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RESEARCH ARTICLE

AGRONOMIC CHARACTERIZATION OF SIX TOMATO GENOTYPES IN TOGO

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Abstract

The study was carried out to determine the agronomic performance of height tomato genotypes. These genotypes were evaluated in a completely random block design with 4 replications. Analyses of variance and means comparison (P≤5%) revealed that he germination rate of genotypes was greater than 80% except for TLCV 15 (24%). The number of leaf per plant ranged from 11.62 to 15.73. The largest size was obtained by IVF 328 with 66.34 cm in height and the smallest size was obtained by the TLCV 15 with 51.46 cm. The yield results showed that IVF 328 and Mongal F1 were better with 26.28 tons/ha and 26.07 tons/ha respectively. Regarding the number of fruit per plant, IVF 328 and IVF 5248 were more productive. Analysis of variance showed that the fruit weightwas significantly higher for the Mongal F1 and lower for the TLCV 15. The results obtained will help in decision making toward the production of these genotypes in Togo, thereby improving tomato production.

Introduction:-

Vegetable farming is an important income-generating activity in Togo (Banito et al., 2015). Among Vegetable crops, tomato is one of the most widely grown fruit vegetables and its demand continues to grow over the years (Kanda et al., 2014). After potato, this crop is the second most consumed fresh or processed vegetable in the world according to the INRA study (Goka et al., 2023). World tomato production was 177 million tonnes in 2016 with an average yield of 37 tonnes/ha according to FAO statistics (Goka et al., 2023). From a dietary and nutritional point of view, tomatoes are rich in vitamins C and lycopene, which are antioxidants (Boumendjel et al., 2012).

In Togo, tomato adapts to all types of soil and is grown throughout the country (Konfe et al., 2019). Unfortunately, this crop is subject to many constraints that lead to significant yield reductions (Bamazi et al., 2022;Banito et al., 2021). One of the main constraints is the absence of high yielding varieties adapted to local production conditions (Garane et al., 2019;Coulibaly et al., 2019).

In Togo, the availability of improved tomato genotypes is still in an embryonic state, thus requires special attention. To satisfy an ever-growing demand in tomatoes throughout the year, the use of new high-yielding tomato genotypes, adapted to environmental and socio-economic conditions, is recommended(Camara et al., 2013;Sawadogo et al., 2015). For this purpose, six new tomato genotypes have been introduced in order to improve yield and production of tomato in Togo. In order to popularize these new genotypes and make it accessible to the population, there is need to

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evaluate its performance under our local conditions. The main objective of this study is to improve tomato productivity in Togo. The specific objectives are to evaluate the agro-morphological performance of the six genotypes and evaluate the yield component of the six genotypes.

Materials and Methods:-

Experimental site

The study was carried out in the Experimental Station for Ecole Superieure d'Agronomie, University of Lome(ESA/UL), this station is characterized by an equatorial Guinean climate with a bimodal pluviometric regime and an average annual rainfall of 1000 mm. The soil is ferrallitic with a PH of 7.73 and has a low rate of organic matter with a slope of 1% (Kintché et al., 2015).

Plant materials

The vegetative material comprises of 8 genotypes of which 6 genotypes (IVF 328, IVF 691, IVF 3349, IVF 3350, IVF 5248 et IVF5315) obtained from the Togo Industries Group (TIG), introduce in Togo for production, and 2 elite varieties commonly grow in Togo (Mongal-F1 et TLCV-15).

A quantity of 300 seeds was randomly selected from the seed lots of each genotype. The seeds were introduce into envelopes and placed at room temperature for a period of 3 days after which sowing were conducted. This was done in order to rise the seeds dormancy, seed previously placed in a refrigerator at 4°C.

Nursery bed

A nursery bed was raised on field by performing deep ploughing to loosen the soil and J-Furadan (Carbofuran 3% G) was introduced in the soil to fight against nematodes. Soil fertility was improve using organic fertiliser after which a seedling bed of 6m/1.2m was raised. Sowing lines were designed perpendicular to the bed separated from each other by 20 cm. Each genotype was sown in 3 lines, making a total of 24 lines on the bed.A shade has been installed to prevent the sunlight and drops of rainwater to destroy the seedlings.- AGRO COMET fungicide treatment (Metalaxyl 120 g/Kg / Copper Oxide 600 g/Kg) was applied against damping-off 10 days after sowing and insecticide treatment (EMACOT 19 EC) was used against leaf miners 14 days after sowing. Watering was done morning at 7am and evening at 5PM, weeding was conducted every week. Germinated seeds were recorded every days from the third days after sowing till the 7^{th} days after sowing. Germination percentage was accessed using the following formula(Coulibaly et al., 2019) :

$$G = \frac{NGS}{TNS} \text{ X } 100$$

Where: G (%) = Percentage of Germination; NGS= Number of germinated seeds; TNS= Total number of seeds.

Experimental design, planting and maintenance

The experimental design was a randomized complete block design with 4 replications and repeated(Garane et al., 2019) during raining season (May-August) and dry season (December-March). Each replication had 8 plots representing the genotypes. The dimension of a plot was of 7.2m² (6m x 1.2m) with 4cm width, on which 21 days old seedlings were transplanted on a rate of 0.8m x 0.4m, 22 seedlings per plot. Distance between plots was 0.4m, and between replication was 0.7m.Organic manure was applied on each plot 2 weeks before transplanting and urea was applied at the rate of 5g per plant, 30 days after transplanting(Moreno et al., 2010 and Coulibaly et al., 2019).

Data assessment

Six agro-morphological character were collected on 8 plants per plots. These are the plant height during flowering, when 50% of plants flowered on a plot; the leaf length at flowering; the number of leaf per plant; the number of leaflet per leaf; the basal stem width; and the fruit size.In order to access the yield component, the number of fruit per plant and fruit weight was measured.The software SPSS 21.1 was used to perform the Analysis of variance (ANOVA) ($P \leq 5\%$) and mean comparison with Ducan test.

Result:-

Germination rate of the seeds

Figure 1 display the germination rate of seeds from 8 genotypes, 7 days after sowing. Germination rate varies from 24% to 100% for TLCV-15 and IVF 3349 respectively. The genotypes from Togo Industries groups had a

germination rate greater than 80%. IVF 5315 (96 %), IVF 691 (93 %) and IVF 3349 (100 %) had higher performance compared to local genotype Mongal F1 and TLCV-15 with 91 % and 24 % respectively.

Figure 1 also showed evolution of the germination rate over the 7 days after sowing. Germination started 3 days after sowing for IVF 5315, IVF 3349, IVF 5248, IVF 3350, Mongal F1, IVF 691 and IVF 328 with germination rate of 70 %, 50 %, 42 %, 40 %, 25 %, 20 % et 15 % respectively. 10% of the seeds from TLCV-15 germinated the 5th day after sowing and maximal germination of 25% was obtain the 8th day, while 100% of IVF 3349 seeds germinated the 4th day.

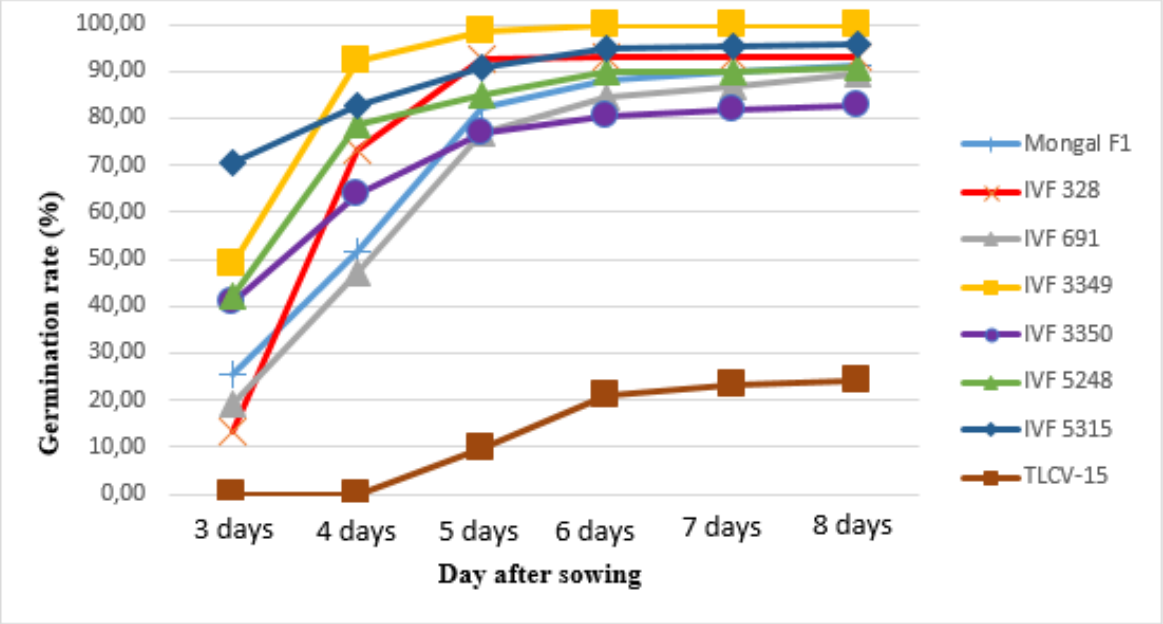

Figure 1:- Germination rate of tomato genotype seeds.

Flower bud initiation, flowering and fruit development

Table 1 showed that on the 15th day after transplanting, the flower buds of TLCV-15 plants appeared while that of IVF 5315 appeared on the 21st day. Flowering was done on the 20th day for the TLCV-15 and on the 30th day for the IVF 5315. The fruitdevelopment started on the 27th day for TLCV-15 and on the 40thday for the IVF 5315 and IVF 5248. The fruit begin to ripen on the 48th day for the TLCV-15 and at the 64thJAR for the IVF 691 genotype.

Table 1:- Days to Flower bud initiation, flowering, fruit development and maturity.

Genotypes	Days after transplanting			
	Flower bud	Flowering	Fruit development	Fruit maturity
Mongal F1	16 a	22 a	33 a	52 b
IVF 328	17 a	23 a	34 a	54 b
IVF 691	20 a	27 a	39 b	64 c
IVF 3349	18 a	25 a	36 b	60 c
IVF 3350	19 a	25 a	38 b	59 c
IVF 5248	20 a	27 a	40 b	60 c
IVF 5315	21 a	30 a	40 b	62 c
TLCV-15	15 a	20 a	27 a	48 a
F	12,825	9,185	7,255	5,966
P	0,418	0,074	0,025	0,015

Meansfollowed by the same letter in a column are not significantly different from each other at 0.05 level.

Agro-morphological performance of height tomato genotypes

Statistical analysis showed variability among genotypes for all agro-morphological variable. The number of leaf per plant varied moderately from 11.62 to 15.73 for Mongal F1 and TLCV-15 respectively. As for the basal stem width, it varied from 51.46cm with TLCV-15 to 66.34cm with IVF 328 genotype. The results of the analysis of variance

showed that there is no significant difference between the height of the plants of IVF 3349, IVF 3350, IVF 691 and Mongal F1 genotypes. The number of leaflets per leaf varied significantly from 21 leaflets per leaf to 17 leaflets per leaf for the IVF 5248 and (TLCV-15 and IVF 328) respectively.

Results in Table 2 showed no significant difference in basal stem width from IVF 328, IVF 3349, IVF 3350, IVF 5315, IVF 691 and TLCV-15. However, the basal stem width of Mongal F1 is statistically larger. The height of IVF 328, IVF 3350 and Mongal F1 plants are significantly higher than that of TLCV-15 with average height of 66.34cm, 65.92 cm 65.80 cm and 51.46 cm respectively.

Yield component of height tomato genotypes

Results from analysis of variance showed in Table 3 revealed that the number of fruit per plant of IVF 328 is significantly higher with approximately 14 fruits per plant. The number of fruit per plant of IVF 3349, IVF 3350, IVF 5315 and IVF 691 are statistically identical. The lowest number of fruit per plant was obtained by the IVF 691 genotype (about 9 fruits). The results reveal that TLCV-15 has the smallest circumference of fruit while Mongal F1 has the largest circumference with 14.43 cm and 18.38 cm respectively. Fruit length results varied significantly and ranged from 6.25 cm (IVF 3348 and IVF 691) to 4.54 (Mongal F1). The heaviest fruit weight is obtained by Mongal (87.23 g) followed by IVF 3349 (66.9 g), IVF 691 (66.28 g) and IVF 3350 (64.94 g).The lightest weight are displayed by IVF 5248 (56.48 g), IVF 5315 (55.19 g) and TLCV-15 (49.75 g). The results in Table 3 also showed that the yields in ton/ha varied significantly from 12.24 t/ha to 26.28 t/ha for IVF 328 and IVF 691 respectively. Analysis of variance showed that the yield of IVF 328 and Mongal F1 are statistically identical. Figure 2 shows the fruit shape of each genotype, the fruit of Mongal F1 had a flattened shape, those from Togo Industries grouphave a tall and rounded shape, and that of the TLCV-15 genotype have a cylindrical shape.

Table 2:- Agro-morphological parameters of the tomato genotypes.

Genotypes	Leaf number per plant	Leaflet number per per plant	Leaf length (cm)	Basal stem width(cm)	Plant height (cm)
IVF 328	11,93 ± 0,25 ab	17,65 ± 0,82 a	35,05 ± 1,03 b	3,32 ± 0,08 a	66,34 ± 1,14 c
IVF 3349	12,03 ± 0,27 ab	19,77 ± 0,93 ab	37,19 ± 1,25 b	3,55 ± 0,07 ab	59,39 ± 1,09 b
IVF 3350	13,08 ± 0,23 b	18,47 ± 0,83 ab	38,17 ± 1,29 b	3,5 ± 0,08 ab	65,92 ± 1,93 c
IVF 5248	12,73 ± 0,35 b	21,12 ± 0,86 b	35,7 ± 1,32 b	3,35 ± 0,1 a	60,41 ± 1,71 bc
IVF 5315	11,95 ± 0,25 ab	19,67 ± 0,7 a	37,27 ± 1,35 b	3,32 ± 0,07 a	58,61 ± 1,49 b
IVF 691	12,17 ± 0,25 ab	17,53 ± 0,77 ab	36,82 ± 1,55 b	3,25 ± 0,08 a	60,33 ± 1,79 bc
Mongal F1	15,73 ± 0,25 c	19,45 ± 0,63 ab	37,96 ± 1,29 b	3,72 ± 0,11 b	65,8 ± 1,83 c
TLCV-15	11,62 ± 0,42 a	17 ± 0,82 a	28,87 ± 1,43 a	3,47 ± 0,11 ab	51,46 ± 1,88 a
F	17,325	3,055	5,205	2,946	9,119
P	0,000	0,004	0,000	0,005	0,000

Meansfollowed by the same letter in a column are not significantly different from each other at 0.05 level.

Table 3:- Yield componentsof thetomato genotypes.

Genotype	Fruit number per plant	Fruit circonference (cm)	Fruit length (cm)	Fruit weight (g)	Yield (t/ha)
IVF 328	14,7 ± 0,82 b	14,52 ± 0,14 c	5,94 ± 0,06 cde	62,99 ± 1,77 b	26,28 d
IVF 3349	10,82 ± 0,68 a	14,29 ±0,14 bc	6,13 ± 0,06 de	66,9 ± 2,28 b	20,23 c
IVF 3350	11,15 ± 0,29 a	14,72 ± 0,15 c	6,25 ± 0,1 e	64,94 ± 1,45 b	17,88 b
IVF 5248	12,23 ± 0,87 ab	13,93 ± 0,10 abc	5,81 ± 0,09 c	56,48 ± 1,83 a	19,39 c
IVF 5315	10,85 ± 0,82 a	13,72 ± 0,18 ab	5,85 ± 0,07 cd	55,19 ± 1,83 a	15,42 b
IVF 691	9,95 ± 0,77 a	14,72 ± 0,23 c	6,25± 0,98 e	66,28 ± 2,58 b	12,24 a
Mongal F1	12,55 ± 0,38 ab	18,38 ± 0,28 d	4,54 ± 0,09 a	87,23 ± 4,43 c	26,07 d
TLCV-15	12,55 ± 0,84 ab	13,43 ± 0,14 a	5,53 ± 0,09 b	49,75 ± 1,21 a	19,71 c
F	3,251	57,366	42,022	23,44	17
P	0,002	0,000	0,000	0,000	0,001

Meansfollowed by the same letter in a column are not significantly different from each other at 0.05 level.

Figure 2:- Fruit shape of the tomato genotypes.

Correlation among variables

In order to access relationships between the variable studied, a Pearson correlation matrix was generated. The agro-morphological variable showed positive and significant correlation between fruit size and fruit weight (0.89), Number of leaflet perplant and leaf length (0.67), leaf length and basal stem width (0.60), leaf length and plant height (0.76), basal stem width and plant height (0.57)(table 4).

Table 4:- Correlation matrixbetween studied variables.

Paramètre	Fruit size (cm)	Fruit length (cm)	Fruit weight (g)	Number leaflet/ plant	Leaf length (cm)	Basal stem width (cm)	Plant height (cm)	Fruit number/ plant
Fruit size (cm)	1							
Fruit length (cm)	-0,19	1						
Fruit weight (g)	0,89**	0,08	1					
Number leaflet/plant	0,04	-0,038	,02	1				
Leaf length (cm)	0,23	0,05	0,24	0,67**	1			
Basal stem with (cm)	0,18	-0,12	0,16	0,44	0,60**	1		
Plant height (cm)	0,30	0,02	0,27	0,45	0,76**	0,57**	1	
Fruit number/plant	0,08	0,01	0,09	-0,03	0,12	0,15	0,23	1

*: Significant at 0.05 level, **: Significant at 0.01 level.

Discussion:-

The results obtained show a low but significant variability in the number of leaf, basal stem width and the plant height, although theleaf length and basal stem width of these six genotypes are statistically identical. Concerning the plant phenology, results show early and semi early genotypes based on to the time to fruit development and fruit maturity. None of the new genotypes where early compared to Mongal F1 and TLCV-15.These results are similar to that of (Fondio et al., 2013;Coulibaly et al., 2019) who evaluated the agronomic performances of tomato varieties.They also emphasis that variability observed in relation to the vegetative development depends not only on the genetic of each varieties but is also affected by environmental conditions such as soil, climate and others. Also

from flowering to ripening of the fruits, several physiological and biochemical phenomena can influence the development of the plant, among which the mobilization of mineral elements for the floral initiation and the filling of the fruits. The ability of each genotype to draw mineral elements and water and then to make them available to the plant organs are under the environmental factors and can affect flowering and fruits development(Sawadogo et al., 2015,Coulibaly et al., 2019;Salim et al., 2020)

A significant variability was observed among genotypes in the estimation of the number of fruit per plant, the fruit circumference and the fruit weight.Regarding the yield, IVF 328 and Mongal F1 genotypes had the best performance.IVF 328 genotype produced more fruit than all the other genotypes, and Mongal F1 recorded the best weight per fruit. Siméon et al. (2021)Demonstrated that tomato fruit weight is pecific to each variety. According to FAOSTAT statistics in 2016, the world tomato production was 25 tons/ha and 10 tons/ha in the Southern Sahara. In this study, only IVF 328 and Mongal F1, with yields of 26.28 and 26.07 tonnes/ha respectively, are significantly higher than the world estimate.Although the other genotypes also yield greater than 10 tons/ha(Garane et al., 2019;Bhattarai et al., 2018). Several positive and significant correlation were observed among variable, the highest was between the fruit size and the fruit weight, thus it is recommended to base selection of heavy fruits on its size. These was also mentioned by Camara et al. (2013)and Terzopoulos and Bebeli(2010)on different varieties of tomatoes.

The pedoclimatic conditions affect tomato production, when the temperature is between 12 and 18°C, the number of fruit per plant increases, whereas if the temperature is above 18°C, the number of fruit per plant decreases considerably. Studies have shown that cultivation techniques and the water system strongly influence tomato yield. Yield variability within genotypes may also be related to the leaf susceptibility to pest and diseases.Garane et al. (2019)explained that species of fungi of the genera Fusarium, Cladosporium, Colletotrichum, Curvuaria, Melanospora and Phoma present in on the fields can cause low yield in tomato production.

Conclusion:-

Agronomic performance of the 6 genotypes gives a high germination rate greater than 80% 7 days after sowing. This genotypes have significantly better agro-morphological performance than the local genotypes with a yield of 26 tons/ha for the IVF 328 genotype. The introduced genotypes are adapted to the pedoclimatic conditions. Studies on other agro-ecological sites are desirable for a better knowledge of the adaptability of these genotypes.

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Literature Cited:-

1. Bamazi, B., Banito, A., Ayisah, K.D., Sikirou, R., Paret, M.L., Kunwar, S., Kamde, K., Tchalla, P., and Afole, N.A.S-L. (2022). Distribution and Incidence of Tomato Bacterial Wilt Caused by Ralstonia solanacearum in the Central Region of Togo. Plant Health Progress, 23(2), 235‑240. https://doi.org/10.1094/PHP-09-21-0117-S
2. Banito, A., Bamazi, B., Kpemoua, E.K., Sikirou, R., Challa, P.T.and Paret, M.L. (2021). Criblage de variétés de tomate pour de la résistance au flétrissement bactérien causé par Ralstonia solanacearum au Togo.Journal of Applied Biosciences, 166(1), 17212-17222.
3. Banito, A., Banla, E. M., Ayisah, D. K., and Sogbedji, J. M. (2015). Efficacité des champignons mycorhiziens contre les nématodes parasites de la tomate au Togo. Journal of Applied Biosciences, 89, 8256‑8262. https://doi.org/10.4314/jab.v89i1.1.
4. Bhattarai, K., Sharma, S.and Panthee, D. R. (2018). Diversity among Modern Tomato Genotypes at Different Levels in Fresh-Market Breeding. International Journal of Agronomy, 2018, e4170432. https://doi.org/10.1155/2018/4170432.
5. Boumendjel, M., Houhamdi, M., Samar, M., Sabeg, H., Boutebba, A.et Soltane, M. (2012). Effet des traitements thermiques d'appertisation sur la qualité biochimique, nutritionnelle et technologique du simple, double et triple concentré de tomate. Sciences et Technologie, 36, 51-59.
6. Camara, M., Mbaye, A.A., Samba, S.A.N., Gueye, T., Noba, K., Diao, S.et Cilas, C. (2013). Evaluation de la virose du jaunissement et de l'enroulement en cuillere des feuilles de tomate (Lycopersicon esculentum Mill.)

sur divers cultivars au Senegal. African Journal of Science and Technology, 12(2), 12(2), 91-98. https://doi.org/10.4314/ajst.v12i2

7. Coulibaly, N.D., Fondio, L., N'gbesso, M.F. et Doumbia, B. (2019). Evaluation des performances agronomiques de quinze nouvelles lignées de tomate en station au centre de la Côte d'Ivoire. International Journal of Biological and Chemical Sciences, 13(3), 1565-1581. https://doi.org/10.4314/ijbcs.v13i3
8. Fondio, L., Djidji, H.A., N'Gbesso, F. et Kone, D. (2013). Evaluation de neuf variétés de tomate (Solanum lycopersicum L.) par rapport au flétrissement bactérien et à la productivité dans le Sud de la Côte d'Ivoire. International Journal of Biological and Chemical Sciences, 7(3), 1078-1086. https://doi.org/10.4314/ijbcs.v7i3.15
9. Garane, A., Some, K., Nikiema, J., Traore, M.et Sawadogo, M. (2019). Etude du comportement de neuf cultivars de tomates (Solanum lycopersicum L.) dans différentes zones agro-écologiques du Burkina Faso pendant l'hivernage. Journal of Animal and Plant Sciences, 40(3), 6656‑6673. https://doi.org/10.35759/JAnmPlSci.v40-3.1
10. Goka, M., Mensah, R., Dufrechou, M., Karou, S.D.et Ameyapoh, Y. (2023). Importance socio-économique de la production et propriétés nutritionnelles de la tomate (Solanum lycopersicum L.) au Togo : Synthèse bibliographique. Journal de la Recherche Scientifique de l'Université de Lomé (Togo), 23(3), 89‑104.
11. Kanda, M., Akpavi, S., Wala, K., Djaneye-Boundjou, G. et Akpagana, K. (2014). Diversité des espèces cultivées et contraintes à la production en agriculture maraîchère au Togo. International Journal of Biological and Chemical Sciences, 8(1), 115-127. https://doi.org/10.4314/ijbcs.v8i1.11
12. Kintché, K., Guibert, H., Sogbedji, J., Lévêque, J., Bonfoh, B.and Tittonell, P. A. (2015). Long-term mineral fertiliser use and maize residue incorporation do not compensate for carbon and nutrient losses from a Ferralsol under continuous maize-cotton cropping.Field Crops Research, 184, 192-200.
13. Konfe, Z., Zonou, B.et Hien, E. (2019). Influence d'intrants innovants sur les propriétés du sol et la production de tomate (Solanum lycopersicum L.) et d'aubergine (Solanum melongena L.) sur un sol ferrugineux tropical en zone soudano-sahélienne au Burkina Faso. International Journal of Biological and Chemical Sciences, 13(4), 2129-2146.
14. Moreno, M., Valencia, M., Villena, J.and Mancebo, I. (2010). Agro-Morphological Characterization of 16 Traditional Pepper (Capsicum annuum L.) Cultivars from Castilla-La Mancha (Central Spain). Acta horticulturae, 918, 557‑564. https://doi.org/10.17660/ActaHortic.2011.918.70
15. Salim, M. M. R., Rashid, M. H., Hossain, M. M. and Zakaria, M. (2020). Morphological characterization of tomato (Solanum lycopersicum L.) genotypes. Journal of the Saudi Society of Agricultural Sciences, 19(3), 233‑240. https://doi.org/10.1016/j.jssas.2018.11.001
16. Sawadogo, I., Koala, M., Dabire, C., Ouattara, L. P., Bazie, V., Hema, A., Gnoula, C., Pale, E.et Nebie, R. H. C. (2015). Etude de l'influence des modes de transformation sur les teneurs en lycopène de quatre variétés de tomates de la région du nord du Burkina Faso. International Journal of Biological and Chemical Sciences, 9(1), 362-370. https://doi.org/10.4314/ijbcs.v9i1
17. Siméon, M., Noukpozounkou, M. S. P., Gougbe, A., Aboudou, K., Goudjinou, C. et Soumanou, M. (2021). Connaissances endogènes et contraintes post-récoltes liées aux techniques de conservation des variétés de tomate produites au Sud-Bénin. Afrique Science Revue Internationale des Sciences et Technologie, 19, 81‑95.
18. Terzopoulos, P. J. and Bebeli, P. J. (2010). Phenotypic diversity in Greek tomato (Solanum lycopersicum L.) landraces. Scientia Horticulturae,126(2), 138‑144. https://doi.org/10.1016/j.scienta.2010.06.022.