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QUANTITATIVE ANALYSIS OF SEXUAL X APOMICTIC CROSSES IN *PANICUM MAXIMUM*

par

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ABSTRACT

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QUANTITATIVE GENETIC ANALYSES OF SEXUAL APOMICTIC CROSSES IN *PANICUM MAXIMUM*.

Maximae group in the genus Panicum is an apomictic complex. Diploid arents are sexual, tetraploid plants are generally apomictic, but sexual tetraploid plants are obtained by doubling the chromosome sets of diploid plants, through colchicine treatment. With cross breeding, tetraploid sexual plants are fecund with apomictic male plants giving sexual tetraploid hybrid plants.

Genetics analysis of quantitative characters was realised by means of 2 different diallel crosses : 1 - among diploid plants. 2 - between sexual and apomictic tetraploid plants.

Heritabilities, combining abilities and maternal effects were estimated. Thus, the efficiency of a breeding schema to improve P.maximum was brought out.

This work was done at the OVER-SEA SCIENTIFIC TECHNICAL RESEARCH OFFICE, in the Center of Adiopodoumé, Ivory Coast (West Africa), it succeeds to that of Jean PERNES and Daniel COMBES (PERNES 1975, COMBES 1975).

Guinea grass, Panicum maximum jacq. is a tropical graminae and forage, economically very important all over the tropics. Because of it's high productivity and high forage value, it can be used to feel cattle in intensive breeding.

The Panicum maximum study started with some plants of south Ivory Coast ; both sample taking all over the country and introductions from all over the world were essential. First studies showed, besides, the usefulness to prospect the origin center of the species.

Most of the plants we used, came from East-Africa, KENYA and TANZANIA. We put together in Adiopodoumé (near Abidjan) a very importante collection of 800 plants (half comes from East Africa) of the maximae section, genus Panicum belonging to species :

Panicum maximum jacq..
Panicum ~~maximum~~ infestum Anders
Panicum ~~maximum~~ trichocladum K. Schum

P. maximum is a example of agamic complex including few entirely sexual diploid plants, and apomict polyploid plants.

Eight is the basic number of Chromosomes of these three species.

Most of natural plants are tetraploid (2n = 32) and facultative apomicts (off-type rate is between 1 and 5 %).

As we said previously, some unusual diploid plants were found in Kenya (2n = 16), they were shown to be entirely sexual.

Digenic artificial tetraploid plants obtained, from sexual diploid plants by colchicine treatment of cuttings or seeds are sexual too.

Hybrid plants made in pollinating digenic tetraploid plants by a tetraploid apomict (male gametogenesis gives normaly reduced pollens in apomicts) are either sexual or apomict (segregation in a 1 : 1 ratio).

The cross of sexual hybrid by an apomict gives again the same segregation (SAVIDAN, 1975 ; PERNES et al., 1975).

There are intermediate forms between Panicum maximum and P. infestum giving off-types, some of them engender dihaploids (2n = 16), with important frequencies, they were shown sterile and always potentially apomict.

Population genetic models, including invasion and keeping of apomixis in natural populations were done (PERNES, 1975).

Different methods of numerical taxonomy were applied to the study of the polymorphism of natural populations. (RENE-CHAUME, 1975).

Methods with indices of similarity led to the construction of dendrogrammes which give a hierachical structure, to differential shading representations, and to nodal clustering of ROGERS and TANIMOTO.

The result of factorial anlysis of correspondances, with important number of datas, was a map of different genotypes and a caracterisation of some well distinct morphological types.

Analysis by dynamical clouds of DIDAY (1971 and 1974) on the same datas, bore out the morphological types and besides a real classification was shown impossible.

All of that showed the large variability of phenotypes of natural populations of Panicum maximum coming from East Africa and the different organisation of this variability according to the geographical sharing out.

This large genetical wealth which seems in opposition to the mode of reproduction by facultative apomixis, can be explained by an evolutive schema which will be shown below.

The results of the research suggest that evolution is perhaps slow but unbroken and apomixis had'not yet completly fixed the well adapted types to every place.

EVOLUTIVE SCHEMA AND BREEDING SCHEMA

The evolutive schema (CHAUME and SAVIDAN, 1977) of agamic group of Panicum maximum is shared in a cyclic system with these important points (Fig. 1)

1 - A sexual diploid nucleus, very allogame where the genic mixing is constant.

2 - The recurrent tetraploidisation (probable) in pollingating sexual tetraploids can give sexual tetraploid and can mix the variability of apomicts.

3 - Dispersion and selection in apomixis is made on the whole genotypes from their total phenotypic adaptation.

4 - The sexuality found again by hybridation between distant genotypes and creation of sexual dilaploid plants (two were effectively created) can mix and recombine heavily.

From this evolutive schema we can build a breeding schema (PERNES et al., 1975) CHAUME and SAVIDAN, 1977), suitable for all agamic complexes like the maximal one this includes several stages (fig. 2) :

Preliminary stage : sorting of all the plants prospected and received.

First stage : Breeding and diversifying of the sexual diploid pool to be tetraploidised by colchicine.

Second stage : Successive cycles of crosses between sexual tetraploid and apomict tetraploids which give improved sexual and apomict tetraploid plants.

Final stage : Multiplication of the best varieties or creation of composites of apomict hybrid plants.

The two main stages of the breeding scgema need the quantitative genetic effectively necessary to test and to know the spread of the variability of sexual diploid plants with accurate characters and to know the modes of transmission of this variability in crosses too.

In the same way for the second stage, study of the combining abilities of the two sexual and apomict groups is essential to know the possibilities of breeding apomict plants through the filter of the sexual tetraploid pool.

QUANTITATIVE GENETICS OF *PANICUM MAXIMUM*

Crosses between plants were simplified since it was not necessary to emasculate because there was a very dominant self-incompatibility. A bag made of waterproof sulfurised paper is put on an influorescence of each parent. After four weeks, the stems are cut. Seeds are picked off each influorescence, thus we get the two reciprocal crosses.

After eight days of germination in Petri-dishes plants are put in pots of earth. Three weeks later they are planted in fields. Then the hybrid plants are vegetatively multiplied (by cutting the tops and dividing the basis) and mesures are made of , at least, ten plants.

Diploid diallel crosses are studied in complete randomised blocks, the groupe diallele crosses, in an entirely randomised plan.

Mesures are taken of a lot of characters, but only those particularly interesting for quantitative genetics are mentioned.

NTR = Number of tillers after the first cutting

l = base ramification length of ramification at base

X = last leaf (flag) length

ll = last leaf (flag) width

L = last internode length

G = last leaf sheath length

n = at base branching inflorescence number

Li = total length of inflorescence

GENETIC STUDY OF DIPLOID PLANTS.

Several diallel crosses and polycrosses were made. We will discuss here only 4 x 4 diallel crosses including selfing and reciprocal crosses, with four sexual diploid plants.

The mathematical model used is the GRIFFING'S (1956) generalised by KEARNEY (1975). Effects are fixed, it is a determinist model which is used.

Although the number of studied parents were low, with the disposition in a complete diallel some generalisations are possible.

Only the character "number of tillers" has a significant general selfing effect which means dominance effects like HAYMAN'S. This character is alone to have significant reciprocal effects too.

There is a very important general combining ability for all the characters in spite of weak variability of parents. For some of them (L, G and ll) specific combining ability is significant too. Two characters present maternal effects (NTR and n).

All the studies showed that the diploid plants gave generally a rather important intra-family variability and there is certainly a large heterozygoty. Non maternal genetic effects are more important than orthers.

So sexual diploids have a classical genetic organisation of allogame plants and an important variability that is very useful for plant breeding.

CROSSES BETWEEN SEXUAL AND APOMICT TETRAPLOID PLANTS.

Among all the experiments we did, we choose here diallel crosses of groups realised between eight sexual tetraploids and eight facultative apomicts.

Sexual parents were :

- Four digenic tetraploids coming from the colchicine treatment of cuttings of natural diploids.

- One digenic tetraploid obtained by treatment of a seed coming from the selfing of a sexual natural diploid.

- Three hybrid tetraploids coming from the crossing of a digenic sexual tetraploid by natural apomicts.

Apomict parents were chosen for their large genetic distances between them, known by factorial analysis of correspondances with 37 morphological qualitative characters (CHAUME 1971 and 1977).

Analyses of variance were done with a lot of characters , showing the relative importance of general and specific abilities of the sexual and apomict groups.

Four main points are exhibited :

1 - It is difficult to obtain a lot of hybrids with digenic sexual plants.

2 - There is a large variability between offsprings and a large variability in combining abilities.

3 - There is preponderance of the apomict action and apomicts are shared in two types.

4 - Only the General combining abilities of apomict is significant for productivity (total dry matter weight).

Quantitative study of crosses between sexual and apomict plants in Panicum maximum shows that genetic ressources inside that aganic complex are important ; possibilities of its usefulness in plant breeding are numerous.

The succes of the selection schema is sure. Study of accurate characters had shown that hybridization is effective and characters of parents - particularly that of male parents - are found in hybrids. General combining abilities are on a whole significant, which allow to classify plants and consequently to guide the breeder's choice. Specific combining ability and large varaibility of offsprings give us a lot of possibilities to create new plants and to expect a quick improvement of the selection.

Application of theoric schema give us expected results, since already in the second cycle of this schema we obtained these greatly improved hybrids (sex. x apo.) x apo.

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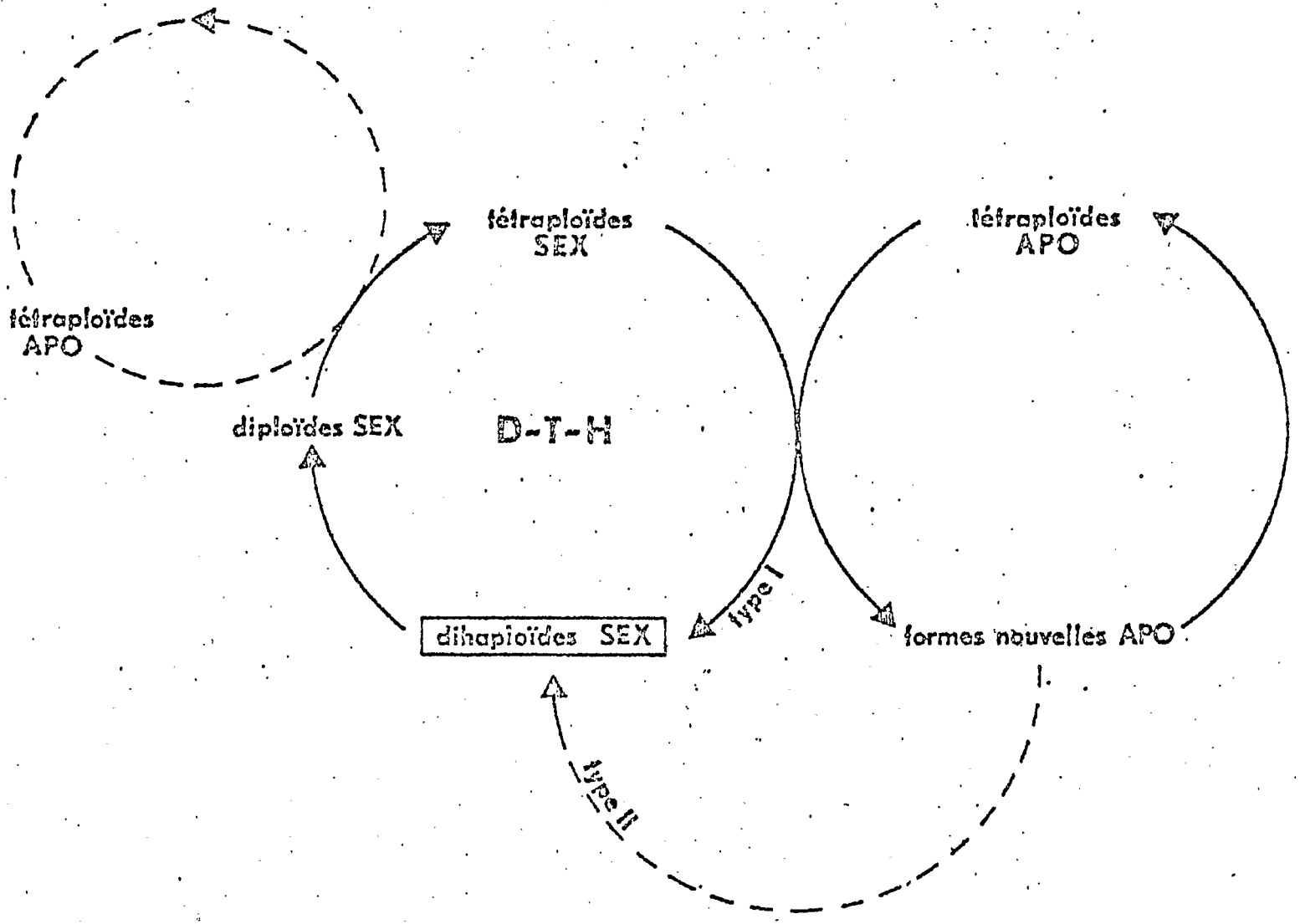

Fig. 1 - Fonctionnement des cycles diploïdes-tétraploïdes-haploïdes (D-T-H) : Polyploïdisation par le processus de tétraploïdisation naturelle récurrente (en haut à gauche) et haploïdisation par hybridation (types I obtenus en F1 et types II obtenus dans la descendance d'un hybride F1) (d'après CHAUME et SAVIDAN 1977).

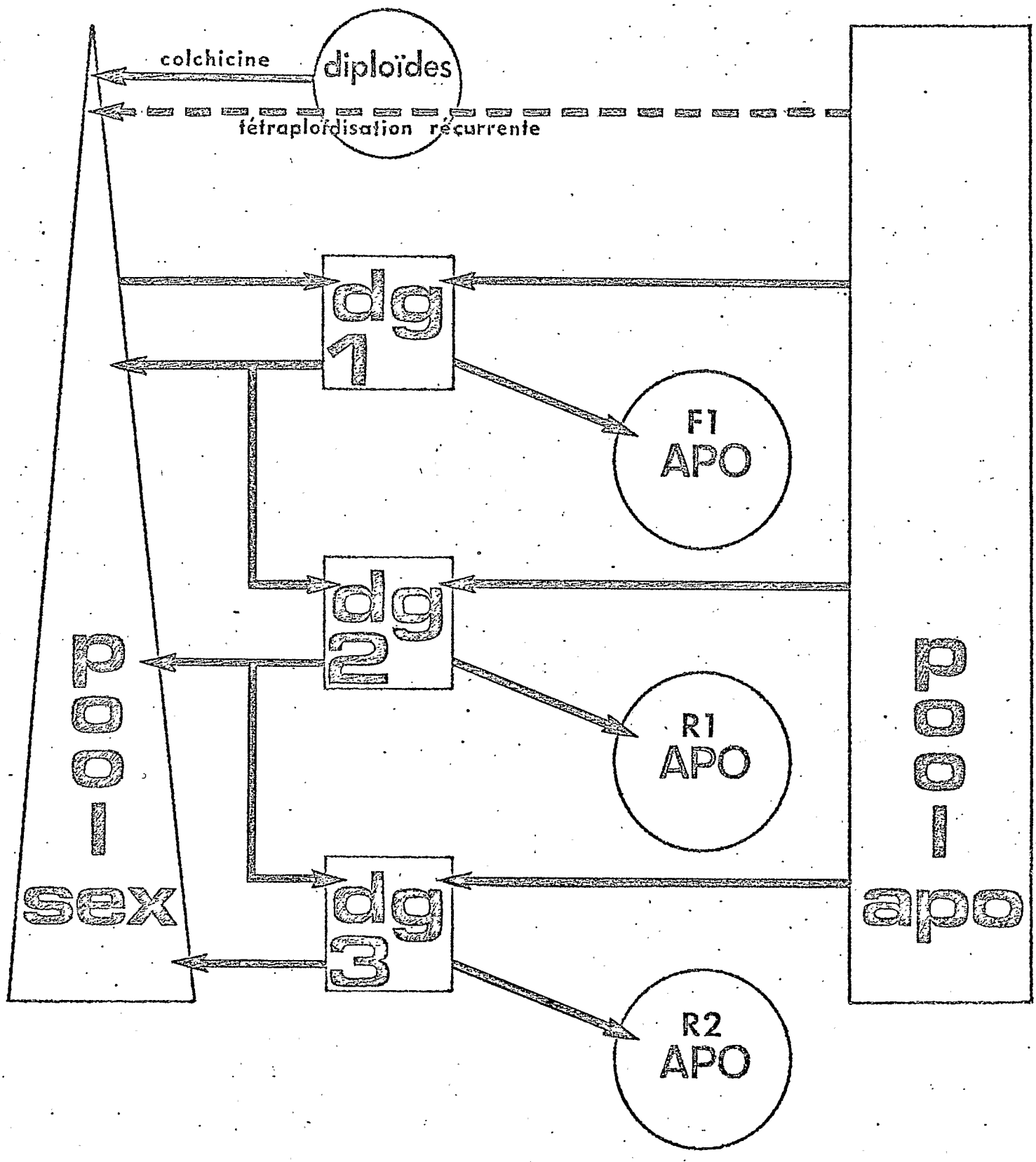

Fig. 2 - Représentation simplifiée du schéma d'amélioration des apomictiques.