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LINKAGE BETWEEN TWO INHIBITORY GENES FOR ANTHOCYANIN PIGMENTATION IN RICE (*ORYZA SATIVA* L.)

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Inherilence of pigmentation in rice has beer, under investigation for the last six decades and enormous amount of data have been accumulated. Different ratios for the same characters realised in different cross combinations with different modes of action have enabled the rice geneticists to identify the genes responsible for various characters. Majority of the characters relate to pigmentation in various plant parts. Detailed studies on the genie architecture of pigmentation in rice have revealed the occurrence of the genes with different modes of action such as complementary, complementary-duplicate, duplicate, inhibitory-complementary, inhibitory-duplicate, anti-inhibitory-complementary, anti-inhibitory duplicate etc. Many more interactions could be worked out with the segregating material of rice and the expected interactions involving two. three and four pairs of factors published by Deokar et al 1961 and Deokar and D'Cruz (1962 are of great help. Interactions with five pairs of factors have been worked out by the authors of this paper (under publication in the Ind. J. Genet). With a view to probe into the genie analysis of pigmentation in rice, attempts are being made in the PL. 480 project on "Linkage maps in rice" to involve large number of parents in different cross combinations to identify genes governing various characters and also to locate them to different linkage groups. The present investigation involving T-141 and K-44-1 parents is one such attempt.

Cross pigmented characters showing segregation have been studied and six characters viz. pigment in coleoptile, leaf-sheath, ligule, auricle, leaf-tip and node are considered in this paper.

Materials and Methods

The cross between T-141, a variety developed by the Orissa state department of Agriculture and K-44-1. an improved variety of the Karnataka state was effected in the Botany garden of the College of Agriculture, Dharwar in 1972. F_1, F_2 and F_3 generations were studied in the subsequent seasons. The F_2 generation consisted of 2624 plants and 60 F_3 families were studied for confirming the F_2 segregation. Product ratio method of Fisher and Balmakund (1928) was applied to estimate linkage values. Gene symbols recommended by the International Rice Commission (Anon 1959) are used in this paper.

Results and Discussion

Behaviour of parents and F_1 and F_2 segregation are given in Table 1. Both pigmented and unpigmented conditions are observed for different charcters in F_1 depending on the type of genie interaction. Chi-square test applied to the observed frequencies of the F_2 segregation on the basis of the ratios in respect of the characters such as coleoptile, leaf-sheath, ligule, auricle, leaf-tip and node has given satisfactory fit. F_3 results from 60 families randomly selected in F_2 popula. tion have confirmed the F_2 segregation. From the study of the combined segregation presented in Table 2, two pleiotropic genes have been discovered. One appears to be the basic gene for purple pigmentation common to the five characters such as coleoptile, leaf-sheath, ligule, auricle and node designated as A (C), another being the inhibitory gene operating simultaneously on coleoptile, leaf-sheath, auricle, leaf-tip and node. On the basis of these findings the characters have been symbolised (Table 1.)

Joint ratios have been modified on the basis of pleiotropic genes and linkage was detected between the pleiotropic inhibitory gene operating on coleoptile, leaf-sheath, auricle, ltaf-tip and node and the inhibitory gene for purple pigment in ligule. The cross-over values ranging from 20.73 to 21.76% have been worked-out.

The genes determining the development of pigment in coleoptile, leaf-sheath, ligule, auricle, leaf-tip and node range from two to five. Pigment in coleoptile (39 purple : 25 white) is governed by three genes, interaction of an inhibitory gene and an anti-inaibitory gene with the complementary gene producing colour. Colour in leaf-sheath (3 purple : 253 green) is caused by four genes, one being complementary and three inhibitory-duplicate. Four pairs of factors are concerned with the pigment formation, in ligule, three of which are complementary, one being inhibitory. Pigment in auricle (387:637) is conditioned by five pairs of factors two being complementary, one inhibitory and two anti-inhibitory-complementary. Leaf-tip colour (1 purple : 15 green) shows the segregation of two inhibitory genes and node colour (9:247 is governed by four genes, two being complementary and two inhibitory-duplicate Interactions of genes concerned with all these characters resulting in unusual rtios are reported for the first time.

Study of joint segregations (Table 2) reveals the occurrence of a pleiotropic complementary gene for pigment in coleoptile, leaf-sheath, ligule, auricle and node. It may be one of the basic genes for anthocyanin pigment formation and thus is designated as A (C) The other pleiotropic gene indentified in the present study is inhibitory in action and acts simultaneously on coleoptile, leaf-sheath, auricle, leaf.tip and node. A linkage between the inhibitory gene for ligule colour (*I-Plg*) and the pleiotropic inhibitor (I) was detected and the cross-over

Table 1

Behaviour of parents and F_1 and F_2 segregation for six colour characters in Z-5 × K-41

Characters	Character expression in			F2 segregation					
Pigment in:	I - 141	K 44 - 1	F	Ratio		Purple	White	χ_2	Symbols
				Purple : White					
1. [illegible]tile	White	White	Purple	39 : 25	Observed	1585	1039		
					Expected	1599	1025	0.3137	*A I Ai - Pc*
2. L[redacted] sheath	White	Purple	White	3 : 253	Observed	34	2590		
					Expected	30.75	2593.25	[illegible]74	*A I Ai - Psh*
3. Ligule	White	Purple	White	27 : 229	Observed	264	2360		
					Expected	276.75	2347.25	0.[illegible]65	*A Plga I gb I-Plg*
4. Auricle	White	White	Purple	387 : 6[illegible]	Observed	1010	1614		
					Expected	991.68	1632.32	0.5[illegible]	*A Paua I Ai-Paua Ai-Paub*
5 Leaf - tip	White	Purple	White	1 : 15	Observed	178	2446		
					Expected	[illegible]	2460	.2748	*I I - Plt*
6. Node	Green	Purple	White	9 : 247	Observed	80	2544		
					Expected	92.25	2531.75	1.6[illegible]58	*A Pn I I - Pn*

Table [illegible]

Combined segregation of ligule colour (27 : 229) with five other pigmented characters

		PP	PW	WP	WW	χ^2
1. Coleoptile (39 : 25)	Observed	200	64	1385	975	
	Expected on i[redacted]endent basis	224.86	51.89	1356.84	990.41	6.3287
	Expected on li[redacted]ge basis C. O. 21.15%	210.66	66.09	1388.34	958.91	0.8834
2. Leaf-sheath (3 : 253)	Observed	9	255	25	2335	
	Expected on independent basis	4.32	272.43	26.43	2320.82	6.3420
	Expected on linkage basis C. O. 21.69%	5.61	266.14	[illegible]	2327.11	1.9099
3. Auricle (387 : 637)	Observed	167	97	843	1517	
	Expected on independent basis	139.35	108.01	821.18	1555.46	8.1392
	Expected on linkage basis C. O. 21.50%	172.71	104.04	818.98	1528.27	1.4460
4. Leaf-tip (1 : 15)	Observed	45	219	133	2227	
	Expected on independent basis	17.29	259.45	146.71	2200.[illegible]	52.3152
	Expected on linkage basis C. O. 20.73%	43.48	233.27	[illegible].52	2226.73	2.2183
5. Node (9 : 247)	Observed	17	237	53	2317	
	Expected on Inde[redacted]ent basis	12.97	263.78	40.36	2306.89	21.8540
	Expected on lin[redacted] basis C. O. 21.76%	31.76	244.99	60.49	2286.76	2.0804

values ranging from 20.73 to 21.76 per cent were obtained, whica is aproximately taken as 21 per cent. This linkage has not been referred to previously by Ramiah (1953) Jodon, (1956), Takahashi (1764) and Misro *et al.* (1966) who have tentatively propounded linkage groups in rice. As such the assignment of these two genes to the linkage groups already formulated is deferred.

Summary

In the analysis of inheritence of six pigmented characters viz : coleoptile leaf-sheath, ligule, auricle, leaf-tip and node in a rice cross – T-141-×K-44-1 two to five genes with differrent modes of action such as complementary, duplicate, inhibitory, anti-inhibitory etc. were involved in determining pigment in them as suggested by the unusual ratios which are reported for the first time. Two pleiotropic genes such PS one basic complementary gene and another inhibitor have been discovered. Linkage between the pleiotropic inhibitory gene and the inhibitory gene for purple pigment in ligule has been detected with a cross-over value of about 21 per cent. These two linked genes have not been referred to previously by Ramiah (1953) Jodon (1956), Takahashi (1964 and Misro *et al.* (1966) who attempted to formulate linkage groups in rice.

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സംഗ്രഹം

നെൽ ചെടിയുടെ ആറ് ഭാഗങ്ങളിൽ അടങ്ങിയിട്ടുള്ള പിഗ്മെൻറിനെ രണ്ട് മുതൽ അഞ്ചു വരെ ജീനADO നിയന്ത്രിക്കുന്നതായി കണ്ടു. ഇവയിൽ രണ്ടെണ്ണം പ്ലിയോട്രോപ്പിക് ജീനുകൾ ആകുന്നു. ഈ പ്ലിയോട്രോപ്പിക് ജീനുകളിൽ ഒന്നിനു മറ്റൊരു ജീനുമായി ലിങ്കേജും 21% ക്രോസ്സ് ഓവറും ഉള്ളതായി കണ്ടു. ഈ ജീനുകൾ മുൻപ് തയ്യാറാക്കിയിട്ടുള്ള നെല്ലിൻെറ ലിങ്കേജ് മാപ്പുകളിൽ രേഖപ്പെടുത്തിയിട്ടുള്ളവയല്ല.

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