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Invasiveness of Feral Plants of Tropical Tuber Crops and its Implications on Germplasm Conservation

Tropical root and tuber crops (cassava, sweet potato, yams, elephant foot yam and taro) are the most important food security crops, especially in the context of climate change. They are the major sources of energy and staple food for millions of people across the globe contributing significantly to the nutritional security of these segments of the society. The Central Tuber Crops Research Institute (CTCRI), Sreekariyam, Thiruvananthapuram ((Latitude: 8^0 32' N; Longitude: 76^0 55' E; Altitude: 50 m above msl) has been conducting research on various aspects of these crops for the past 50 years and a detailed resource inventory of the farm was prepared using geoinformatics tools by Sabitha Soman and Byju (2013; 2014). Most of the tropical tuber crops, except cassava and sweet potato, are propagated through whole or cut corms or tubers and elephant foot yam and taro produce side tubers or cormels. Since these tubers are produced underground, it is not possible to remove all the tubers during harvesting, resulting in the appearance of feral plants or ground keepers in the following year. Up to 3,67,000 potato tubers per hectare have been estimated to remain in the field after mechanical harvest (Lutman, 1977). Even when potatoes are carefully hand-harvested, the frequency of volunteers ranged from 0.4-2.9 m^{-2} (Reader at al., 2005). Presence of such volunteers or feral plants has got very serious ramifications by mixing of cultivars/varieties, particularly in germplasm conservation and also provides a potential pathway for gene flow in seasons following the planting of a transgenic crop.

The present study was conducted to quantify the presence of feral plants in tropical tuber crops as a result of the presence of left over whole tubers or corms or side tubers or cormels. The study was conducted in the Experimental Farm of Central Tuber Crops Research Institute (CTCRI) during March – April 2014 after the harvest of the previous crops of yams, elephant foot yam and taro. Systematic random sampling was made with the help of a square quadrat of 1m x1 m size. The square quadrat was randomly placed in the experimental fields and the number of sampling sites in each plot was decided at the rate of one sample for every five cents. After placing the square quadrat, total count of the plants sprouted from the previous crop was recorded. Nineteen experimental fields located in all the five blocks of CTCRI farm where yams, elephant foot yam and taro were planted during the previous season were used for the study and the number of plants sprouted from the previous crop was recorded from a total number of 230 sampling locations of 1 m^2 grids. Before descriptive statistical analysis, the data were tested for their normality using Kolmogorov-Smirnov (K-S) test as well as normal quantile-quantile (Q-Q) test. Since all data sets were found to be normally distributed, no transformation was done. The data sets were analyzed for their descriptive statistical parameters such as mean, minimum, maximum, median, coefficient of variation (CV), skewness and kurtosis. Of these different parameters, the CV is the most discriminating factor; when CV is $<$ 10.00, the property shows low variability, and if CV is $>$ 90.00, the property shows great variability (Xing-Yi et al., 2007). The data with a range of -1 to $+1$ skewness were considered as normally distributed (Virgilio et al., 2007). If kurtosis of the data is $<$ 3, the distribution is more peaked than the Gaussian distribution, if kurtosis is equal to 3 it is as peaked as the Gaussian and if it is $>$ 3, it is less peaked than Gaussian. The descriptive statistical analysis was performed using Excel 2007.

The descriptive statistics of the number of plants sprouted is given in Table 1. The number of sprouted plants of *Dioscorea alata* was recorded from six different fields of the experimental farm. Results of the study showed that

Table 1. Descriptive statistical analysis of the number of sprouted plants of the previous crop in yams and aroids

Name of crop	Count	Mean	Minimum	Maximum	Median	CV* %	Skewness	Kurtosis
	Number of plants m^{-2}							
D. alata	85	5.38	1	41	3.00	113.39	3.57	16.09
D. esculenta	10	2.40	1	4	2.50	48.91	0.04	-1.46
D. rotundata (trailing)	10	1.20	1	2	1.00	35.14	1.78	1.41
D. rotundata (dwarf)	10	3.50	2	7	2.50	57.54	1.17	-0.02
Elephant foot yam (normal setts)	65	2.83	1	9	2.00	67.42	1.36	1.59
Elephant foot yam (minisett)	35	4.63	1	16	4.00	65.47	2.24	6.10
Taro	15	7.47	1	20	5.00	128.90	1.15	0.39

CV – coefficient of variation

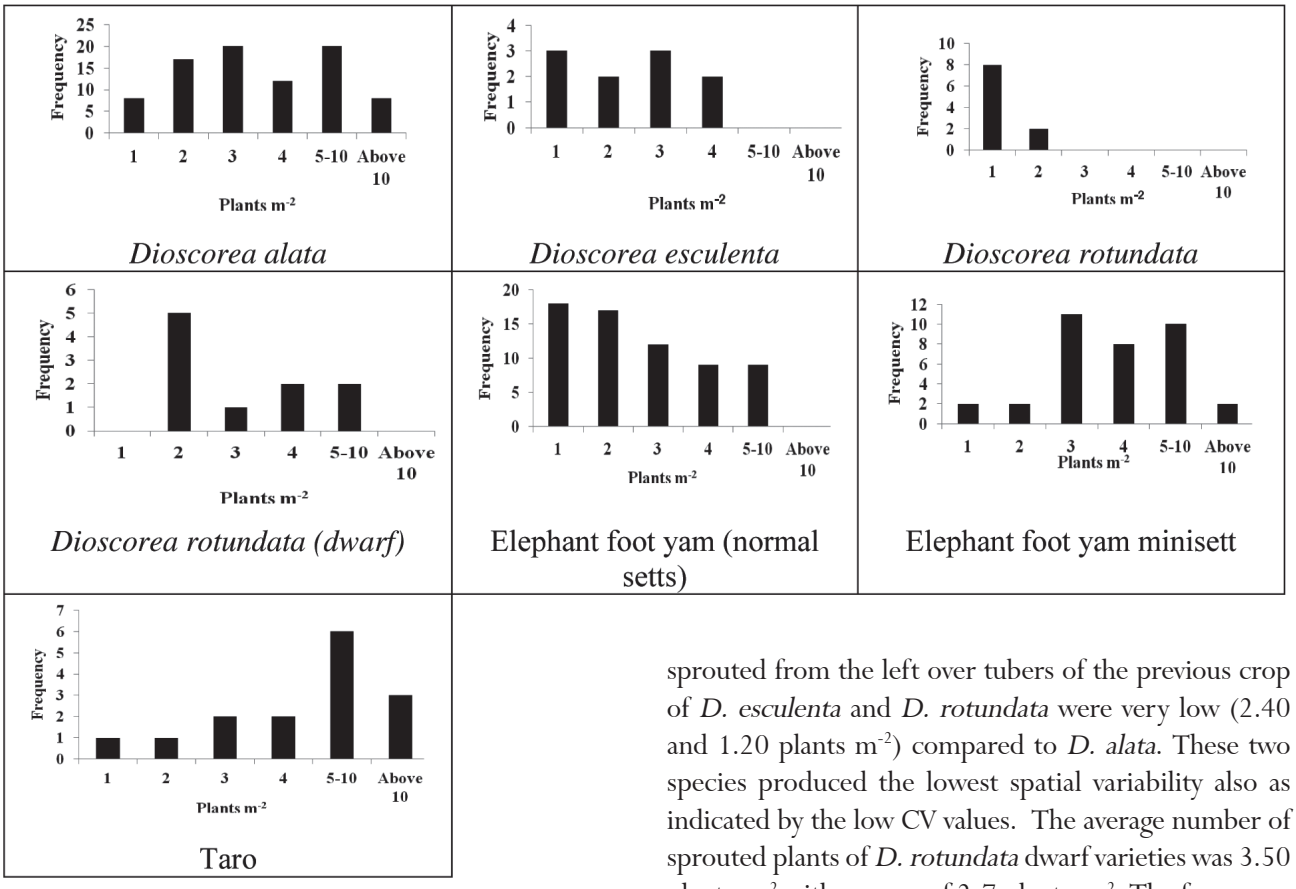

Fig. 1. Frequency distribution showing the variations in the number of plants sprouted from the previous season crop of yams and aroids

5.38 plants m^{-2} sprouted from the previous crop of *D. alata* which ranged from 1 to 41 plants m^{-2}. Among the different crops studied, the coefficient of variation (CV) was found to be greatest for *D. alata* as indicated by a CV value of 113.39%. The mean number of plants sprouted from the left over tubers of the previous crop of *D. esculenta* and *D. rotundata* were very low (2.40 and 1.20 plants m^{-2}) compared to *D. alata*. These two species produced the lowest spatial variability also as indicated by the low CV values. The average number of sprouted plants of *D. rotundata* dwarf varieties was 3.50 plants m^{-2} with a range of 2-7 plants m^{-2}. The frequency distribution of the variations in the number of plants sprouted from the previous season crop is shown in Fig 1. The tally results done in Genstat 'survey analysis tally' option showed that for *D. alata*, in 20 out of 85 sample grids studied, 5-10 plants germinated and eight sampling grids showed germination of more than 10 plants. Thirty three per cent of the sampling locations had germination of more than 5 plants m^{-2}.

The number of plants sprouted from elephant foot yam (*Amorphophallus paeoniifolius* (Dennst.) Nicolson) fields were measured from experimental fields planted with whole or cut corms of normal size as well as from fields planted with minisetts separately. The average numbers were 2.83 and 4.63 plants m^{-2}. The range varied from 1-9 for fields planted with planting materials of normal size, whereas it varied from 1-16 in minisett planted fields. Taro (*Colocasia esculenta* (L.) Schott) also showed great variability in the number of sprouted plants of the previous crop as shown by the highest CV of 128.90, which is a large variability according to Xing-Yi et al. (2007). On an average, 7.47 plants m^{-2} sprouted from left over corms or cormels of the previous crop. An analysis of the kurtosis of the data showed that the distribution of the values of *D. alata* and elephant foot yam *minisett* was less peaked than Gaussian distribution.

Based on calculations of data collected (Fig. 1) it is seen that 14 and 34 per cent of the sampling grids of elephant foot yam fields planted using normal setts and minisetts respectively had sprouting of more than 5 plants m^{-2}, which is a very significant number. The analysis of data from taro fields showed that 60 per cent of the sampling grids studied had sprouting of more than 5 plants m^{-2}.

The results of the study clearly showed the possibility of mixing of varieties or germplasm from feral plants of yams, elephant foot yam and taro. Maximum number of feral plants was recorded for taro (74,700 plants ha^{-1}) followed by *D. alata* (53, 800 plants ha^{-1}), which also recorded maximum variability as indicated by the very high CV values for these two crops. The study clearly showed that whatever precautions are taken while harvesting, there is a very high chance of left over cormels or side tubers getting sprouted in the next growing season resulting in the development of feral plants. When the data of the three species of *Dioscorea* are critically analysed, it could be observed that the mean, range and CV values of *D. alata* were very high compared to *D. esculenta* and *D. rotundata*, which may be due to the fact that *D. alata* produces a number of aerial tubers on the vines, which may fall to the ground and sprout during the next growing season.

The results of the present study clearly showed the presence of a large number of feral plants in taro, yams and elephant foot yam and the possibility of mixing of varieties and germplasm, unless we rotate the field with another species or crop, season after season or year after year. This is very important in the conservation of genetic resources, to maintain the genetic purity of varieties as well as to avoid the gene flow in seasons following a transgenic crop.

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