FRUIT CHARACTERISTICS IN *Cola acuminata*. II. NUT SIZE, COTYLEDON NUMBER AND COLOUR[1] /

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Resumen

Se estudió 29 428 semillas de Cola acuminata, *obtenidas de mazorcas frescas colectadas en los Estados de Oyo, Ogun y Ondo, Nigeria. Las semillas se clasificaron con base a su tamaño, número de cotiledones y color. La clase más abundante por tamaño fue de 6-10 g, seguido por la clase de 11-15 g. Los cotiledones se presentaron con mayor frecuencia en número de cuatro, indiferentemente de su color o tamaño. Las semillas rosadas se presentaron con mayor frecuencia que las rojas, mientras que las blancas representaron tan solo el 4%.*

El análisis estadístico mostró diferencia significativa al 0.1% para el tamaño, el número, el color y el origen del cotiledón, con una interacción significativa al 0.001% entre ellas. Se discute la importancia de las características mencionadas y el uso futuro de esta variabilidad en trabajos de selección futura de Cola acuminata.

Introduction

Russell (8) recognized *Cola acuminata* to have three to five cotyledons while Keay *et al.* (6) classified *C. acuminata* as that species of *Cola* with nuts of 3 to 5 cotyledons but rarely 2 or 6. Ibikunle (5), while recognizing the pleiocotyl nature of *C. acuminata*, found that germination velocity of *C. acuminata*, varies with cotyledon numbers, four and five cotyledon nuts giving the best germination rate. In the same report, he found that nuts of 11 – 15 g size had the best germination velocity. In classifying the nuts he used in the experiment into sizes, he found 11 – 15 g class size to have 28.2% frequency, followed by 6 – 10 g and 16 – 20 g class sizes with 26.3% and 22.4% frequency respectively. The least frequency of 4.5% was recorded for greater than 25 g size. However, the number of the nuts considered was rather small (only 1 433 nuts) and the classification was limited to only the nut size, leaving information on cotyledon number and colour distribution blank.

Colour variation in Kola was studied by Voelcher (9) but the study was limited to only *Cola nitida*. While he recognized the existence of three colours, red, pink and white, he found the dark red to be most common and the white comparatively rare. Most important however was his conclusion that colour of the nuts may vary from follicle to follicle, from tree to tree and on the same tree, from year to year. He believed that colour in Kola is determined by a number of genes which is complex. This partially agreed with Chamney (2) who showed variation of nut colour from year to year, and concluded that colour is a function of age and not a Mendelian character. Dublin (1) and Eijnatten (4) also confirmed the existence of these three colours, but Dublin believed the division into the three distinct colours to be quite arbitrary and unrealistic since observation on a large number of *C. nitida* nuts revealed that one can pass progressively from a deep red coloured nut to a white or creamish nut, through a range of intermediate coloration giving a wide spectrum of colour variation. Finally, Dublin (1), expressing the curiosity of several authors at this phenomenon of multiple coloration, stated that there is no known precedence of this coloration in the plant kingdom. He believed that only *C. nitida* showed the three colours, while other species such as *C. ballayi*, *C. acuminata* and *C. verti-*

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cillata, have pink to pale pink nuts. Russell (8), however, recognized the three colours in *C. acuminata*.

In view of rather scanty information on *C. acuminata* (Eijnatten, 3) and imminent increase in its demand, a need arises for studies to be initiated on the species. Thus a study of nut size, cotyledon number and colour distribution in this species will give quantitative and qualitative relationships among the three factors and will thus serve as handy information for ultimate selection and breeding studies.

Materials and method

Fresh pods were bought directly both from the rural markets and the farmers on their farms. They were then split open and the nuts, covered with the testa, were soaked overnight prior to the removal of the testa. The skinned nuts were then left in the baskets so that water could drain off overnight. The nuts were sorted out into 1 – 5, 6 – 10, 11 – 15, 16 – 20, 21 – 25, 26 – 30, 31 – 35, 36 – 40 and 41 + g-class sizes. Each of these classes was then sorted out into 1, 2, 3, 4, 5 and 6-cotyledon number subclasses. The subclasses were finally sorted into red, pink and white colours. Records bases on these three factors were statistically analysed to detect both the significant differences and possible interaction among the factors.

Results

Nut size class 6 – 10 g had the highest frequency (34.8%) of the whole population of 29 428 nuts investigated (Figure 1). This was followed by 11 – 15 g size class. In all, about 90% of the whole population fell between 1 and 20 g-nut weight, while the average nut weight was 15.3 g. On the nut cotyledon number basis, four-cotyledon nuts accounted for 59.3% (Figure 2) followed by five-cotyledon nuts. More than 95% of the entire nuts sorted out had 3, 4 and 5 cotyledons, while least frequency was recorded for one cotyledon (or "akiriboto" variant) with only 0.5% . Two nuts with 7 cotyledons were observed and these are shown in Figure 9. Pink nuts outstripped the red nuts, while the white nuts had the least frequencies (Figure 3).

When the percentage distribution of the nut size with respect to location was considered, it was observed that in all the locations, the majority of the nuts fell between 1 and 20 g-size (Figure 4). However, there is a conspicuous difference in size distribution in the nuts procured from Oke Agbe. Here, 11 – 15 g-size class had the highest frequency followed by 6 – 10 g and 16 – 20 g-size classes respectively.

Except for Ijan Ekiti where three-cotyledon nuts ranked second to the four-cotyledon nuts, the trend in all the locations is four, five and three cotyledon nuts in decreasing order of abundance (Figure 5). Four-cotyledon nuts accounted for about 60% of the population in all the locations except at Ijan Ekiti where 56% was recorded.

Variation in nut colour with location seemed to be much more pronounced than experienced with nut size and nut cotyledon number (Figure 6). A similar trend of pink, red and white nuts, in decreasing order of abundance, was displayed by the nuts from Ifewara, Oke Agbe, Ondo and Ijebu Imushin. However, red nuts were in the majority at Ijan Ekiti.

Other interactions that were found to be significant at $P = 0.001$ are shown in Table 1. Figures 7 to 8 show the nuts as they vary in size and colour, while Figure 9 shows the one and seven cotyledon nuts.

Discussion

The frequency values for the various weight classification shown in Figures 1 and 4 indicate that the average nut weight of *C. acuminata* is rather low only very few weighed more than 20 g while the average was 15 g. Though this value is said to be low, it is similar to 16 g reported for *C. nitida* by Russell (8) and agrees with Eijnatten (4) who stated that weight of the *C. nitida* nuts may be up to 100 g, but usually varies from 10 – 25 g. The percentage distribution with respect to size class was similar to that reported by Ibikunle (5), although 6 – 10 g size recorded the highest frequency as against 11 – 15 g size reported by him. The frequency distribution showed a significant variation with locations, and nuts from Oke Agbe tended to be heavier than in other locations.

For the first time, a report is made of one cotyledon and seven cotyledon *C. acuminata* nuts. The occurrence of one cotyledon variant ("Akiriboto" variant) is not uncommon in *C. nitida* in the Southern part of Nigeria, but it is surprising that such a record did not exist for *C. acuminata* in all the sources on Kola taxonomy consulted so far. This variant recorded 0.53% frequency in this study.

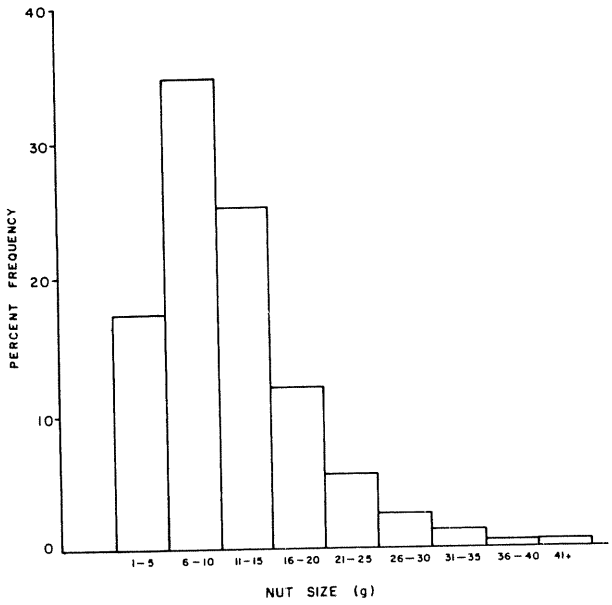

Fig. 1. Percent frequency distribution of *Cola acuminata* nuts on weight basis.

However, the seven-cotyledon variant is both uncommon and unrecorded in any available literature on Kola.

The fact that 3, 4 and 5 cotyledon nuts accounted for more than 95% of the entire nuts in this study could be viewed against the germination velocity of the various cotyledon classes as reported by Ibikunle (5) and confirmed by Oladokun (7). One can relate the natural selection influence to the frequency distribution, since the most common cotyledon types recorded the fastest germination velocity and percentage.

Colour distribution in *C. acuminata* seems to be the most variable character, with respect to nut size, cotyledon number and location. This agrees with Eijnatten (4) who stated that the most obvious variation in the nuts lies in their colour. Colour categorization may appear as simple as shown in Figure 8a, but Figure 8b shows that the exercise may not be all that simple as the graduation of colour intensity from white to dark red shows a streamlined pattern that makes the creation of colour demarcations a difficult task. Thus the wide range and graduality of colour intensity variation makes classification somewhat difficult and subjective. It tends to make such a classification favour pink as reported by Eijnatten (3).

Its variability suggests that colour variation in *C. acuminata* may not after all be a Mendelian character in agreement with Chamney (2) working with *C. nitida* in Ghana. If, however, it is a Mendelian character, Voelcker's (9) conclusion that colour in *C. nitida* is determined by a number of genes, which is itself no doubt complex, may be considered appropriate.

The existence of the three colours, red, pink and white, while disagreeing with Dublin (1) that only *C. nitida* showed the three colours, agrees with Russell (8) who reported the same phenomenon

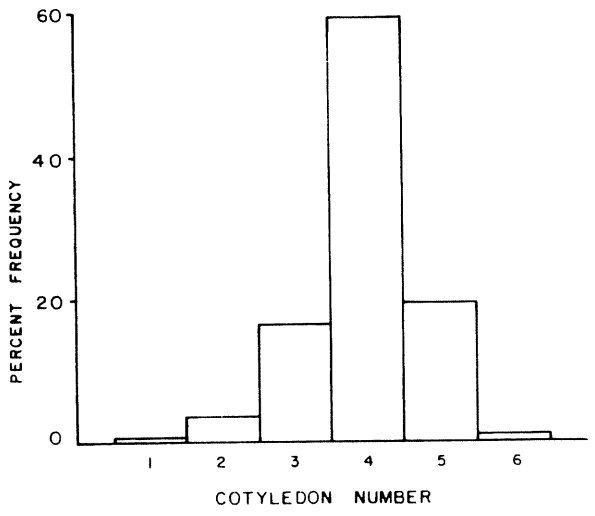

Fig. 2. Percent frequency distribution of *Cola acuminata* nuts on cotyledon number basis.

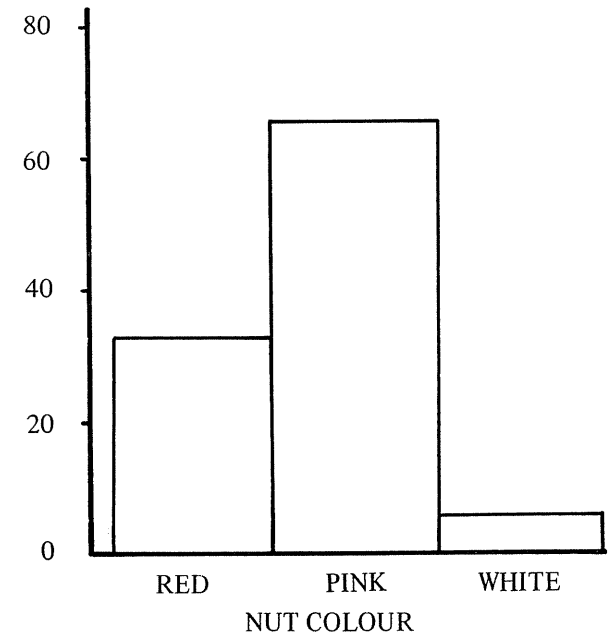

Fig. 3. Percent frequency distribution of *Cola acuminata* nuts on nut colour basis.

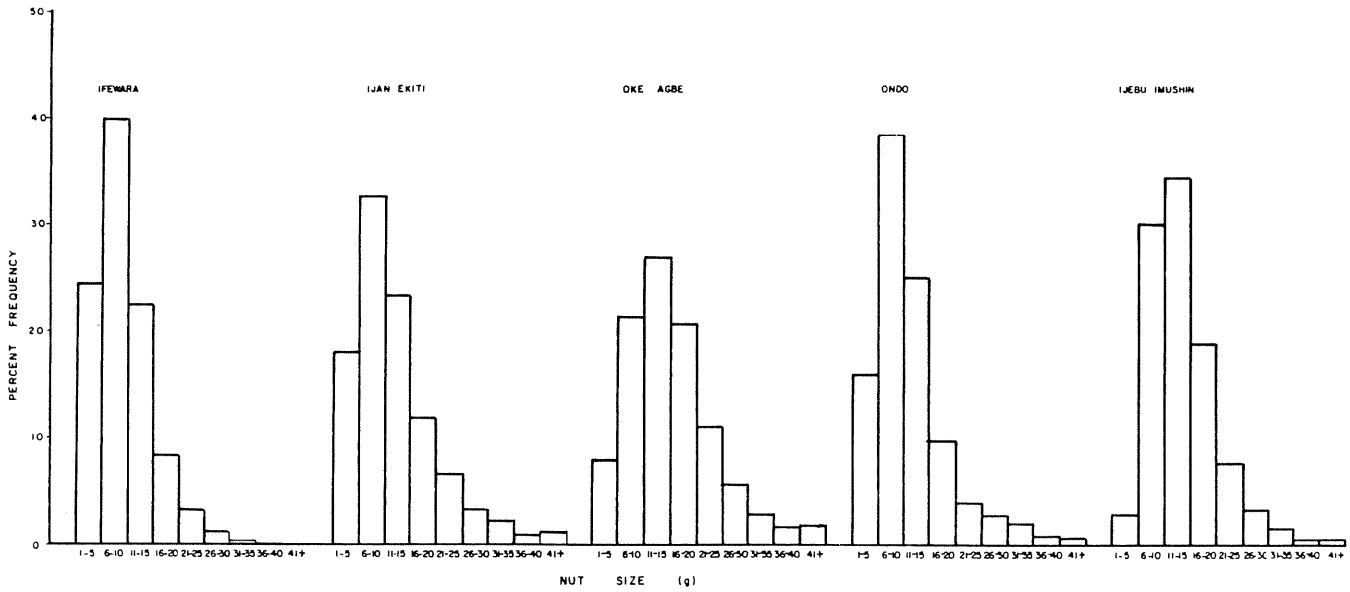

Fig. 4. Variation of *Cola acuminata* nut weight distribution with location.

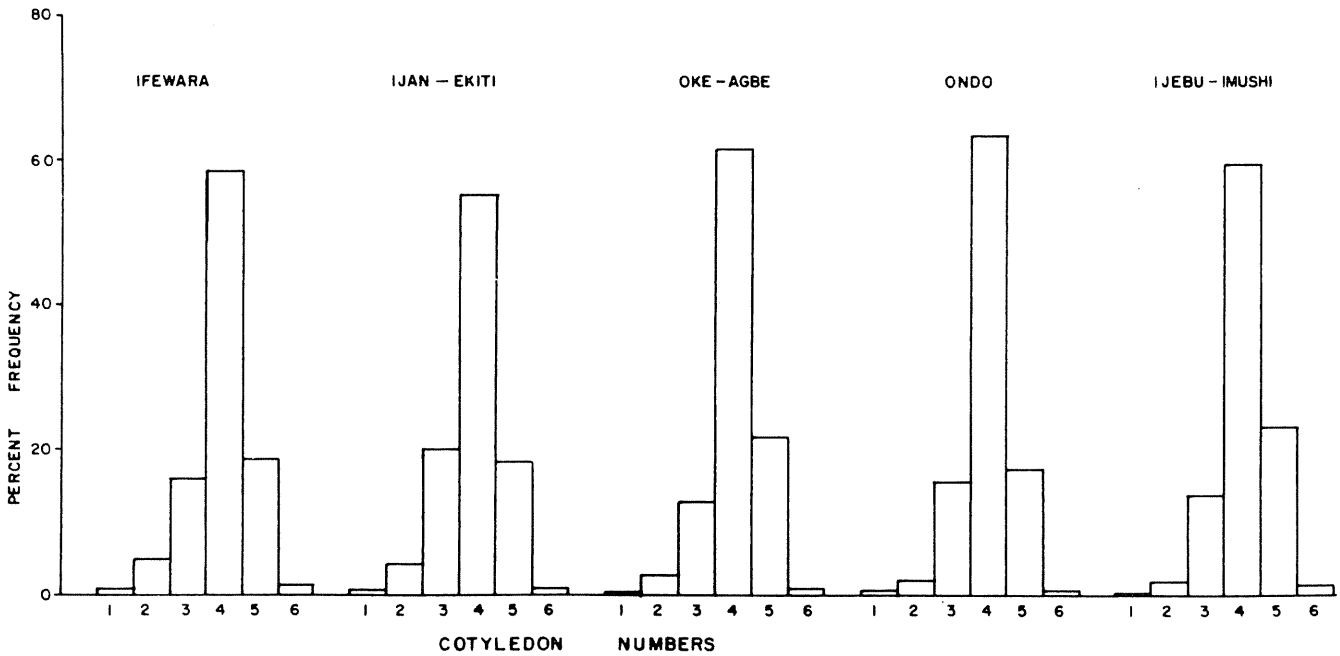

Fig. 5. Variation of *Cola acuminata* cotyledon number distribution with location.

in *C. acuminata* in Nigeria. It is noteworthy to discover that pink nuts were in the majority followed by the red. White nuts convincingly were in the minority. Eijnatten (3) writing on *C. nitida* stated that white nut is recessive to the red nut, while the latter is recessive to the pink nut. On the basis of the results produced above, it is probable the same thing applied to *C. acuminata.* Oladokun (7) found that pink nuts recorded the best germination performance in terms of percentage emergence and velocity. Red nuts came second while the white nuts came last. Thus the influence of genetic colour dominance is manifested in germination ability and is thus understandably manifested in natural selection processes.

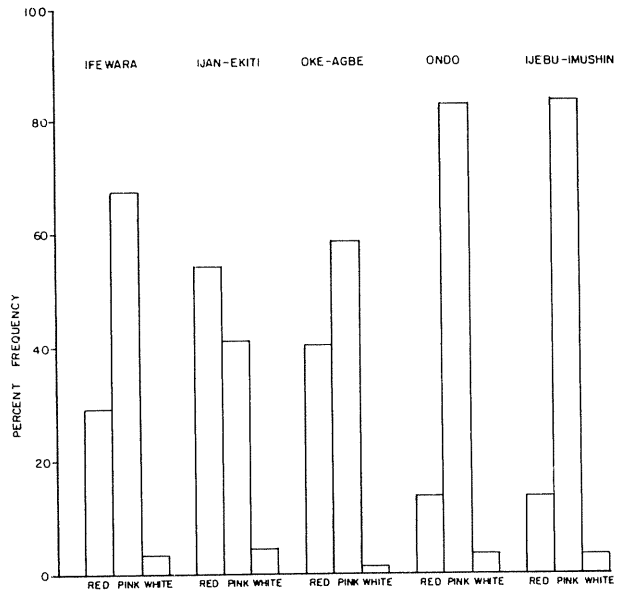

Fig. 6. Variation of *Cola acuminata* nut colour distribution with location.

Conclusions

Nut size, nut cotyledon number and colour are important and distinct characteristics of *C. acuminata.* The variability of these characteristics and the significant interactions among them show them to be a considerable source of breeding and selection programme. White *C. acuminata* nuts are highly preferred to other colours. Breeding for the colour will need to take into consideration its linkage with slow rate of germination as well as nut cotyledon number.

Table 1. Analysis of variance on the arcsin transformed data of nut size, nut cotyledon number and nut colour variation in *Cola acuminata.*

Sources of variation	D. F.	S. S.	M. S.	F.	SIG. LEVEL
Nut size (S)	8	2 296.00	287.000	313.51	* * *
Nut cotyledon number (N)	5	3 176.147	635.229	693.91	* * *
Nut Colour (C)	2	1 376.280	688.140	751.71	* * *
Location (L)	4	29.843	7.461	8.15	* * *
S X N Interaction	40	1 284.907	32.123	35.09	* * *
S X C Interaction	16	434.893	27.181	29.69	* * *
S X L Interaction	32	242.671	7.583	8.28	* * *
N X C Interaction	10	930.325	9.303	10.16	* * *
N X L Interaction	20	64.818	3.241	3.54	* * *
C X L Interaction	8	244.296	30.537	33.36	* * *
S X N X C Interaction	80	317.352	3.967	4.33	* * *
S X N X L Interaction	160	182.525	1.141	1.25	* * *
S X C X L Interaction	64	236.322	3.692	4.03	* * *
N X C X L Interaction	40	235.196	5.880	6.42	* * *
Residual (SXNXCXL)	320	292.939	0.915	–	
TOTAL	809	11 344.514	–	–	

*** Significant at 0.1%.

** Significant at 1.0%.

* Significant at 5.0%.

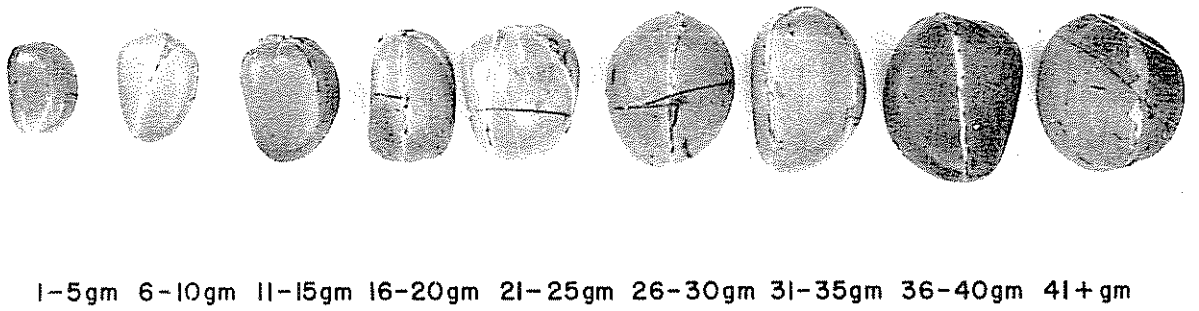

Fig. 7 Nut size variation in *Cola acuminata*

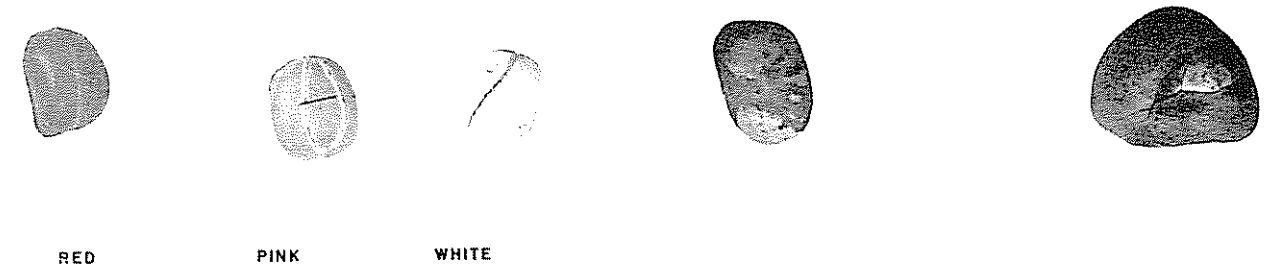

Fig. 8 Nut colour variation in *Cola acuminata*

Fig. 9 One –and seven– cotyledon nuts

Abstract

29.428 nuts of *Cola acuminata* obtained from fresh pods collected from Oyo, Ogun and Ondo States were sorted out on the bases of size, cotyledon number and colour. The most common size class was that of 6 – 10 g, followed by 11 – 15 g size class. The most frequent cotyledon number irrespective of size of colour, was four followed by nuts with five cotyledons. Report is made of one and seven cotyledon nuts. Pink nuts were the most frequent, followed by the red. White nuts were relatively few with about 4% frequency.

Statistical analysis showed a 0.1% significant difference for size, cotyledon number, colour and location and the interactions among them were also highly significant (P = 0.001). The importance of the above characters and the use of their variability in future selection work on *Cola acuminata* is discussed.

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Notas y comentarios

Publicaciones

El Servicio de Conservación de Suelos de los Estados Unidos de Norteamérica ha creado el Programa Internacional de Suelos bajo la dirección del Dr. Hari Eswaran. Este programa mantiene correspondencia con personas interesadas en mantenerse al día en la Taxonomía de Suelos a través del National Soil Taxonomy Handbook. Los interesados en este tipo de información pueden dirigirse al Dr. Hari Eswaran National Coordinator International Soil Program. P. O. Box 2890. Washington, D. C. 20013 USA.