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RESEARCH ARTICLE

CULTURAL PRACTICES AND PRODUCERS PERCEPTION ON SENSORIAL CHARACTERISTICS OF SOME TOMATO VARIETIES PRODUCED IN SOUTH BENIN.

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Abstract

The tomato is grown in all regions of Benin with cultivation practices varying according to production areas. This study documents the cultural practices and producer's perception on quality of tomato varieties produced in South Benin. A survey was carried on 120 market gardeners with 40 tomato producers in Sèmè-Kpodji; Pahou and Grand-Popo. Survey results showed that all producers interviewed produced improved varieties of tomatoes and those of local are cultivated by all interviewed producers of Pahou and 45% of interviewed producers in Sèmè-Kpodji. Drilling is the main source of water for crops irrigation of different tomato varieties in three surveyed areas. Regarding band irrigation system and using connection, were mostly used in Grand-Popo and in two other localities. The surveyed producers number using the organic, mineral and foliar fertilizers varied according to area surveyed. The trowelling of plants was carried out by 23.93 % of producers. To investigate the damage caused by pests/ diseases, 94.83 % of tomato producers used phytosanitary treatments through chemical control against 3.45 % for biological control. Principal Component Analysis (PCA) allowed to identify four main tomato cultivation practices in South Benin. The tomato is produced once a year according to most producers interviewed whose the appreciation of organoleptic characteristics varied whatever the variety.

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Introduction:-

Native to South American Andes, tomato (*Lycopersicon esculentum* Mill.) has become one of most important vegetables of world. It was introduced later in Europe and from there, it cultivation spread to Africa (Shankara et al., 2005). In Benin, tomato is grown throughout the territory and particularly in six departments of southern Benin that provide 80% of production. Its cultivation is a lucrative activity for many producers in rural, urban and peri-urban areas (Djidji et al., 2010; Agassounon et al., 2012). It provides producers a substantial income that allows them to

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meet a few vital needs, despite low production mainly due to biotic constraints. The annual production is constantly increasing, from 157 414 tons in 2005 to 400 000 tons in 2015 (DSA / MAEP, 2015). In southern Benin, cultivated areas are becoming increasingly scarce because of population pressure. The colonization of sandy zones of Littoral authorizes many market gardeners to indulge in tomato cultivation as well of high season as against season (Mensah, 2004). Cultivation practices include soil preparation, nursery, plant transplanting, crop maintenance (watering, mulching, manure, phytosanitary treatment) and harvesting. Lawani et al. (2000) reported that vegetable crops cannot be grown without fertilizer inputs. This is why organic fertilizer (manure from poultry) and minerals (NPK and urea) were applied in order to have good productivity and high efficiency (Dablaka, 2004). The lack of control over farming techniques (irrigation doses, chemical fertilizers, organic fertilizers, pesticides, etc.) and composting techniques (incomplete sorting of waste) increases the risk of accumulation of some pollutants in the soil, water and in plants (Vodouhe, 2014). The tomato requires sufficient soil moisture and regular watering is favorable for its development. In addition, climatic and edaphic factors lead a high parasite pressure and considerably limits the production of this crop (Huat 2006, Péron 2006). In fact, the high pluviometry and the constantly high temperature promote the development of fungal diseases, which reduce tomato production. The high intensity of rains causes the bursting of fruits which generates a high fruit damage rate (Djidji et al., 2010). According to Son et al. (2017), apical necrosis caused either by calcium deficiency or by water stress (poor distribution of irrigations) is observed frequently for producers with an impact on quality fruits. The knowledge of current conditions of tomato production in Benin is a prerequisite for actions aimed at improving them and therefore quality of tomato produced. The present study aims to listing cultivation practices and producer's perception on quality of some varieties of tomato introduced recently in Southern Benin.

Methodology:-

Presentation of study area

The study was carried out in three production areas (Sèmè-Kpodji, Pahou, and Grand-Popo). These three zones are located in department of Oueme, department of Atlantic and in department of Mono respectively and were chosen for the high production of improved varieties of tomato found in these localities. The choice of these zones was confirmed by Regional Center for Agricultural Promotion (CeRPA) and office "Afrique Conseil" which reported that the study on these three areas allows a good level of representativeness for sector of tomato production in Benin (Yehouessi, 2012).

Sampling and data collected

The survey was carried on 120 producers whom cultivate the tomato in priority. About forty tomatoes were sampled per commune. The questionnaire administered to producers was on types of cultivated varieties, factors of production, cultural practices and producer's perception on organoleptic quality of some cultivated varieties. Thus, data on cultivated tomato varieties; water source; irrigation system; types of fertilizer used and the assessment of their contribution; pest / disease types; control methods and organoleptic criteria for cultivated varieties were collected from tomato producers.

Data analysis

The survey cards were manually tabulated and entered into an EpiData version 3.1 data mask and analyzed using Minitab 14 software. The Pearson chi-square test was used to evaluate the dependence of type of cultural practice on area surveyed. In order to characterize tomato cultural practices in southern Benin, a Principal Component Analysis (PCA) was used to identify the links between different types of varieties, of fertilizer, of irrigation system and to identify the main groups of producers using these practices. A correlation value of one point on an axis greater than 0.500 in absolute value is considered significant in PCA.

Result:-

Description of cultural practices.

Improved tomato varieties are cultivated by all interviewed producers whatever the survey area (Table 1). The main improved varieties produced were Mongal, Padma, Thorgal, Platinum, Petomech, Tropimech, Roussol, Caribbean, Totine, Royal, Pentaire, Palemous and Sumo. Local varieties (Tounvi, Akikon and Waga) are produced by all producers of Pahou and 45% of those of Sèmè-Kpodji.

Different water sources are exploited by surveyed producers to produce the tomato (Table 2). In all surveyed areas, the main source of water supply for crop irrigation was drilling for 91.6% of interviewed producers namely 32.8%; 33.6% and 25.2% respectively in Grand-Popo; Pahou; and Sèmè-Kpodji. Results of Chi-square independence test indicated that the water source is independent of surveyed area (chi-square = 14.366, dof = 4, $p = 0.006$). The irrigation system used by surveyed producers, however, depended of surveyed locality (Chi-square = 107.493, dof = 6, $p = 0.000$). Watering by tourniquet was the most used in Grand-Popo by 18.2% of all interviewed producers. Those in Pahou and Sèmè-Kpodji used the majority of interviewed producers, respectively 28.2% and 14.5% of all producers interviewed, compared to 1.8% and 13.6% respectively who used watering cans to irrigate their crops. The band irrigation system is applied by 17.3 and 8.33% of all interviewed producers respectively in Grand-Popo and Pahou.

The use of different types of fertilizer is a practice observed in all surveyed producers (Table 3). In general, organic manures and chemical fertilizers are distinguished. The organic manures used were: poultry droppings according to 17.2 and 33.6% of all producers interviewed found in Grand-Popo and Pahou; the cow dung according to 0.9 and 13.8% of producers found in Pahou and Grand-Popo and garbage by 0.9% of all producers found in Grand-Popo and Sèmè-Kpodji. The use of these different organic manures varied according to the area surveyed (Chi-square = 38.443, dof = 6, $p = 0.000$). Chicken dung was the main form of organic fertilizer used. All producers met confirmed the use of mineral fertilizers. Urea and cotton NPK are the two types of mineral fertilizers used by market gardeners. They are applied much more alone than in mixed form. The use of NPK was more common. In the case of foliar fertilizers, DI-Grow is used for 1.4 ; 2.7 and 20.5% of the producers surveyed in Pahou; Sèmè-Kpodji and Grand-Popo respectively whereas 37; 16.4% and 21.9% of producers surveyed in the same areas used other foliar fertilizers such as Super-Grow or Harvest-More. The use of mineral fertilizers (Chi-square = 12.125, dof = 2, $p = 0.002$) and foliar (Chi-square = 16.908, dof = 2, $p = 0.000$) depended significantly on the locality surveyed. During the production cycle of the tomato, all surveyed producers brought to the plants an average of twice the organic fertilizer whatever the type that is to say during the first and fifth weeks after transplanting. The average quantities declared to be used by the producers of Pahou; Sèmè-Kpodji and Grand-Popo were 112; 69.18 and 91.5 kg / 125 m² and 73.56; 69.6 and 71.66 kg / 125 m² for poultry droppings and cow dung respectively. The quantities of NPK declared to be applied to the tomato plants were 5.65; 7 and 8.24 kg /125m² for Sèmè-Kpodji producers; Grand Popo and Pahu. This fertilizer is provided once (respectively 22 or 24 days after transplanting) in the areas of Grand-Popo and Sèmè-Kpodji and twice (13 and 26 days after transplanting) by the producers of Pahou. As for urea, it is applied once (respectively 27 or 31 days after transplanting) to Grand-Popo and Pahou and twice (22 and 49 days after transplanting) to Sèmè-Kpodji. The average amounts of urea reported to be used by producers were 3.73; 3.92 and 4.1 kg / 125 m² respectively in the Sèmè-Kpodji areas; Grand Popo and Pahou. Some producers mixing urea and NPK at 1: 1 ratios reported applying this fertilizer mixture during the fourth or sixth week after transplanting at a rate of 1.52 kg / 125 m². Survey data also revealed the use of foliar fertilizers at least twice from the sixth week after transplanting the plants to medium amounts ranging from 44.56 to 55.88 ml / 16 l for an area of 125 m².

The percentage of tomato producers who practice staking in the surveyed areas was 23.93%. Staking is a practice that supports plants and keeps fruits and leaves above the ground.

The daily fight against pests and diseases is a constraint for all producers surveyed. So, the different types of pests according to the periods of attack and the means of control used (Table 4) were identified with the producers. According to the latter, regardless of the survey area, attacks by caterpillars, mites, viruses and plant wilt caused by *Scleotium rolsii* and *Ralstonia solanacearum* can be distinguished in order of their importance. They occur at any time of the year. But attacks are more important in the rainy season than in the dry season. According to 88.7% of the respondents, more chemicals than organic products were used to fight against these attacks. The sprayer is used more than the watering can by the producers for the application of phytosanitary products to the tomato plants.

The ACP of the cultural practices and the producers interviewed allows us to note that the first component explains 51.8% of the initial information and that with two components, we manage to explain 74.1% of the information contained in the initial variables, which is sufficient to guarantee a precision of interpretation of Figure 2. The variety variable is positively correlated with the first component while the fertilization variable is negatively correlated with it. We can deduce that the type of fertilization depends on the choice of the variety to be cultivated. On the second component, irrigation system and control variables are representative and negatively correlated. This reveals that the irrigation system is associated with the means of struggle for the cultivation of tomatoes in South Benin.

A joint observation of Figures 2 and 3 classified the producers into four main groups. The first group consists of producers A12 to A40; B23 to B40 and C27 to C40 from Grand-Popo, Pahou and Sèmè-Kpodji respectively, which grow the improved tomato variety with a combination of organic and mineral fertilizers. The second group included producers (A1 to A4) from Grand-Popo, who grow the improved tomato variety with a combination of organic, mineral and foliar fertilizer. Producers B4 to B22 and C5 to C26 respectively of Pahou and Sèmè-Kpodji form the third group, they use the irrigation system by fitting or watering can and use chemical control to cultivate the local variety of tomato. Producers A5 to A11; B1 to B3 and C1 to C4 respectively of Grand-Popo, Pahou and Sèmè-Kpodji constituting the fourth group have adopted the irrigation system by band or tourniquet associated with chemical control to cultivate the improved variety of tomato. In general, an improved variety of tomato is grown with an expensive irrigation system (strip or turnstile) and receives balanced fertilization (organic, mineral and foliar). On the other hand; the local variety is cultivated with an intermediate irrigation system (connection or watering can) and intermediate fertilization (organic and mineral).

Perception of producers on the organoleptic characteristics of cultivated varieties

The interviewed producers produce the tomato at least once a year. The interviewed producers' assessment of the organoleptic characteristics of fruits from the six main tomato varieties grown in southern Benin varied from one variety to another (Table 5). According to the majority (59.38 to 95.65%) of the producers, the fruit texture of the Tounvi and Akikon local varieties and the improved varieties Padma, Thorgal and Platinum were firm while that of the improved Mongal variety was soft. As for the shape of the fruits, the four improved varieties had large fruits while the forms of those of the local varieties were qualified as average by the producers. Regarding the color of the fruits, at least 63.64% of the producers found that those of the Tounvi, Akikon, Padma, Thorgal, Platinum varieties were red and those of the Mongal variety less red. The latter had an acid taste according to the majority (93.75%) of the producers surveyed, whereas in their opinion the Thorgal variety appeared sweet. The producers remained indifferent about the taste of Tounvi, Padma and Platinum varieties.

Discussion:-

In the study area, it is observed that all producers interviewed produce the improved tomato varieties. In fact, improved tomato varieties are seed-derived plants that have been propagated by manual pollination and where male and female parent lines are controlled. These hybrids combine the characteristics of high yield and good resistance against diseases (Shankara *et al.*, 2005). Thus, growing these tomato varieties will improve the yield (8t / ha) (FAO, 2013) of local tomato production in Benin. These results corroborate those obtained by Mensah (2004) who reports that the improved varieties are the most cultivated in urban areas. Access to water is a factor that determines the type of irrigation system. The producers surveyed are located on sites located on sand, which implies a high permeability of the soil, which is why they mainly use drilling to obtain water. Irrigation is very important for good plant development during the vegetative growth phase, but is even more important during fruit formation (Verolet *et al.*, 2001; Courchinoux, 2008). In fact, an irregular water supply causes apical necrosis on fruits (concentric dark brown spots at the end of the fruit), due to a slowing down of the migration of calcium towards the fruits (Edouard, 2010). Thus, the soil of the three localities surveyed being sandy; it is necessary to ensure a good regularity of the irrigation because the lack of regular water decreases the caliber of the fruits. All the market garden farms surveyed use organic and mineral fertilizers to fertilize the soil and obtain a good yield. Some growers spray the leaves with foliar fertilizers for good growth. In Benin, the recommended research dose is 10t / ha for poultry droppings and 200 kg / ha for NPK. For this purpose, producers use doses higher than those recommended for mineral fertilizers, which leads to soil degradation (Mensah, 2004). It is observed that tomato fruits of better quality are those obtained with a balanced organic and mineral fertilization. Excess nitrogen causes excessive vegetation, delayed production, sometimes hollow fruit formation, increased susceptibility to diseases and pests, and reduces the shelf life of tomatoes (Edouard, 2010). It is recommended by research to bring potash at the rate of 100 kg / ha to meet the needs of the plant. Unfortunately, none of the producers surveyed uses it, and tomatoes need potassium for fruit formation and ripening.

Prevention of diseases and pests is extremely important for tomato cultivation. Thus, to control these, 94.83% of producers use chemical fertilizers whose products and non-recommended doses are applied to tomato plants. The non-use of pesticides recommended by producers leads to pollution of the environment, contamination of tomato fruits which can lead to poisoning of consumers (Padap 2003, Assogba Komlan *et al.*, 2007, Son *et al.*, 2017).

At least three-quarters (76.07%) of the producers surveyed do not practice gold staking according to Edouard (2010). Tutors facilitate plant development; pinching and harvesting fruit. In addition, staking reduces fruit rot. So, not doing the staking, the producers are exposed to a high rate of fruit rot, especially in the flood zones. On the other hand, the staking requires more resources and a large workforce, hence the low rate of achievement of this practice by the respondents.

The typology made on the basis of PCA of the cultural practices reported in this study and of the interviewed producers made it possible to distinguish four types of tomato growing practices in South Benin. Tomato cultivation according to current production practices is more interesting because the irrigation system has improved compared to the traditional use of watering cans by producers to water their crops based on the work of Mensah (2004). These new cropping practices will also produce tomatoes without waiting for rain, as tomato production was based exclusively on the rainfed system in southern Benin. The appreciation of the organoleptic quality of the tomato fruit varied from one producer to another according to various criteria. It is also apparent from the perception of the producers surveyed that improved tomato varieties are more popular than local varieties.

Conclusion:-

From this study, it appears that all the producers surveyed cultivate the improved varieties whereas the local ones are produced in Pahou and Sèmè-Kpodji. Drilling and tap irrigation are the main modes of water use for tomato production in the three surveyed areas. Only band and turnstile irrigation systems are found in Grand-Popo. With regard to cultural practices, the variations observed from one locality to another are due to the non-respect by producers of the recommendations of the national research, in particular the staking of plants and especially the doses of fertilizers and products phytosanitary. Combining the levels of four main factors (type of cultivated variety, irrigation system, fertilizer use and control), four types of tomato growing practices were established in southern Benin. Producers' perceptions of fruit quality were highlighted by taking into account the organoleptic criteria of the six main varieties grown.

Of all the above, a certain number of actions deserve to be carried out by the competent authorities and researchers of the National System of Agronomic Research of Benin for the promotion of the cultivation of improved tomato varieties in South Benin.

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Table 1:-Types of cultivated varieties by farmers in surveyed areas of South Benin

Areas	Local variety		Improved variety	
	Proportion of producer's number per area (%)	Name of varieties	Proportion of producer's number per area (%)	Name of varieties
Grand-Popo	0	-	100	Mongal
				Padma
				Thorgal
				Platinum
				Petomech
				Tropimech
				Caraiibe
Pahou	100	Tounvi Akikon	100	Mongal
				Padma
				Thorgal
				Platinum
				Pectomech
				Tropimech
				Roussol
				Totine
Sèmè-Kpodji	45	Tounvi Akikon Waga	100	Royal
				Mongal
				Padma
				Thorgal
				Platinum
				Tropimech
				Pentaire
				Palemous
				Sumo

- : No Local variety

Table 2:-Different mode of using water by producers in surveyed areas in South Benin

Areas	Water source	Proportion of producer's number total (%)	Irrigation system	Proportion of producer's number total (%)
Grand-Popo	Drilling	32.8	Turnstile	18.2
	Rainwater	0.8	Band	17.3
			Connection	0.9
Pahou	Drilling	33.6	Connection	28.2
	Rainwater	0.8	Band	8.33
			watering	1.8
Sèmè-Kpodji	Drilling	25.2	Connection	14.5
	River water	5.0	watering	13.6
	Rainwater	1.7	Turnstile	2.7
chi-square = 14.366 ; dof = 4 ; p = 0.006			chi-square = 107.493 ; dof = 6 ; p = 0.000	

Table 3:-Different mode of using water by producers in surveyed areas in South Benin

Type of fertilizer		Areas														
		Grand – Popo					Pahou					Sèmè – Kpodji				
		Proportion of producer's number total (%)	Application Number	Application period (DAT)		Average quantity (kg)	Proportion of producer's number total (%)	Application Number	Application period (DAT)		Average quantity (kg)	Proportion of producer's number total (%)	Application Number	Application period (DAT)		Average quantity (kg)
Organic fertilizer	Poultry manure	17.2	2	7	26	91.5	33.6	2	5	24	112	31.9	2	7	30	69.18
	Cow dung	13.8	2	15	30	71.66	0.9	2	15	30	73.57	-	2	15	30	69.60
	Household waste	0.9	-	-		-	-	-	-		-	0.9	-	-		-
chi-square = 38.443 ; dof = 6 ; p = 0.000																
Mineral fertilizer	NPK	22.7	1	22		7	32.8	2	13	26	8.24	21.0	1	24		5.65
	Urea	10.9	1	27		3.92	1.7	1	31		4.1	10.9	2	22	49	3.73
	Mixture	-	2	26	45	1.25	-	1	34		1.52	-	1	33		1.52
chi-square = 12.125 ; dof = 2; p = 0.002																
Foliar Fertilizer	Di-grow	20.5	2	20	27	44.56	1,4	2	30	37	55.88	2,7	2	29	38	55.13
	Other	21.9	2	30	38	55.13	37.0	2	28	36	54.37	16,4	2	22	32	45.38
chi-square = 16.908 ; dof = 2; p = 0.000																

DAT: Day after Transplanting

Table 4:-Pest attacks and means of struggle indicated by tomato producers surveyed in South Benin

		Proportion of producer's number total (%)
type Attack	Caterpillar	31.66
	mites	31.66
	Viroses	18.33
	wilting	15.83
Period of attack	Any period	43.10
	Dry season	20.69
	Rainy season	36.21
Organ attacked	Leaf	45
	rod	36.36
	Root	13.33
	Fruit	4.16
Control method	Biological	3.45
	chemical	94.83
	Biological and chemical	1.72
Type of pesticide	Biological	0.87
	Chemical	88.70
	Biological and chemical	10.43
Phytosanitary treatment device	Sprayer	97.37
	watering	2.63

Table 5:-Producers' assessment of the organoleptic characteristics of the six main varieties of tomatoes grown in southern Benin

Proportion (%) of total producers by sensoral characteristic							
Features		Tounvi	Akikon	Padma	Thorgal	Mongal	Platinum
consistency	Farm	84.62	86.81	60.61	78.26	4.69	50
	Molle	15.38	13.19	39.39	21.74	95.31	50
Size	Big	29.23	20	59.38	95.65	91.8	81.82
	Middle	49.23	66.67	34.38	4.35	8.2	18.18
	Small	21.54	13.33	6.25	0	0	0
Color at maturity	Red	73.44	81.11	84.38	100	39.06	63.64
	Less red	23.44	17.78	15.63	0	60.94	36.36
	Not red	3.13	1.11	0	0	0	0
Taste	Sucré	35.38	52.75	29.41	59.09	4.69	45.45
	Acid	1.54	3.3	5.88	13.64	93.75	0
	Neither sweet Neither acid	63.08	43.96	64.71	27.27	1.56	54.55

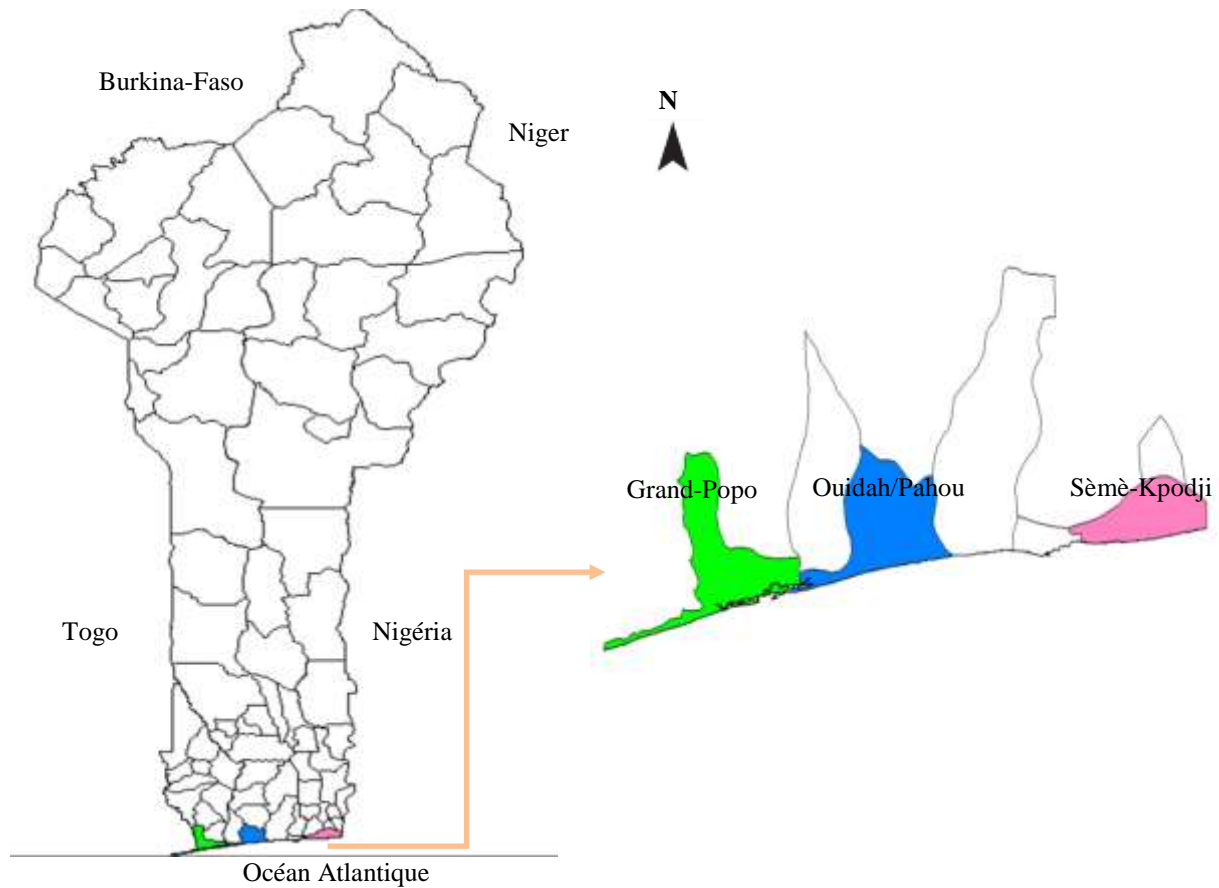


Fig 1:-Location of surveyed municipalities in South Benin

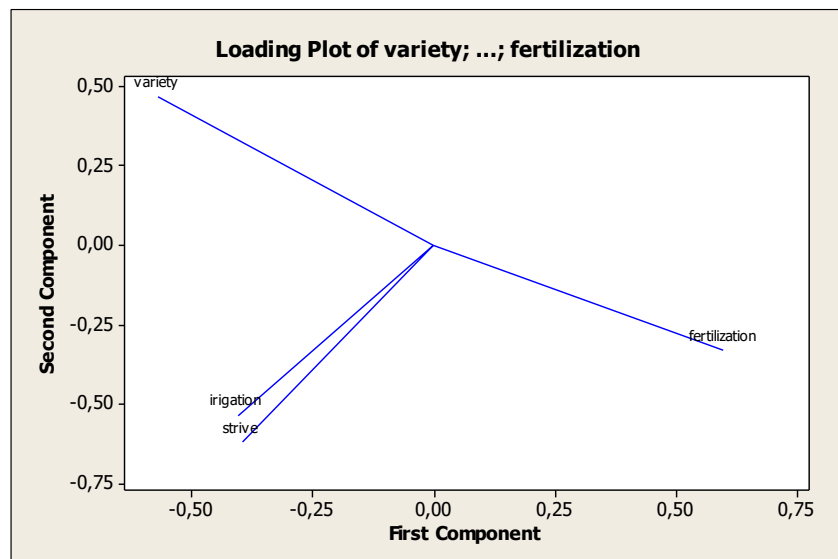
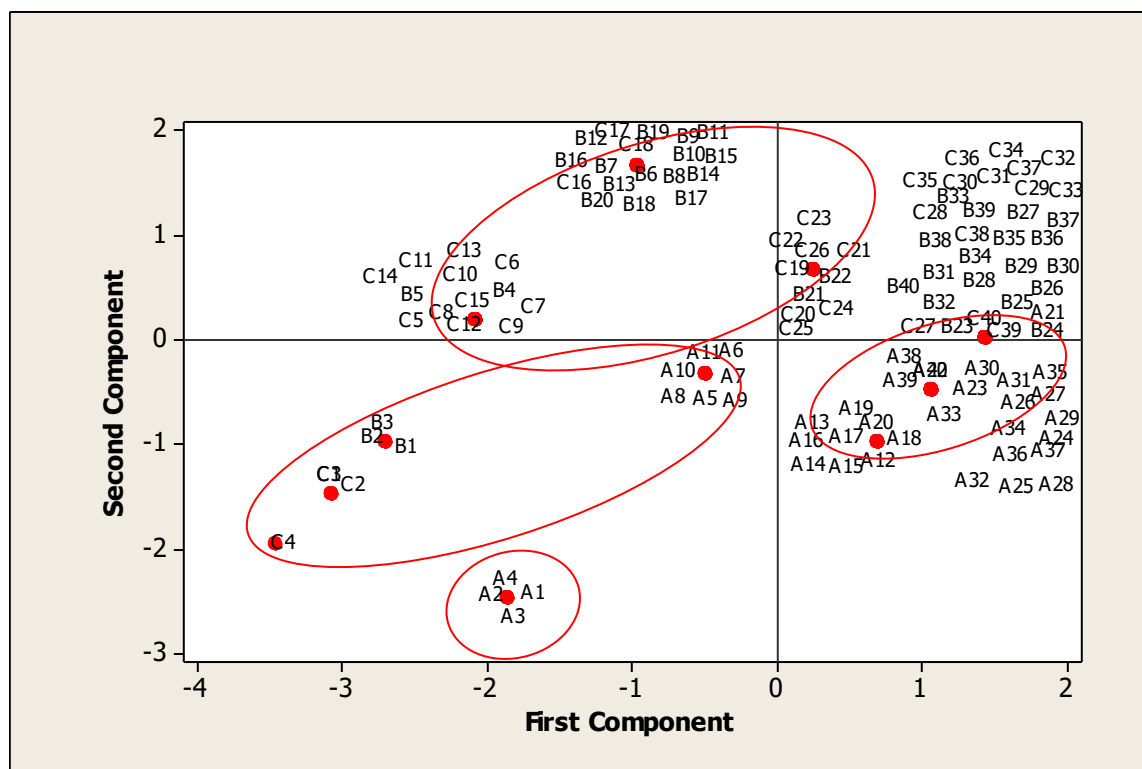


Fig 2:-Projection of different cultures practices of tomato on factorial plan



A1.....A40: Producer of Grand-Popo; B1.....B40: Producer of Pahou; C1....C40: Producer de Sèmè-Kpodji

Fig 3:-Projection des different surveyed producers on factorial plan

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