Farmer Participatory Evaluation of Five Taro Lines for Food Security in Ghana

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Abstract
Taro [Colocasia esculenta (L.) Schott] is the fifth most important root crop consumed worldwide. Its production in Ghana over the years has been bedeviled by the taro leaf blight disease (TLBD). There is the need for improved taro cultivars that are tolerant to TLBD to avert the negative impact the disease has on taro production and utilization in Ghana. Five introduced taro lines (CE/IND 12, BL/SM 158, BL/SM 151, BL/SM 115 and BL/SM 16) from International Network for Edible Aroids (INEA) were evaluated at farmers' field alongside farmer's variety. Data were collected on TLBD incidence and severity, corm yield, corm length, corm diameter, corm dry matter and harvest index. Sensory evaluation was done at harvest. Agronomic data were subjected to ANOVA using Genstat in RCBD. Data on the sensory evaluation were presented graphically. Genotype x location interaction was significant for all the traits. Significant genotypic differences were observed for the traits. Corm yield ranged from 2.25 t/ha to 6.42 t/ha. All the lines had significantly higher corm yield than the local variety except CE/IND 12. Corm length, corm dry matter, and harvest index ranged from 13.22 cm to 16.61 cm, 10.81 cm to 15.20 cm, and 0.45 to 0.69, respectively. Sensory evaluation showed preference for all the lines except CE/IND 12. BL/SM 158, BL/SM 151, BL/SM 115 and BL/SM 16 had relatively higher dry matter content and will meet the food need of farmers and consumers and therefore, must be selected for further testing in multilocational trials for subsequent release to farmers.

Key words: Corm dry matter, Corm yield, Food security, Taro leaf blight

Évaluation Participative Des Agriculteurs De Cinq Variétés De Taro Pour La Sécurité Alimentaire Au Ghana

Résumé
Le taro [Colocasia esculenta (L.) Schott] est la cinquième culture de racine la plus importante qui est consommée dans le monde. Sa production au Ghana au cours des années a été compliquée par la maladie de la brûlure foliaire du taro (TLBD). Il est nécessaire d'améliorer les cultivars de taro qui sont tolérants à la TLBD pour éviter l'impact négatif de la maladie sur la production et l'utilisation du taro au Ghana. Cinq variétés du taro introduites (CE / IND 12, BL / SM 158, BL / SM 151, BL / SM 115 et BL / SM 16) du Réseau international pour les orchidées comestibles (INEA) ont été évaluées sur le terrain des

agriculteurs. Des données ont été recueillies sur l'incidence et la sévérité du TLBD, le rendement en cormes, la longueur du bulbe, le diamètre de la corme, la matière sèche du corme et l'indice de récolte. L'évaluation sensorielle a été faite à la récolte. Les données agronomiques ont été soumises à ANOVA en utilisant Genstat dans RCBD. Les données sur l'évaluation sensorielle ont été présentées graphiquement. L'interaction génotype x emplacement était significative pour tous les caractères. Des différences génotypiques significatives ont été observées pour les caractères. Le rendement en cendres variait de 2,25 t / ha à 6,42 t / ha. Toutes les variétés ont un rendement en cormes significativement plus élevé que la variété locale sauf CE / IND 12. La longueur des cormes, la matière sèche du corm et l'indice de récolte varient respectivement de 13,22 cm à 16,61 cm, 10,81 cm à 15,20 cm et 0,45 à 0,69. L'évaluation sensorielle a montré une préférence pour toutes les variétés sauf CE / IND 12. BL / SM 158, BL / SM 151, BL / SM 115 et BL / SM 16 avaient une teneur en matière sèche relativement plus élevée et répondaient aux besoins alimentaires des agriculteurs et des consommateurs. par conséquent, doivent être sélectionnés pour des essais plus poussés dans des essais multilocaux pour être ensuite remis aux agriculteurs.

Mots-Clés: Matière sèche de Corm, rendement de Corm, sécurité alimentaire, brûlure de feuille de Taro

Introduction

The potential of root and tuber crops including taro has not been fully exploited and utilized despite their contribution towards food security and income generation. Taro is a very important food security crop in Ghana. The crop is rich in easily digestible starch as well as iron and zinc. It also has medicinal value as a specialty food for potentially allergic infants and persons suffering from gastro-intestinal disorders (Onyenekenwa, 2013). Its production has been bedeviled by the taro leaf blight disease which has almost caused extinction of the crop (Oyenka, 2014), affecting food security and income levels of farmers. Measures such as chemical and cultural control are largely ineffective and that breeding for disease resistance is the most sustainable approach to manage the disease (Singh *et al.*, 2012). The future of taro in Ghana thus, depends on availability of improved taro cultivars. Variability drives crop improvement and wider genetic base is a prerequisite for taro breeding. The genetic diversity of taro suggest narrow genetic base (Mbouobda *et al.,* 2007). Three conventional ways of making improved cultivars available to farmers are collection, evaluation and selection from local germplasm; introduction/importation of varieties bred in another programme and evaluating them under local conditions; and evaluation and selection from progenies developed through local hybridization programme (Baafi, 2014). Farmers' participation in evaluation and selection of variety is an efficient and economical approach to disseminate and increase the rate of adoption of improved crops (Atung *et al.,* 2015). This work aimed at using farmer-participatory approach to test five introduced taro lines to identify and select superior line(s) for further testing and release to famers.

Materials and Methods

Five introduced taro lines (CE/IND 12, BL/SM 158, BL/SM 151, BL/SM 115 and BL/SM 16) from the International Network for Edible Aroids (INEA) were used. The lines were evaluated in two major taro growing areas (Bipoa and Abrakaso) in the forest ecozone of Ghana under rain-fed conditions alongside farmer's variety (Local).

The work was carried out from October 2014 to October 2015. The planting distance was 1m x 1m. Five farmers were used at each location. Harvesting was at 12 months after planting. Data collected were Taro Leaf Blight Disease (TLBD) incidence and severity, corm yield, corm length, corm diameter, corm dry matter and harvest index. TLBD severity was scored on a scale of 1 - 5; where 1 No disease, 2 Minimum, 3 Average, 4 High, 5 All plants affected or dead. Incidence indicates the percentage number of plants in the field affected by TLBD. Sensory evaluation was also done at harvest. The agronomic data were subjected to Analysis of Variance (ANOVA) using Genstat statistical package Release 12.1 (Genstat, 2009), in a randomized complete block design (RCBD), where farmers were used as replication. The data on the sensory evaluation were presented graphically.

Results and Discussions

All the lines had high tolerance to TLBD except CE/IND 12 and the local (Table 1). Genotype x location interaction was significant for all the traits (Table 2). G x E interaction is essential in evaluating genotypes adaptation, selection of parents and development of genotypes with improved end-product quality (Ames *et al.,* 1999). The significant G x E interaction may complicate selection for the traits. This indicates that selection should be carried out in a range of environments (Falconer and Mackay, 1996). This is because progress from selection is realized only when genotypic effects can be separated from environmental effects (Miller *et al.*, 1958). Significant genotypic differences were observed for the traits (Table 2).

Mean corm yield ranged from 2.25 t/ha (CE/IND 12) to 6.42 t/ha (BL/SM 115) (Table 3). All the lines had significantly higher corm yield than the local except CE/IND 12. Corm length ranged from 13.22 cm for CE/IND 12 to 16.61 cm for BL/SM 151 (Table 4). Mean corm length was generally higher for all the lines than the local except CE/IND 12. The local and BL/SM 151 had the shortest and the longest corm diameter of 10.81 cm and 15.20 cm, respectively (Table 5). The reverse was true for harvest index where the lowest (0.45) and the highest (0.69) values were given by BL/SM 151 and the local (Table 6). In all, CE/IND 12 showed poor performance compared with the local among the five introduced lines. Dry matter content was

Table 1: Tolerance of the taro lines to TLBD for the two locations

Line	Location				Mean	
	Abrakaso		Bipoa			
	*Sev	*Inc	*Sev	*Inc	*Sev	Inc
BL/SM158	2	10	2	9	2.0	9.5
CE/IND 12	5	100	5	100	5.0	100.0
BL/SM 115	2	11	2	10	2.0	10.5
BL/SM 151	2	8	2	10	2.0	9.0
BL/SM 16	1	0	2	10	1.5	5.0
LOCAL	5	100	5	100	5.0	100.0
Mean	2.8	38.2	3.0	39.8		

*Sev.= severity; Inc.=Incidence

Table 2: Mean squares for the traits of the five taro lines and the local across two locations

Source of variation	Df	Corm yield	Corm length	Corm diameter	Corm dry matter	Harvest index
Block	4	4.469	14.11	9.984	8.983	0.043
Loc.	1	10.541*	10.32^{ns}	58.469**	1.194^{ns}	0.007ns
Gen.	5	8.840**	14.84*	26.281**	235.931**	0.063*
G x L	5	2.839*	19.71*	3.817*	35.830**	0.013*
Error	34	42.069	10.23	4.535	2.121	0.026

*Significant at p<0.05; ** Significant at p<0.01; ns = not significant

Table 3: Corm yield (t/ha) of taro lines across locations

Line	Location		Mean
	Abrakaso	Bipoa	
BL/SM158	5.96	5.76	5.86
CE/IND 12	1.85	2.64	2.25
BL/SM 151	8.00	3.56	5.78
BL/SM 115	6.76	6.08	6.42
BL/SM 16	7.28	3.20	5.24
LOCAL	2.99	1.54	2.27
Mean			

Lsd (5%) Line=2.61; Loc=1.51; Line x loc=3.70

Table 4: Corm length (cm) of taro lines across locations

Line	Location		Mean
	Abrakaso	Bipoa	
BL/SM158	13.91	15.23	14.57
CE/IND 12	14.04	12.39	13.22
BL/SM 151	17.44	15.78	16.61
BL/SM 115	14.20	16.61	15.40
BL/SM 16	14.56	14.67	14.62
LOCAL	16.43	10.91	13.67
Mean	15.10	14.27	

Lsd (5%) Line=2.91; Loc=1.68; Line x loc=4.11

Table 5: Corm diameter (cm) of taro lines across locations

Line	Location		Mean
	Abrakaso	Bipoa	
BL/SM158	15.88	13.65	14.84
CE/IND 12	15.18	12.47	13.83
BL/SM 151	15.88	14.52	15.20
BL/SM 115	15.88	13.65	14.76
BL/SM 16	15.11	13.76	14.43
LOCAL	12.74	8.87	10.81
Mean	14.96	12.99	12.99

Lsd (5%) Line=1.94; Loc=1.12; Line x loc=2.74

Table 6: Harvest index of taro lines across locations

Line	Location		Mean
	Abrakaso	Bipoa	
BL/SM158	0.62	0.47	0.54
CE/IND 12	0.59	0.63	0.61
BL/SM 151	0.44	0.47	0.45
BL/SM 115	0.61	0.60	0.60
BL/SM 16	0.61	0.60	0.61
LOCAL	0.69	0.68	0.69
Mean	0.59	0.57	0.57

Lsd (5%) Line=0.15; Loc=0.08; Line x loc=0.21

significantly higher for the local than all the lines (Table 7). High dry matter is one of the important attributes that affects consumer preferences in most of sub-Saharan Africa (Tumwegamire *et al.,* 2004). This means that these lines will meet the food need of farmers and consumers and therefore, should be selected for further multilocational testing and release to farmers. The performance of the taro lines was higher in Abrakaso than Bipoa except for dry matter content. Sensory evaluation showed high preference for all the five lines and the local except CE/IND 12 (Fig. 1).

Table 7. Corm dry matter content (%) of taro lines across locations

Line	Location		Mean
	Abrakaso	Bipoa	
BL/SM158	33.30	33.24	33.27
CE/IND 12	15.45	22.50	18.98
BL/SM 151	43.20	31.10	37.32
BL/SM 115	38.20	47.00	42.60
BL/SM 16	39.11	42.96	41.03
LOCAL	46.57	46.67	46.60
Mean	36.03	37.24	37.24

Lsd (5%) Line=2.77;
Loc=1.60; Line x loc=3.91

Conclusion

Genotype x location interaction was significant for all the traits. Significant genotypic differences were also observed for the traits. In all, CE/IND 12 showed poor performance

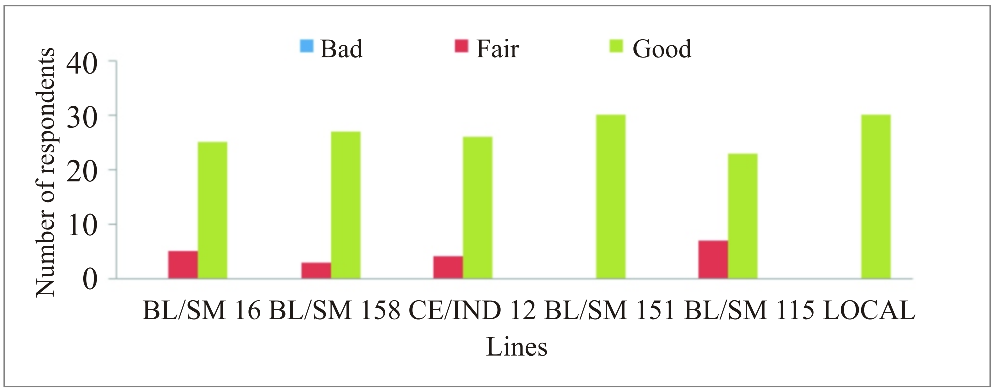

Fig 1 (a): Cooking quality preferences of the taro lines by farmers and consumers at Bipoa

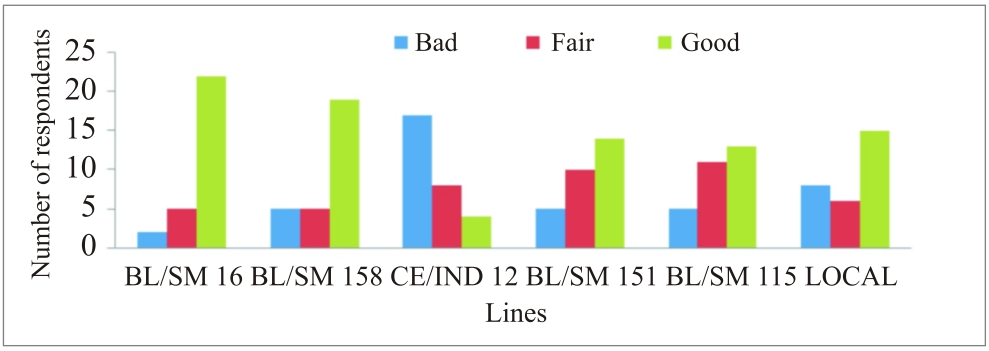

Fig 1 (b): Cooking quality preferences of the taro lines by farmers and consumers at Abrakaso

compared with the local among the five introduced lines. The other four lines (BL/SM 158, BL/SM 151, BL/SM 115 and BL/SM 16) had significantly higher yields and relatively higher dry matter content. This means that these lines will meet the food need of farmers and consumers and therefore, should be selected for further multilocational testing and release to farmers.

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