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GENETIC STUDIES OF PERENNIAL HABIT IN SOME SPECIES OF THE GENUS *ORYZA.*

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ABSTRACT

Perennial habit was observed in various accessions of three species of *Oryza (Oryza sativa, Oryza glaberrima* and *Oryza punctata*) and their intervarietal and interspecific hybrids. In the specific case of TOS PURPLE and TOS 15223, the F_1 was advanced to the F_2 to monitor the mode of segregation for the perennial habit exhibited by TOS PURPLE.

Two kinds of perennial habit were noticed in the three species studied—continuous production of new tillers by the rootstock leading to a massive accumulation of above and below-ground biomass as in all *O. punctata* accessions and AWGU DWARF-W; production of new tillers from the rootstock after a period of quiescence at the end of a life cycle with the old tillers completely dead as in TOS PURPLE. All *O. barthii* and *O. glaberrima* accessions are annuals. This paper reports the behaviour of the first type and full details of the second type of perennial habit

The interspecific crosses showed that perennial habit of the first type is dominant over annual habit while the second type is conditioned by a single recessive gene i.e. it is recessive to the annual habit. The significance of this finding for peasant agriculture is discussed.

INTRODUCTION

Out of about 23 species of rice, the only two species used in agriculture are *O. sativa* (the so-called Asian rice) and *O. glaberrima* (the so-called African rice; Grist, 1975). *O. sativa* has taken precedence over *O. glaberrima* in West Africa since its introduction some 450 years ago (Porteres, 1956; Nayar, 1973; Carpenter, 1978).

A lot of work has been done on the genetics of minor and major agronomic characteristics of rice, particularly the Asian rice, *O. sativa* (Chandraratna, 1964; Chang, 1964). This cannot be said of the African rice, *O. glaberrima* and indeed all-indigenous wild relatives of these species (Faluyi and Nwokeocha, 1993)

Plants can be divided into three types on the basis of their life forms-herbs, trees and vines (Crawford, 1989). Trees are usually perennials while herbs and vines can exhibit both annual and perennial habit/life forms. Annuals complete their seed-to-seed cycles in one growing season and in so doing, they allocate more dry matter to seeds than other life forms.

Perennial plants are however more successful in stressed sites because of their capacity to store reserved carbohydrate. In wild rices, perennial types carry more genetic variation in their populations (Morishima and Oka, 1970; Oka, 1988).

Perennial and annual habits have not been the subject of much investigation, perhaps because they are not major agrobotanical characters. Perennial habit Is however a useful character for genetic studies since perennial hybrids can be maintained for a long time for further

experimentation. It also has some value in raising ratoon crops, which can boost harvest for peasant farmers. The specific objective of this study is to determine the mode of inheritance of perennial habit in the rice cultivar TOS PURPLE and also attempt an overview of the genetics of this trait in the genus *Oryza* based on results from interspecific hybrids generated within and among indigenous wild and cultivated rices.

MATERIALS AND METHODS

The materials used for this study were either obtained from the Genetic Resources Unit of International Institute of Tropical Agriculture (IITA) or collected by authors as indicated in Table1.

Table 1: *Accessions used for the Study and their Sources.*

Accession	Description	Sources
TOS PURPLE	*O. sativa*, cultivar, purple leafed, perennial	IITA
TOS 15223	*O. sativa*, cultivar, obligate annual	IITA
TOG 5281	*O. glaberrima*, annual	IITA
IJ86-W	*O. sativa*, land rice, annual	FALUYI
TOG 16771	*O. glaberrima*, annual	IITA
TOB 10838	*O. barthii*, annual, wild	IITA
TOP 13596	*O. punctata*, (4n), perennial, wild	IITA
TOP IPETUMODU	*O. punctata*, (4n), perennial, wild	NWOKEOCHA
TOP MORO	*O. punctata*, (4n), perennial, wild	NWOKEOCHA
TOG 12082	*O. glaberrima*, annual	IITA
TOP 15119	*O. punctata*, (4n), perennial, wild	IITA
TOP 12083	*O. glaberrima*, annual	IITA
TOP 15116	*O. punctata*, (4n), perennial	IITA
AWGUDWARF-W	*O. sativa*, land race, dwarf, perennial	FALUYI

IITA = International Institute of Tropical Agriculture.

Seedlings were raised in good top soil in the screen house and at maturity (booting stage) reciprocal crosses were made by physical emasculation between the cultivars TOS PURPLE and TOS 15223 on one hand and among accessions of *O. sativa*, *O. punctata* and *O. glaberrima* on the other. Pollination was by physical emasculation and transfer of pollen. F_1 seeds were advanced to the F_2 on which observations were made in the TOS PURPLE x TOS 15223 cross. For the

Table2: *Agronomic Characters of the Accessions used and their Hybrids*

Accessions	Tiller no	New culm height (cm)	Plant form	Habit	Panicle type/form	Maturity (days)	Reproductive state
TOS PURPLE	27 – 35	55.84±1.25	Erect	Perennial	Compact, droopy	90	Fertile
TOS 15223	26 – 36	54.74±0.66	Erect	Annual	Compact, droopy	71	Fertile
TOS PURPLE x TOS 15223	30 – 35	85.90±5.90	Erect	Annual	Compact, droopy	90	Fertile
TOS 15227 x TOS PURPLE	32	90.00±5.12	Erect	Annual	Compact, droopy	90	Fertile
TOG 16771	20	80.63±1.12	Erect	Annual	Open	96	Fertile
TOS 15223 x TOG 16771	72	78.60±1.98	Erect	Annual	Open	169	Infertile hybrid
TOG 16771 x 152213	80	74.85±2.2.09	Erect	Annual	Open	170	Infertile hybrid
IJ86 – W	9	139.50±1.17	Erect	Annual	Compact, droopy	121	Fertile
TOB 10838	14	74.73±1.60	Erect	Annual	Compact, erect	98	Fertile
TOB 10838 x IJ86 – W	60	109.34±2.09	Erect	Annual	Compact, erect	194	Fertile
TOG 12083	19	77.43±2.14	Erect	Annual	Compact, erect	90	Fertile
TOG 12083 x TOG 16771	9	95.72±3.34	Erect	Annual	Open	97	Fertile
TOG 5281	19	78.70±1.02	Erect	Annual	Open	90	Fertile
TOG 13596	19	106.50±1.21	Open	Perennial	Open	136	Fertile
TOG 5281 x TOP 13596	76	107.03±2.90	Open	Perennial	Open	178	Infertile hybrid
TOP IPETUMODU	38	152.01±1.22	Open	Perennial	Open	145	Fertile
TOG 16771 x TOP-IPETUMODU	68	103.50±1.90	Open	Perennial	Open	196	Infertile hybrid
TOP MORO	34	150.04±1.20	Open	Perennial	Open	132	Fertile
TOG 5281 x TOP MORO	65	118.70±2.50	Open	Perennial	Open	180	Infertile hybrid
TOG 12082	9	78.55±1.14	Erect	Annual	Compact, erect	90	Fertile
TOP 15119	27	134.70±1.31	Open	Perennial	Open	145	Fertile
TOG 12082 x TOP 15119	80	120.43±2.20	Open	Perennial	Open	190	Infertile
TOP 15116	25	101.77±1.48	Open	Perennial	Open	142	Fertile
TOS PURPLE x TOP 15116	75	57.62±1.70	Open	Perennial	Open	198	Infertile
AWGU DWARF - W	23	54.11±1.72	Erect	Perennial	Compact, droopy	154	Fertile
IJ86-W x AWGU DWARF - W	32	87.50±1.02	Erect	Perennial	Compact, droopy	220	Fertile

interspecific crosses whose F_1 were infertile, observation was carried out on the F_1, which were maintained for years by subculturing the culms after each growing season.

Nine hundred and Fifty-one F_2 seedling of the TOS PURPLE x TOS 15223 cross were raised in a 12m x 12m fenced enclosure at a spacing of 15cm x 15cm. Perennial habit in TOS PURPLE is characterized by deadth of the aboveground biomass at maturity and a regeneration of young tillers from the rootstocks. Two critical criteria were applied to determine perennial habit in F_2: (1) the aboveground biomass of a plant must be dead (2) new tillers must be seen sprouting from the rootstock of nodes close to the ground. These criteria excluded plants that were green on account of maturity date rather than on perennial habit. Matured panicles were harvested 135 days after seeding and before seed shattering to ensure that shattered seeds do not germinate and present like emerging tillers. For the interspecific hybrids, perennial habit was defined as sustained growth and biomass accumulation for more than two years.

Data were analysed using the Chi-square test.

RESULTS AND OBSERVATIONS.

The agrobotanical characters of the two cultivars of *Oryza sativa* used in segregational studies are shown in Tables 1, 2 and 3. TOS PURPLE and TOS 15223 are moderately tillering plants with dense, droopy and compact panicles and of early maturity—90 days for TOS PURPLE and 71 days for TOS 15223. All *Oryza glaberrima* accessions are annuals of medium maturity; they are between moderate and heavy tillering with open to compact panicles and of medium duration *Oryza barthii* are also generally annuals of medium duration and their tillering habit is between low and medium: they have open panicles. *Oryza punctata* accessions are distinctly of high biomass, strongly perennial and open with large panicles. (Plate 1).

Table 3: Classification of the TOS PURPLE x TOS 15223 F_2 Plants for Perennial and Annual Habits.

Total no. of plants	Perennial	Annual	$\Sigma X^2_{(1)}$ 1:3	P
951	240	711	0.27139	0.5≤P≤0.9

The hybrids between TOS PURPLE and TOS 15223 possess strong culms of moderate height and they were heavy tillering. They were of early maturity (90 days) and they carried dense, compact and droopy panicles. The F_1 plants of the reciprocal crosses died after first fruiting. The annual x annual interspecific crosses (TOS 15223 x TOG 16771; TOB 10838 x IJ86-W; and TOG 12083 x TOG 16771) were all annuals but with enhanced performance. They could be maintained beyond one season if they were sub-cultured shortly before booting.

The hybrids involving *O. punctata* were all of heavy biomass, strong perennial habit and they were distinctly *punctata*-like (Plate 1). IJ86-W x AWGU DWARF-W and TOS 15223 x TOS PURPLE were the only *sativa* x *sativa* crosses in this study. The perennial habit of the F_1 of the crosses involving *O. punctata* was found useful in propagating this hybrid for a long time. The F_1 was mid-way in morphological expression unlike the crosses involving *O. punctata.*

Out of 951 plants in the F2 of the TOS PURPLE x TOS 15223 cross, 240 plants showed perennial habit (Table 3.) The choice of 135 days for the scoring of segregants for life form ensured that annual plants had properly died and perennial ones had started to produce new tillers. The annual segregants exhibited rapid growth and development but died after fruiting. There was no observed relationship between purple leaf colouration and life form.

DISCUSSION

The following crosses represent annual and perennial combinations: (TOG 5281 x TOP 13596; TOG 16771 x TOP-IPETUMODU; TOG 5281x TOP MORO; TOG 12082 x TOP 15119; TOS PURPLE x TOP 15116; IJ86-W x AWGU DWARF-W) and annual x annual combinations (already listed).

In all annual x annual crosses, the F_1's were annual although hybrid vigour gave some of them quasi-perennial ability, for example, it was possible to sustain TOB 10838 x TOS IJ86-W and TOS 15223 x TOG 16771 for more than one season by subculturing tillers from the main plant when it was at prime biomass accumulation. *Oryza punctata* accessions involved in the crosses were perennial and they imparted this habit on their F_1's. The general trend observation of perennial habit in the F_1 of interspecific crosses suggests that perennial habit is dominant over annual habit. The F_2 data from the TOS PURPLE x TOS 15223 cross confirm monogenic recessive inheritance for perennial habit in TOS PURPLE. There is a fundamental difference in the presentation of perennial habit in the interspecific crosses and TOS PURPLE. In the accessions of *Oryza punctata*, the old biomass does not die back after a season; the rootstocks produce new tillers continuously leading to a massive accumulation of above-and below-ground biomass. This character is transmitted as a dominant state to the F_1. TOS PURPLE on the other hand dies back after a season, remains quiescent for about three weeks after which new tillers emerge from the rootstock. These two events are definitely two different presentations of the same phenomenon as the patterns of inheritance suggest.

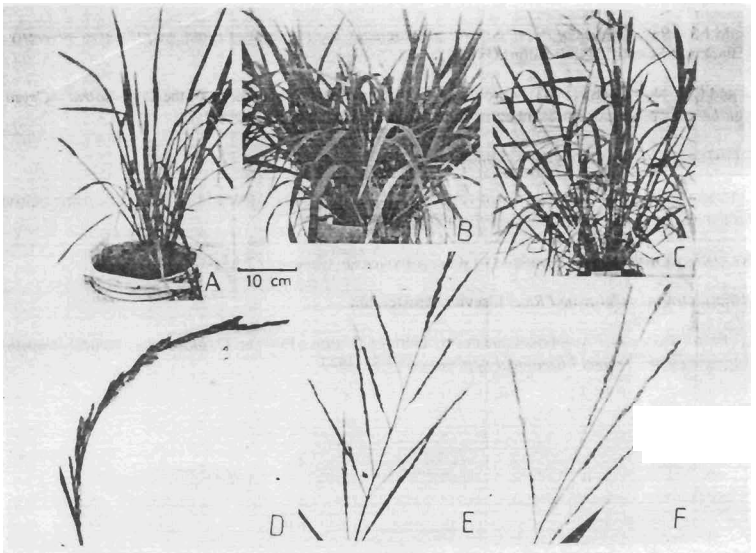

Plate 1: Typical Plant Forms in *O. sativa* x *O. punctata* crosses. A. TOS PURPLE (annual); B. F_1 between TOS PURPLE and TOP 15116. Note the heavy tillering and vigorous habit; C. Open plant type of 15119; D. Compact panicle of TOS PURPLE, E. Panicle of TOS PURPLE x TOP 15116.

Perennial and annual habits have not been given any serious attention as an agronomic character. We have however observed that peasant farmers have changed the old system of harvesting rice by cutting the panicles alone to cutting the above-ground biomass and threshing by beating out the spikelets. The cut back culms often ratoon giving opportunity for a second although reduced harvest particularly in swampy locations. The obligate annual habit in TOS 15223 is too drastic; it does not seem that the cultivar could raise seeds to maturity if adverse weather conditions prevailed at seed set.

There seems to be some advantages in the perennial habit displayed by TOS PURPLE – for example, the new tillers emerge like new seedlings undisturbed by old culms.

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