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DIRECT AND SCATTERED REFLECTION AS AN ASPECT OF SOIL SURVEY ON THE MANAUS - CARACARAI - ROADSIDE

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The region :

The 40 to 60 meter wide, about 160 km long, clear-cut line of the future Manaus-Caracaraí-Road carves a partially deep intersected plateau, the upper drainage basin of the rivers Urubú, Prêto da Eva, Cuieiras, their tributaries et al.

High tropical rain forest prevails on yellow to reddish yellow latosols or closely related soil types. Carrascos (Pseudo-caatingas) and Campinas predominate on sandy soils or white, deep sand layers. The steep valley slopes expose the weathering products of multicolored terciary sandstone and clay beds. Light sandy or dark loamy soils, humified and waterlogged, cover the bottom of the valleys.

Sampling :

In September 1968 a four-day field excursion was carried out on this road, which is open to jeeps in the dry season only. Covering the roadside from km 38 to km 92, seventeen main

top-soil samples were collected, being represented by ten subsamples each. These samples give rather a good impression of the region's top-soil layer mosaic.

General aspects :

The total reflection of a material is given as the sum of direct and scattered reflection. The total reflection ratio is a function of the surface characteristics, moisture conditions and some specific peculiarities of the two reflection types. For standardization all soil samples were placed into equal-sized containers. Surface characteristics, mainly grain size (roughness) of the samples were brought to a considerable uniformity. At the grain size ranges under experimentation some additional tests showed a negligible effect on direct reflection values only.

Direct reflection (gloss), scattered reflection, and soil color of the 170 samples were determined, providing different soil moisture conditions as :

A — Oven-dried samples — 110°C/48 hours

B — Air-dried samples — 25°C/about 50% relative humidity/3 weeks

C — Completely water-saturated samples

and a wavelength from 3500 A to 7800 A approximately.

Direct reflection (gloss) :

Method :

Direct reflection was studied handling a gloss meter (120° angle) and two colored glass filters (RG 2; VG 9; th = 1 mm) over a black, polished gloss standard. The standard was calibrated to the scattered reflection normal stated below. Readings were done on a highly sensitive galvanometer.

Results :

Some direct reflection data using an arbitrary unit for airdried and completely water-saturated soil samples are given in table 1.

Main sample	Normal		RG 2		VG 9	
N.º	B	C	B	C	B	C
38	1.4	5.4	1.5	5.1	1.5	4.1
56(2)	1.0	3.9	1.1	4.0	1.0	4.6
56(3)	1.0	1.5	1.1	1.2	1.0	1.1
91(1)	1.5	2.4	1.9	2.4	1.5	2.3

Tab. 1 Direct reflection of air-dried (B) and completely water-saturated (C) soil samples (in per cent arbitrary unit)

Considering the different soil groups sampled, the air-dried soil samples give rather a good impression of the specific direct reflection variance. In general, the values are extremely low with absence of outliers. The normal light beam and the filtered light show quite a difference. On the other hand, the gloss of completely water-saturated soil samples is fairly higher as a result of a thin water film on the soil particles, i. e. the total direct reflection (specific direct reflection and added reflection) depends considerably on the angle of light incidence. This problem was solved by light beam standardization (120° angle). Under natural conditions, however, total reflection (gloss and scattered reflection) is the more influenced by the angle of light incidence, the greater the gloss fraction of the total reflection unit.

Calculating a correlation of the arbitrary units given in tab. 1, and the standard used for scattered reflection determination stated below, the direct reflection values of air-dried soil samples are in the order of 1% at the maximum, i. e. negligible. But the completely water-saturated soil samples showed a maximum gloss at about 4%, a fact, that should be paid a fair attention, especially at high absorbent soils.

Scattered reflection :

Method :

Scattered reflection was recorded operating a reflection meter and a set of 3 colored glass filters (RG 2; VG 9; BG 12; th = 1mm) over a 99 % magnesia-white normal. Readings were taken of a highly sensitive galvanometer.

Each soil sample was tested 4 times. As the error of observation was rather negligible, no corrections were necessary. All experimental data were subjected to frequency analysis. The data were grouped in 8 classes, establishing a class interval of 10% over the range of 5% to 85% scattered reflection values. Absolute cell frequency of the experimental data, considering soil moisture conditions A, B, C, and sum of A B C stated above, was calculated as cumulative relative frequency and plotted on probability paper with respect to normal light beam and spectral (filtered) light.

Results :

The scattered reflection data, as given in figures 1 to 5, follow a multivariate normal distribution. The graphs A and B are rather equal in shape and position, i.e. the scattered reflection of oven-dried and air-dried soil samples is approximately the same, whereas completely water-saturated soil samples, presented as graphs C, show a remarkable shifting to low scattered reflection values (see figs. 1 to 5).

The graph analyses, considering different light input (see figs. 1 to 4) and soil color estimation, the latter matching Munsell Soil Color Charts up to the nearest approximation, allow the discrimination of at least four reflection-color groups, following a specific rank order. Some general informations are given in table 2 (see fig. 5).

Rank order	moisture cond.	reflection group	color group	soil group
dominant	B	35 — 65 %	yellow, reddish brown/pink	latosolic soils, multicolored
	C	25 — 45 %	brownish yellow/reddish yellow	sand and clay beds
subdominant	B	45 — 55 %	white/very pale brown	sandy soils
	C	25 — 35 %	light gray/pale brown	
subdominant	B	25 — 35 %	grayish brown/light yellowish brown	loamy, sandy soils (humified)
	C	15 — 25 %	dark grayish brown/brown	
outlier	B	65 — 75 %	white	kaolinic soils
	C	55 — 65 %	white	

Tab. 2 Scattered reflection, soil color and soil groups with respect to soil moisture and distribution order.

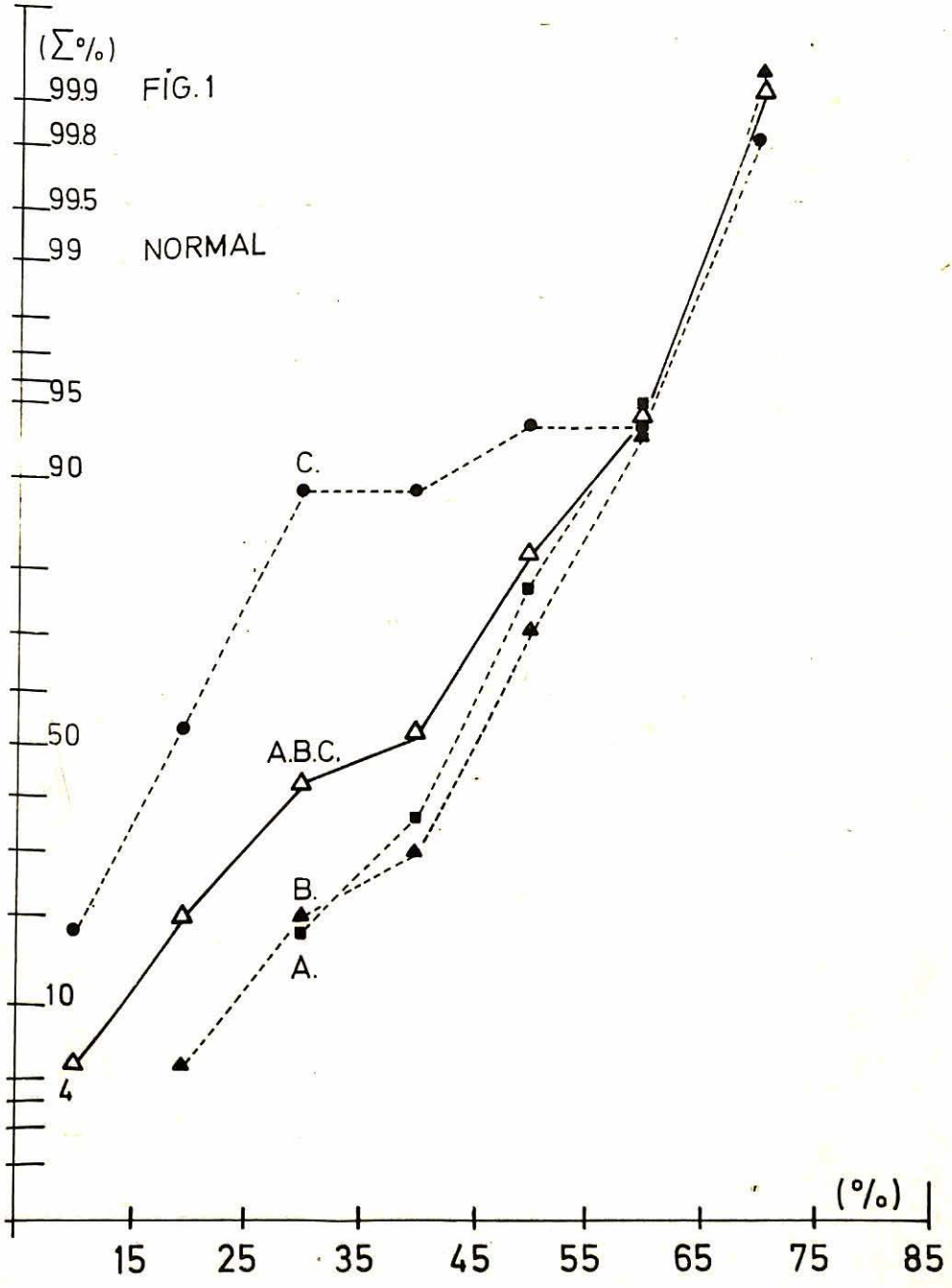
In order to specify the general results of tab. 2, spectral (filtered) scattered reflection was studied (see figs. 2, 3, 4). Operating red-filtered light, the experimental data show a considerable shift to high reflection percentage for both air-dried and completely water-saturated soil samples (see fig. 2). Green-and blue-filtered light cause very low scattered reflection on completely water-saturated soil samples (see figs. 3, 4). In general, spectral scattered reflection is extremely helpful in reflection color group discrimination.

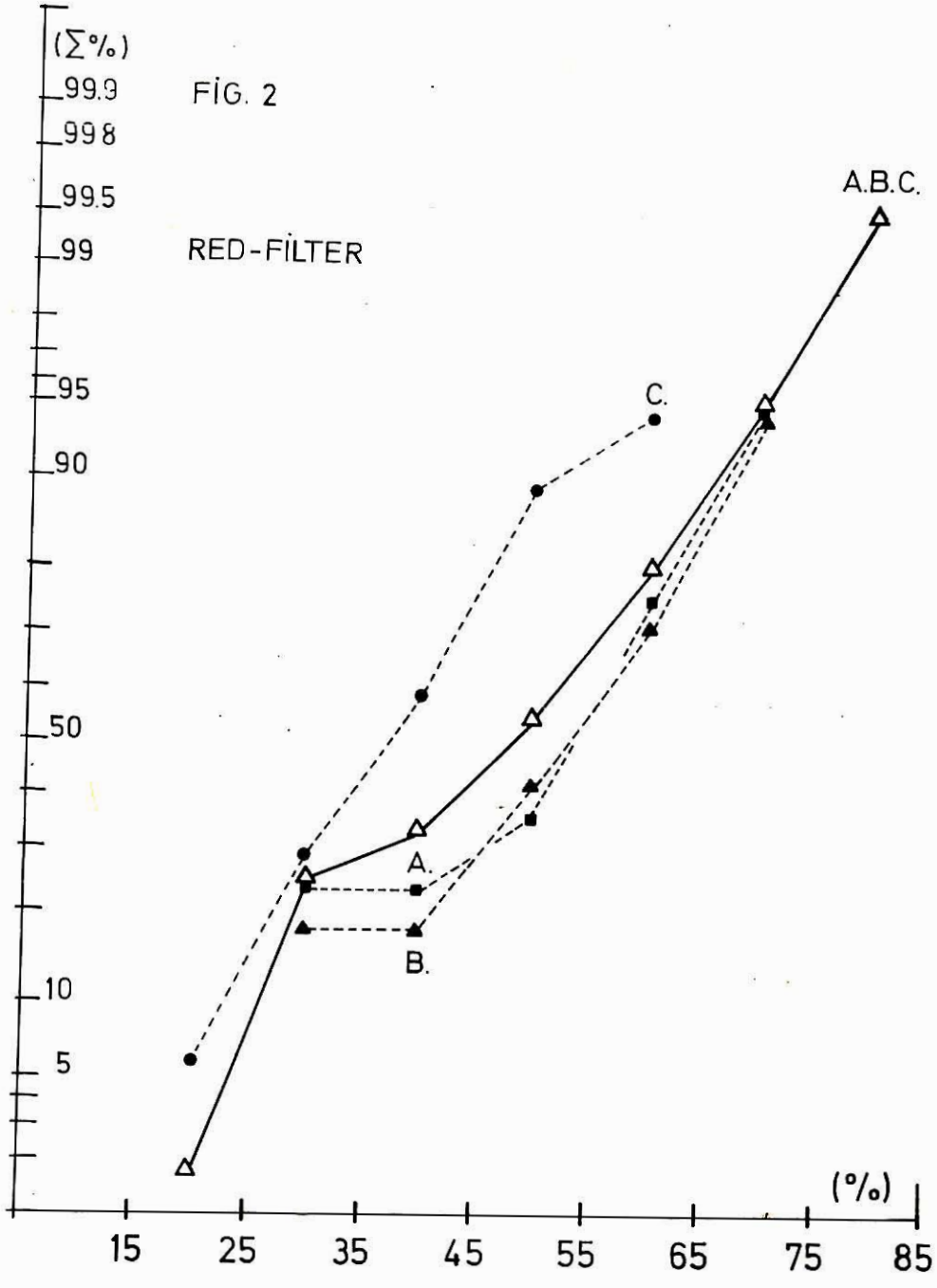
Conclusions:

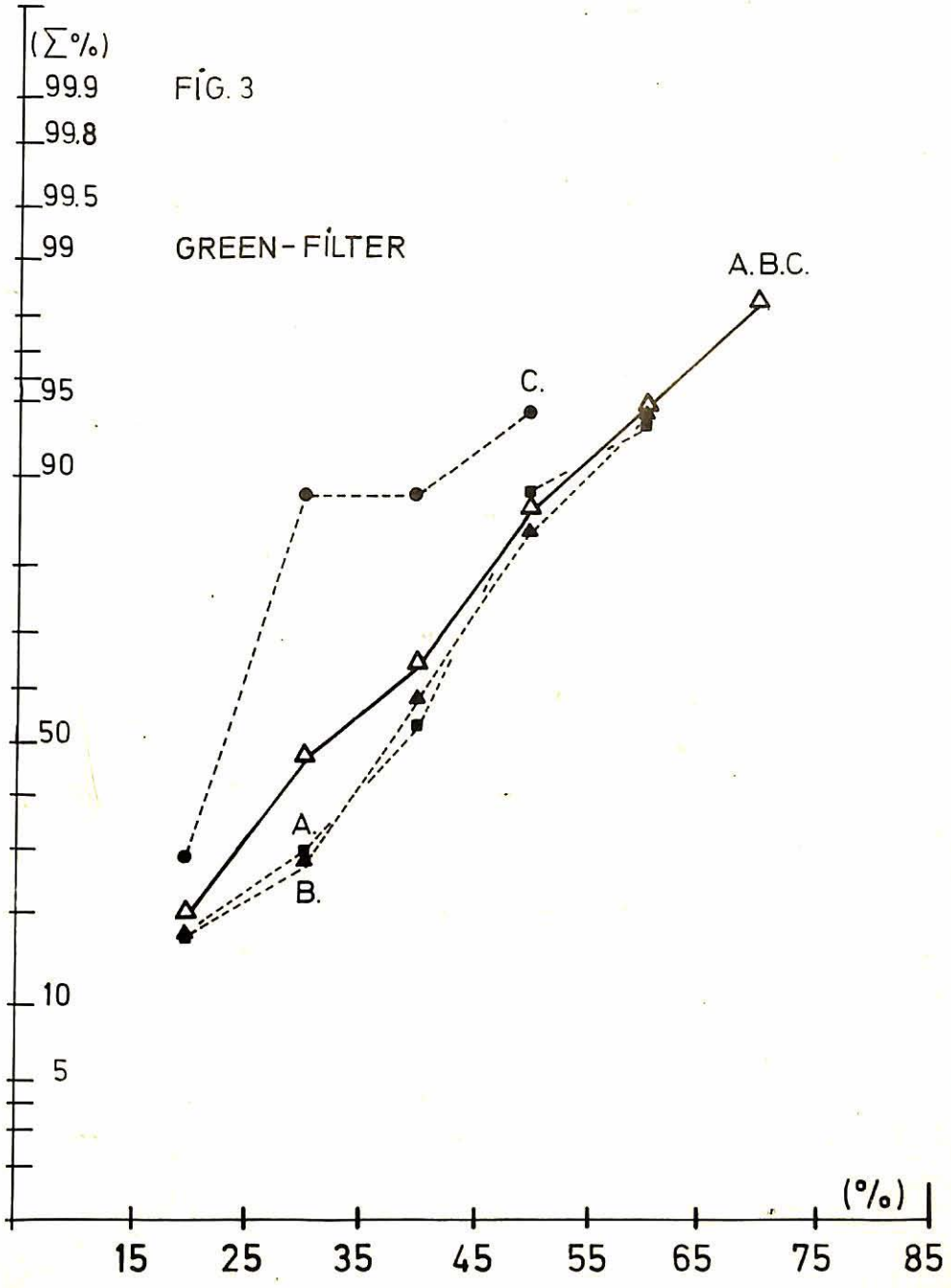
Total reflection analyses of the relative representative soil mosaic was intended to be one aspect of basic research for future agricultural and silvicultural development of the Manaus-Caracaraí-Region up to km 90.

During the wet season the total reflection values will oscillate between air-dried and completely water-saturated conditions stated in tab. 2, with a considerable shift to high soil moisture content reflection, i.e. remarkably high absorption rates, which are of some inportance as far as germination processes are concerned.

During the dry season (July-October) total reflection data will remain on a high level almost all the time. By lack of sufficient water reservoirs and irrigation facilities, the development of seedlings and radiation sensitive plants is interfered with at high radiation input and additive reflection rates. A minimum seedling height related to the reflection-color group must always be granted. Considering reflection conditions only, gray — white sandy soils and dark loamy/sandy soils, given as subdominant in table 2, can be estimated to be best for land-use. But shortly after clear-cut the latter group will be subjected to bleaching, i.e. to higher total reflection rates. To reduce total reflection to a convenient level, a shelter wood system, well related to reflection-color groups and plant requirements, is advisable.


(Σ%)
99.9
99.8
99.5
99
95
90
50
10
4
FIG. 1
NORMAL
C.
A.B.C.
B.
A.
(%)
15
25
35
45
55
65
75
85


(Σ%)
99.9
99.8
99.5
99
95
90
50
10
5
FİG. 2
RED-FİLTER
A.B.C.
C.
A.
B.
(%)
15
25
35
45
55
65
75
85


(Σ%)
99.9
99.8
99.5
99
95
90
50
10
5
FIG. 3
GREEN-FILTER
A.B.C.
C.
A.
B.
(%)
15
25
35
45
55
65
75
85

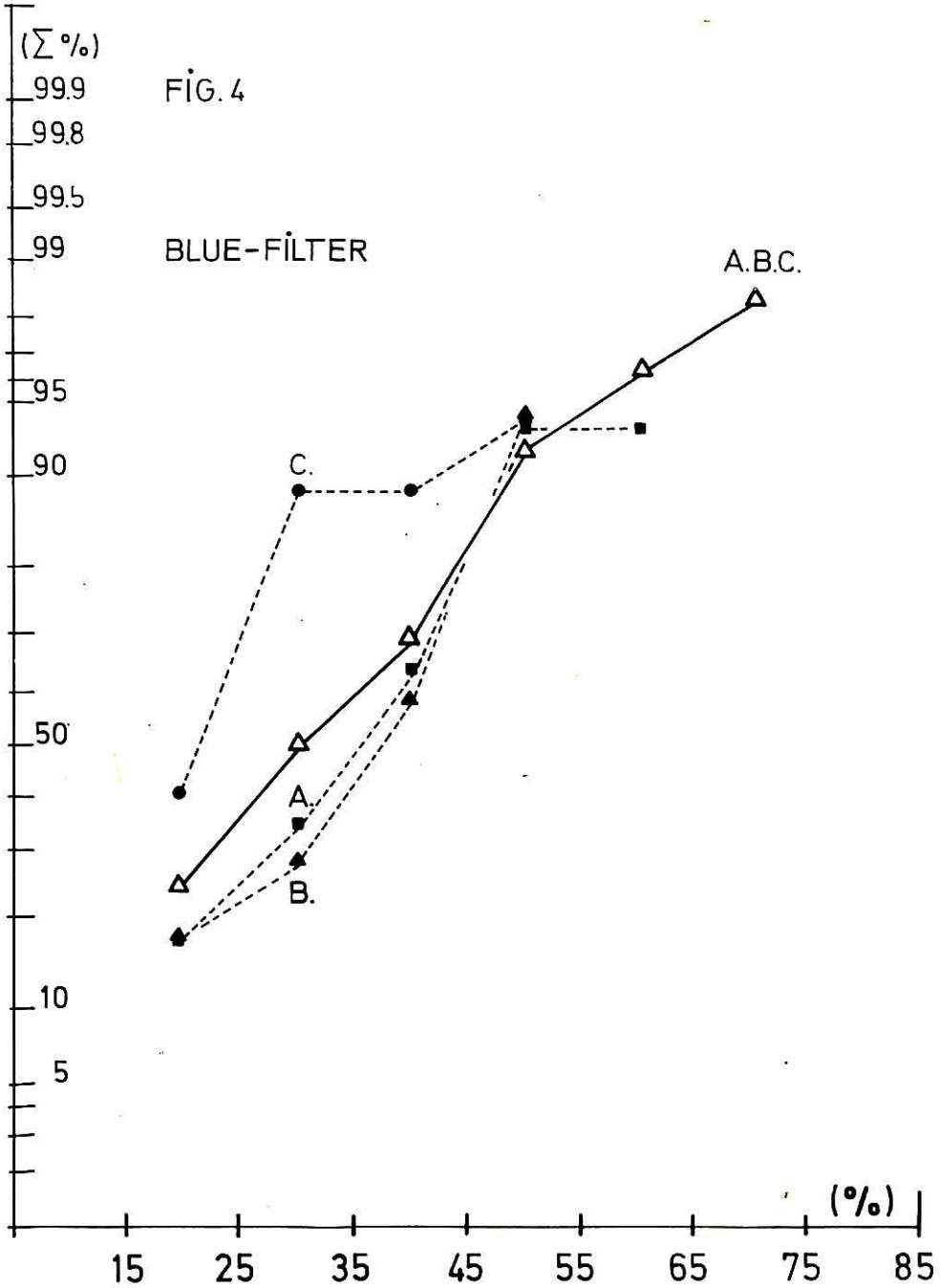
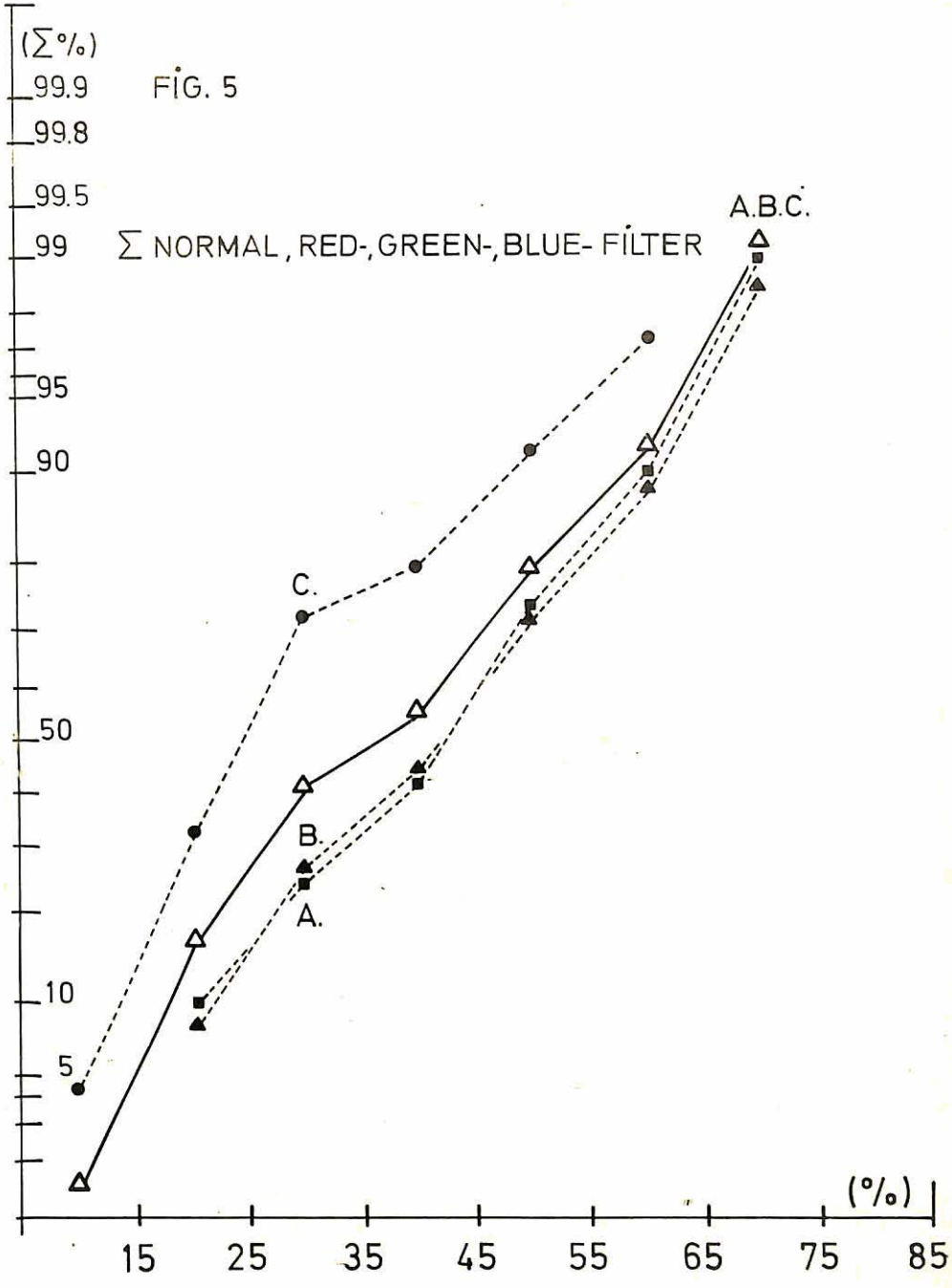

(∑%)
99.9
99.8
99.5
99
95
90
50
10
5
FIG. 4
BLUE-FILTER
A.B.C.
C.
A.
B.
(%)
15
25
35
45
55
65
75
85

FIG. 5


(Σ%)
99.9
99.8
99.5
99
95
90
50
10
5
Σ NORMAL, RED-, GREEN-, BLUE- FILTER
A.B.C.
C.
B.
A.
(%)
15
25
35
45
55
65
75
85

SUMMARY

The total reflection, i.e. direct and scattered reflection, of 170 top-soil samples relatively representative for the Manaus-Caracaraí-Roadside up to km. 90 was studied.

Direct reflection was of fair importance, considering completely water-saturated, high absorbent soils only.

Using cumulative relative frequency analysis, 4 scattered reflection-color groups, closely related to specific soil groups were discriminated, spectral (filtered) reflection being extremely helpful. According to the experimental data, gray to white sandy soils and dark loamy/sandy soils are preferable for land-use, considering the total reflection aspect.

RESUMO

O Autor estudou a superfície do solo ao longo da estrada Manaus-Caracaraí até a altura do quilômetro 90 tendo em vista a reflexão total i.e. reflexão direta mais reflexão difusa. Foram colhidas 170 amostras relativamente representativas daquela região.

Nos solos altamente absorventes e saturados com água, a reflexão direta foi certamente importante.

Usando a análise das frequências relativas acumuladas, foram distinguidos 4 grupos de reflexão difusa conforme a cor, tendo sido para aquele fim particularmente útil o estudo da reflexão espectral (filtrada).

De acôrdo com os dados experimenais, para fins agrícolas, os solos arenosos variando do cinza ao branco e os solos escuros lodosos ou arenosos são preferíveis no que diz respeito à reflexão.

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Krinow, E. L., Spektrale Reflexionseigenschaften von natürlichen Formationen. (russ.) 1947. Translated : Nat. Council of Canada Techn. Trans. T.T. — 439. Ottawa 1953.

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