parcels of the same block is 0.75 m, while that between two contiguous repetitions is 1 m. the experimental plot dimensions are 31 m x 12 m, 372 m² with 300 m² floor space as. Thus, all cultivars were first sown in nurseries and transplanted later to the field. Planting was carried out in June on boards 2 m² (2 m x 1 m). These boards have been amended NPK 10-18-18 at 20 g/m² rate. After sowing, the boards were regularly watered. The nurseries were transplanted 45 days after sowing (DAS) for all accessions. It is performed on ridges already enriched NPK10-18-18 at 250 kg/ha and 200 kg/ha of potassium sulphate. After planting, the plants were watered every morning and every evening for two weeks. The first harvest began at fruit maturity taking into account the maturity criteria that differ from one cultivar to another. After the first harvest, the following crops were weekly performed for all cultivars.

Statistical analysis

Statistical analyzes were performed with SAS software. The analysis of variance ANOVA followed by a comparison of average by Duncan test at 5% level was carried out to separate the means of various parameters studied.

Results

Vegetative parameters

Cultivars Aub42K/06Ti and Aub33K/06Gn recorded the largest number of plants (28) per elementary parcel at 30 days after transplant (DAT). They are followed by Aub1N/06Dk cultivars Aub21N/06Du and AUBT who recorded 27 plants per elementary parcel. The accessions were therefore introduced in all a good vegetative development that decreases over time (4.3 to 2.72). Cultivars Aub1N/06Dk, Aub21N/06Du and Aub42K/06Ti were better developed than the cultivars Aub33K/06Gn and AUBT. The Klongbo Aub42K/06Ti has developed the largest size at flowering stage. It is followed in descending order by Aub21N/06Du, Aub33K/06Gn, Aub1N/06Dk then AUBT.

Table 1. Yield and yield componnents as affected by state of vegetative development.

Cultivars	Plants number of 30 day after transplant (DAT)	State of vegetative development				Plant height at flowering (cm)
		30 DAT	50 DAT	60 DAT	9 0 DAT	
Aub1N/06 Dk	27,2 ± 2,2 a*	5,0 ± 0,0 a	4,0 ± 0,7 a	4,2 ± 0,9 a	3,0 ± 0,0 a	47,6 ± 5,4 cd
Aub21N/06Du	27,2 ± 2,4 a	4,2 ± 0,4 bc	3,5 ± 0,5 a	3,7 ± 0,8 ab	3,2 ± 0,8 a	54,6 ± 2,9 b
Aub33K/06Gn	27,7 ± 2,1 a	3,7 ± 0,4 c	3,3 ± 0,6 a	2,7 ± 0,5 c	1,8 ± 0,5 c	49,6 ± 2,4 bc
Aub42K/06Ti	28,2 ± 0,4 a	4,5 ± 0,5 ab	3,6 ± 0,4 a	3,4 ± 0,6 abc	3,1 ± 0,5 ab	67,4 ± 3,2 a
AubT	26,7 ± 3,1 a	4,0 ± 0,7 bc	3,3 ± 0,4 a	3,1 ± 0,2 bc	2,3 ± 0,4 bc	42,4 ± 3,3 d
P (%)	0,9445	0,0252	0,2393	0,0386	0,0085	0,0001

* In the same column, values followed by the same letter are not significantly different (Duncan test at 5%).

Analysis of variance revealed no significant differences between cultivars in number of plants to 30 DAT. However, a difference was observed between cultivars in state of vegetative development of cultivars and plant height at flowering (Table1).

Phenological dates

The parameter studied (emergence period) showed that cultivars Aub1N/06Dk, Aub42K/06Ti and AUBT germinate faster than cultivars Aub21N/06Du and Aub33K/06Gn. Plant emergence was observed on average 5 day after sowing (DAS). N'drowa were more precocious than Klongbo regarding the parameters flowering period and time to first harvest. Statistical analysis revealed no significant difference between cultivars regarding the emergence period. However, a significant difference was observed between cultivars at time of flowering and first harvest (Table 2).

Table 2. Components as affected phenological dates.

Cultivars	Emergence period (Days)	Flowering period (DAS)	Time to first harvest (DAS)
Aub1N/06Dk	5,0 ± 0,0 a	90,2 ± 3,5 d	101,5 ± 0,8 d
Aub21N/06Du	6,0 ± 0,0 a	94,0 ± 1,3 cd	107,5 ± 5,5 bc
Aub33K/06Gn	6,0 ± 0,0 a	100,2 ± 5,4 b	109,7 ± 5,6 b
Aub42K/06Ti	5,0 ± 0,0 a	108,5 ± 4,5 a	117,0 ± 0,0 a
AubT	5,0 ± 0,0 a	95,5 ± 4,3 bc	102,0 ± 0,0 cd
P (%)	0,0001	0,0001	0,0004

* In the same column, values followed by the same letter are not significantly different (Duncan test at 5 %).

Fruit setting rate and yield components

Accessions Aub42K/06Ti (87.3 %), Aub21N/Du (72.2 %) and Au1N/06Dk (66 %) were the top performers in terms fruit set. They are followed by Aub33K/06Gn and AUBT who got 45.5 % and 43.7% respectively. The number of fruits produced per plant at harvest was higher in Klongbo with an average 7.5 and 12.5 fruits per plant. On average, an eggplant plant brought six fruits per harvest. N'drowa produced fruit with the highest average weight, with 30.7 g (AUBT), 29.2 g (Aub21N/06Du) and 24.3 g (Aub1N/06Dk). Statistical analysis confirmed that the difference observed between the cultivars, regarding these three parameters (fruit setting rate, number of fruits per foot per crop and average weight of a fruit), is significant (Table 3).

Table 3. Rate of fruit set and some yield components.

Cultivars	Taux de nouaison (%)	Nombre de fruits par pieds et par récolte	Poids moyen d'un fruit (g)
Aub1N/06Dk	66,0 ± 1,3 ab	3,9 ± 0,4 c	24,3 ± 1,0 b
Aub21N/06Du	72,7 ± 1,1 a	4,0 ± 0,3 c	29,2 ± 1,3 a
Aub33K/06Gn	45,5 ± 1,6 bc	12,5 ± 3,5 a	7,8 ± 0,5 d
Aub42K/06Ti	87,3 ± 1,3 a	7,5 ± 0,6 b	9,5 ± 0,7 c
AubT	43,7 ± 1,3 c	1,5 ± 0,2 c	30,7 ± 1,2 a
P (%)	0,0045	0,0001	0,0001

* In the same column, values followed by the same letter are not significantly different (Duncan test at 5 %).

Accessions Aub1N/06Dk, Aub21N/06Du, Aub42K/06Ti were more productive with respective net yields 10 t/ha and 10.4 t/ha. They are followed by (6.8 t/ha), Aub33K/06Gn (6.3 t/ha), AUBT (2.8 t/ha) respectively. Klongbo produced more fruit than N'drowa and recorded the lowest rate rotten fruit. The difference between cultivars for each of these parameters is significant (Table 4)

Discussion

Parameters vegetative

The high rate (90 %) of vegetation recovery observed in accessions would be justified by their ability,

though from diverse ecological origins to adapt to ecological conditions and farming techniques when performing the test. Before 50 days after transplant (DAT), cultivars show good vegetative development with an average of 4.3 out of 5. This is due to mineral fertilizers made and maintenance (weeding and watering) which probably favored the growth of plants.

After this date, the relative decrease in crop development may be related to the transition from the vegetative phase to reproductive stage (flowering and fruiting): the first buds appeared between 44 and 60 days after transplant for all cultivars. N'tamon (2007) also reported the decrease in vegetative development of eggplant cultivars during the transition from the vegetative phase to reproductive phase.

Table 4. Evolution of yield components as affected of varieties.

Cultivars	Gross yield (t/ha)	Net yield (t/ha)	Total number of fruits	Rotten fruit rate
Aub1N/06Dk	14,6 ± 2,3 a	10,4 ± 2,0 a	902,2 ± 2,3 ab	34,5 ± 5,9 a
Aub21N/06Du	13,3 ± 1,4 a	7,8 ± 1,2 ab	690,5 ± 2,7 b	27,6 ± 3,3 a
Aub33K/06Gn	6,9 ± 3,1 b	6,3 ± 2,8 c	1293,2 ± 2,1 a	12,9 ± 3,0 c
Aub42K/06Ti	8,4 ± 1,5 b	6,8 ± 1,3 abc	1296,0 ± 3,4 a	20,4 ± 3,8 b
AubT	3,7 ± 0,7 c	2,8 ± 0,9 c	181,7 ± 2,1 c	30,7 ± 4,7 a
P (%)	0,0001	0,0004	0,0005	0,0001

* In the same column, values followed by the same letter are not significantly different (Duncan test at 5 %).

Dates phénologiques

All cultivars germinate after 5 to 6 days after sowing (DAS). This result confirms the work of Lester and Seck (2004) who indicated within 5 to 9 days for germination of *Solanum aethiopicum*. The lack of significant difference observed between the cultivars compared to delay germination and the plants number having taken at 30 days after transplanting, means that accessions, although belonging to two different cultigroups, would have the same behavior at a young age. However, the significant difference observed between cultivars for the flowering period settings and first harvest delay would show that Klongbo would later that N'drowa. This result is contrary to that of N'tamon (2007) who observed no significant difference between these accessions on these two parameters. In addition, his work has reported an average time to flowering of 103 day after sowing and an average time to first harvest of 129 days after sowing against 98 and 108 days after sowing respectively with this study. There has been a reduction of cultivars development cycle. Also, according to Van Damme (1986) from June to July seedlings have the effect of reducing the eggplant production cycle in contrary those from March to May. Planting date could therefore play an important role in the duration development cycle for our seeding was conducted in June while those N'tamon (2007) were made in May.

Fruit setting rate and yield components

Fruit set of eggplant cultivars took place during the month of September. During this month, the humidity was high (84%). Despite this factor that hinders fruit set of eggplant, accessions Aub42K / 06Ti and Aub21N / 06Du have well established. Indeed, in eggplant fruit set occurs only in the presence of high dry matter content. But the strong dry matter content is subject to significant perspiration causing a significant deficit of saturation of sheet. Thereby saturating humidity, as well as water rationing, causing adverse stomatal regulation in carbon assimilation, are adverse factors in fruit set (Nyadanu *et al.*, 2014). The above show the ability of both accessions to establish well in adverse circumstances unlike other eggplant cultivars. The significant difference detected at the average fruit weight, number of fruit per plant and harvest could be explained by the interaction between flowers number per inflorescence, the fruit set rate and genotypes of each cultivar.

Indeed, solitary flowers at accessions usually give bigger and heavier fruit than those of inflorescence cultivars. In addition, artificial enhancement of fruit setting rate in a cultivar is accompanied by a reduction in the size and weight of fruit (Nyadanu *et al.*, 2014). The size and weight, are a classification criteria of species (Schippers, 2000). Moreover, the number of fruits per plant per harvest is 9.1 to 12.37 for Klongbo (A cultigroupe *Solanum aethiopicum*) characterized by small fruits. While that of *Solanum macrocarpon* characterized by big fruits, varies from 1.2 to 2 (N'tamon, 2007). This implies a reduction in the number of fruits harvested by foot following an increase in fruit size. Thus, the Klongbo plants characterized by clusters of 5-15 flowers produced many more smaller fruits than those of N'drowa characterized by solitary flowers and relatively big fruits (N'tamon, 2007).

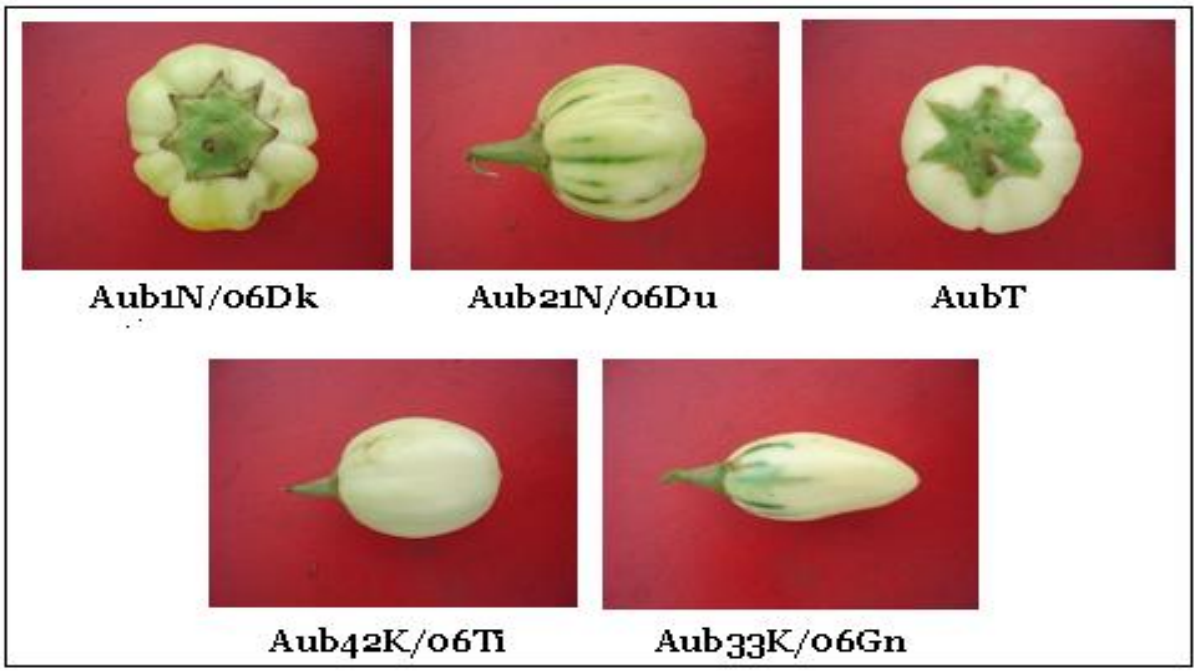

Fig. 1. Eggplant cultivars Fruits studied.

This would justify why the total number of fruit was higher in Klongbo than N'drowa. For yield, the significant difference observed between cultivars of same species (*Solanum. aethiopicum*) and between accessions same cultigroupe indicate a yield variability within species and each cultigroupe. Schippers (2000) indicated that yield variability for cultivars of Gilo group (12 to 20 t/ha). N'tamon (2007) also observed this yield variability: 18.3 t/ha to 23.9 t/ha for N'drowa and 14.1 t/ha to 17.2 t/ha in Klongbo. Accessions Aub33K/06Gn and AUBT were less productive. This is due to their low fruit set. The relatively high yields recorded in Aub1N/06Dk, Aub21N/06Du and Aub42K/06Ti are justified by their ability to form well. This result concord with the work of N'tamon (2007) who have shown that high yields of these cultivars have succeeded high fruit set rate.

Damaged fruit rates observed in our study ranged from 12.9 % to 34.6 %. This seems to justify the low net yields of 6.9 t/ha to 10.7 t/ha. Furthermore, the low yields observed in our study unlike those of N'tamon (2007) which are of 14.1 t/ha to 23.9 t/ha would be due to reduction of production cycle. Indeed, Van Damme (1986) reported that the reduction of production cycle leading to yield reduction.

Conclusion

The test agronomic evaluation of five of eggplant cultivars led to the production station and experimentation station of Anguédédou (Côte d'Ivoire) revealed that cultivars, although they come from different agro-ecological zones, were vegetatively well developed in ecological conditions of study environment, with a high rate (90%) recovery plant 30 days after transplanting.

Accessions Aub1N/06Dk, Aub21N/06Du and Aub42K/06Ti recorded the best rate of fruit set and the best net returns. The best performing cultivars by uncrossing order are Aub1N/06Dk, Aub21N/06Dk and Aub42K/06Ti.

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