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TESTING OF COLCHICINE-INDUCED FERTILE AMPHIDIPLOIDS OF RONPHA GRASS UNDER IRRIGATION IN CENTRAL QUEENSLAND

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SUMMARY

The testing in irrigated swards of a range of fertile amphidiploids derived from Ronpha grass (*Phalaris tuberosa* x *arundinacea*) is reported. These proved difficult to establish with *Trifolium repens* cv. Ladino as the companion legume and subsequent performance was poor.

A decline in first season vigour of spaced plants, as measured by the diameter of leaf spread, was recorded with advancing generation. Seed yield of the three families studied was not affected.

Because of their poor performance and the availability of possible alternative species, the development and testing of the Ronpha grass derivatives has ceased in Central Queensland.

I. INTRODUCTION

Preliminary testing of Ronpha grass, a natural interspecific hybrid between *Phalaris tuberosa* L. and *P. arundinacea,* showed it to have desirable characteristics for use in irrigated pastures in the subcoastal regions of subtropical Central Queensland. It is, however, a sterile plant and requires vegetative propagation, a feature which distinctly limits its value.

The induction of fertile amphidiploids from the sample of Ronpha grass received at the Department of Primary Industries, Biloela Research Station, in 1957 has been described by Grof (1960, 1967). These fertile lines were subsequently subjected to several series of single plant selection. This was based mainly on their vigour of growth and relative seed production in the first season. Another objective was maintenance of a desirable lax leafy plant type with reasonable winter and summer growth rates. Limited selection for rust resistance was also carried out on the C4 plants.

Seed was harvested from several sources. These included open-pollinated seed from outstanding plants of the C1 to C4 generation, seed from isolation crossing plots established both from seed and from clonal portions of these plants; and bulk seed of the unselected spaced plants in the C1 and C4 generations. The present paper describes the field testing under irrigation of various samples of this material at two centres in Central Queensland.

II. MATERIALS AND METHODS

Details of the experiments reported are shown in Table 1. Those located at Biloela were planted on a grey brown clay loam of the Kroombit Land System (Perry 1968). They were spray irrigated and regularly grazed with dairy cattle. The two experiments at Theodore were located on a much heavier grey clay of the same Land System. They were flood irrigated and grazing was with sheep.

TABLE 1

DETAILS OF THE INDIVIDUAL EXPERIMENTS

Expt. No.	Location	Establishment Method	Date		Design	Plot Size	Planting Rate	White Clover	Sampling Areas		Comments
			Planted	Terminated					Population	Dry Matter	
1	Theodore	Seed ..	24.iv.63	ii.66	8 x 4 RB	30 x 16 ft	2 lb/ac ..	Yes	—	One 3 x 16 ft	No water Aug.–Dec. 1965
2	Biloela ..	Seedlings ..	*20.vi.63	ix.65	14 x 4 RB	$10\frac{1}{2}$ x $10\frac{1}{2}$ ft	18 in centres	Yes	Whole Plot ..	Two 5 x 2 lk	*P. arundinacea* Veg. Est.ix.63
3	Biloela ..	Seedlings ..	*11.vi.64	iv.65	12 x 4 RB	$17\frac{1}{2}$ x 7 ft	$3\frac{1}{2}$ ft centres	No	—	—	Interrow cultivated, not grazed
4	Biloela ..	Seed ..	9.v.66	ix.69	14 x 3 RB	15 x 15 lk	5 lb/ac ..	Yes	Ten 2 x 1 lk	Two 5 x 2 lk	Inadequate water 1967–68 summer
5	Theodore	Seed ..	23.ii.67	iv.71	3 x 4 x 3 RB	60 x 50 lk	4 lb/ac ..	Yes†	Ten 5 x 2 lk	One 3 x 16 ft	1 cwt/ac superphosphate/ annum, no water March–Oct. 1969

* Date pregerminated seedling in 2-leaf stage placed in position.

† Factorial design of 3 grasses and 4 legumes (Cooper and Clarence glycines, Silverleaf desmodium and Ladino clover) in simple mixtures.

The lines planted in each experiment, including commercial cultivars of other temperate species, are shown in Table 2. Further information on the material from the various crossing plots is presented in Table 3.

TABLE 2

MATERIAL PLANTED IN EACH EXPERIMENT

Identity	Seed Generation	Experiment No.*			
		1	2	3	4
Fertile Amphidiploids of Ronpha					
Ex J53 Crossing Plot	C3		X		
Ex B2 Crossing Plot	C3		X		
C4 Polycross (Original seed)	C4	X	X		X
C4 Polycross	C5				X
C4 Polycross—Ex Gatton	?				X
9 N/9 Seln from C4 Polycross	C5				X
C6 Polycross	C6				X
1/6 A Bulk	C3			X	
1/6 A Bulk/Bulk	C4	X	X		
1/6 A Bulk—25 L/12	C4			X	
1/6 A Bulk—25 L/12—10 0/5	C5			X	
1/6E Dark Bulk	C3			X	
1/6E Dark Bulk	C4	X	X		
1/6E Dark—22H/18	C4			X	
1/6E Dark—22H/18—27 0/4	C5			X	
1/6F ex Crossing Plot—Bulk	C3			X	
1/6F ex Crossing Plot—Bulk	C4		X		
1/6F ex Crossing Plot—29 H/15	C4				X
1/6F ex Crossing Plot—29 H/15—11 0/7	C5				X
1/6F ex Crossing Plot—29 H/15—11 0/7	C6				X
1/6E Light Bulk	C4		X		
1/6A ex Crossing Plot Bulk	C4		X		
1/6F—34 L/9	C4				X
Bulk Seed	C3	X		X	
Bulk Seed	C4	X		X	
Bulk Seed	C5			X	X
Commercial Cultivars and Other Species					
Original Ronpha	—	X	X		X
Phalaris tuberosa cv. Australian	—	X	X		
Phalaris tuberosa cv. Siro Seedmaster	—				X
P. arundinacea—Commercial	—	X	X		
Q5388 *P. tuberosa* x *arundinacea* (SCS–586)	—		X		
Q5406 *P. tuberosa* x *arundinacea* (CSIRO, F1, 2n = 35)	—		X		
Q5405 *P. tuberosa* x *arundinacea* (CSIRO, 2n = 70)	—		X		
H1 Ryegrass (*Lolium* sp.)	—				X
9–7–2 Ryegrass (*Lolium* sp.)	—				X
Festuca arundinacea cv. Demeter	—				X
Bromus unioloides cv. Priebe	—				X

* Expt. 5 contained C5 seed of C4 Polycross, *Panicum coloratum* var. *makarikariense* cv. Bambatsi and *Setaria sphacelata* cv. Nandi

Experiment 3 was established to assess the effects of the selection processes being used. Three selected families plus bulk seed of each generation from C3 to C5 were used. Vegetative vigour was assessed by measuring individual plant diameters of the ungrazed plants at 2 and 6 months (August 28 and December 23) after placement of the seedlings in the field. Seed production over the first summer was measured by collecting mature heads at regular intervals and threshing these on a whole-plot basis. Twelve days after the initial field placement of seedlings it was necessary to replant a number in each plot. These numbers were recorded.

TABLE 3

Details of Material in Various Crossing Plots

Identity of Plot	Component Lines
J53 Crossing Plot ..	80 vegetative portions each of 4 plants, namely 5/12 B2 2/3; 1/6F2; 1/A; and 1/6E4, arranged as repeated 4 x 4 latin squares. (C2 plants)
B2 Crossing Plots ..	Alternate rows of vegetative portion of 2 plants, ½ B31/3 and ½ B311/5. (C2 plants)
C4 Polycross	Derives from 4 adjacent rows of C3 plants in the C3 Spaced Plant Nursery which were bulk harvested. Each row contained 43 plants of one of the following lines—1/6E Dark; 1/6F ex Cross Plot; 1/6A ex Cross Plot; 1/6A Bulk
C6 Polycross	An isolated crossing plot planted with C5 seed of 9 single C4 plant selections hills of 4 or 5 seeds planted, thinned to 1 plant per hill, leaving 15 randomly distributed plants of each of the following—1/6A Bulk—27 P/6; 1/6A ex CP—8 N/8; 1/6F ex CP—28 M/9 and 12 N/7; 1/6E Dark 24 N/4; 1/6E Light—12 0/1; C4 Polycross—9 N/9 and 17 0/1; 1/6F—34 L/9—26 P/2

In experiment 4, plant populations were recorded 6 weeks after sowing and then each spring. A heavy invasion of thistle (*Cirsium vulgare*) in the first spring may have affected establishment. Dry-matter yields were recorded before some grazings over winter and spring each year.

In experiment 5, plant populations were recorded 5 weeks after planting and then each spring. Relative visual assessments and actual yield measurements were carried out at irregular intervals before some but not before all grazings, which were more regular.

III. RESULTS

In experiment 1, a good germination was obtained but establishment was slow and little grazing was available before December. This is usual on these heavy clays. By winter 1964 the area was heavily clover dominant and the grass yields in October, at the one harvest taken, indicate the level to which the stands had deteriorated (Table 4). Original Ronpha gave the highest yield but there were insufficient plants and these were suppressed by the clover.

TABLE 4

DRY-MATTER YIELDS FROM EXPERIMENT 1 ON OCTOBER 6, 1964 (lb/ac)

Identity	Sown Grass	White Clover	Total Dry Matter
Original Ronpha ..	402	569	1,270
1/6E Dark	287	1,867	2,292
C4 Bulk	225	1,462	1,896
C4 Polycross	162	1,942	2,259
C3 Bulk	104	1,529	1,814
P. tuberosa	76	1,935	2,212
1/6A	60	1,085	1,356
P. arundinacea	18	1,427	1,886
LSD 5%	283	677	829

Experiment 2 showed intense clover dominance over the first spring and grass yields were low even at the first grazing in October (Table 5). By the following autumn, 10 months after planting, few plants remained. The best all-round performance was by Q5406, a sterile F1 of *P. tuberosa* x *arundinacea* developed by C.S.I.R.O., Canberra. The C4 polycross and 1/6A ex CP were amongst the best local material.

TABLE 5

DRY-MATTER YIELD (LB/AC) AT FOUR MONTHS AND PLANT PERSISTENCE (%) TEN MONTHS AFTER PLANTING IN EXPERIMENT 2

Identity	Sown Grass	White Clover	Total Dry Matter	Persistence 29.iv.64
Q5388 *P. tuberosa* x *arundinacea*	1,370	2,940	4,600	0·21* (4·5)
P. tuberosa	1,320	2,700	4,210	0·10 (1·0)
Q5406 *P. tuberosa* x *arundinacea*	1,310	2,710	4,220	0·44 (18·0)
1/6A ex CP	810	3,330	4,540	0·19 (3·8)
C4 Polycross	660	3,360	4,060	0·30 (8·6)
Original Ronpha	510	3,620	4,240	0·32 (10·0)
1/6E Light	510	3,470	4,100	0·15 (2·2)
1/6A Bulk	440	3,570	4,150	0·16 (2·7)
1/6E Dark	340	3,800	3,380	0·26 (6·5)
C3 ex B2 Cross Pl.	330	3,690	4,310	0·09 (0·7)
Q5405 *P. tuberosa* x *arundinacea*	280	3,430	3,960	0·24 (5·8)
1/6F ex CP	270	3,670	4,020	0·31 (9·5)
C3 ex J53 CP	100	3,900	4,360	0·05 (0·3)
P. arundinacea	70	3,600	3,900	0·22 (4·9)
LSD 5%	70	420	500	0·16

* Analysis of inverse sine transformation; actual percentage persistence in brackets.

In experiment 3, replacement of a number of seedlings which failed to survive transplanting was necessary in most plots. The numbers per plot replaced are arranged by family and generation in Table 6. These data have not been analysed but show a consistent trend of increasing replanting as generation

TABLE 6

NUMBER OF SEEDLINGS REPLANTED PER PLOT ON JUNE 23, 1964—EXPERIMENT 3

Family	Generation			Mean
	C3	C4	C5	
Bulk	3	3·5	3·8	3·4
1/6A Bulk	0·3	1·0	1·8	1·0
1/6F ex CP	1·5	1·8	0·8	1·3
1/6E Dark	0	0·3	1·8	0·7
Mean	1·6	2·2	2·7	

number increased. This decrease in vigour, at least over the first 6 months, is again illustrated in Table 7, which shows the diameter of spread of the leaf canopies.

TABLE 7

EFFECT OF FAMILY AND GENERATION ON PLANT DIAMETER (IN.) IN EXPERIMENT 3

Generation	Bulk	Family			Main Effect
		1/6A Bulk	1/6F ex CP	1/6E Dark	
Harvest 28.viii.64					
C3	10·4	14·4	12·8	15·7	13·3
C4	10·9	10·9	12·3	13·1	11·8
C5	10·4	10·7	12·0	9·2	10·6
Main effect	10·6	12·0	12·4	12·7	
Harvest 23.xii.64					
C3	30·3	35·8	33·7	36·2	34·0
C4	27·8	29·2	29·3	30·3	29·1
C5	26·3	28·6	28·9	26·8	27·6
Main effect	28·1	31·2	30·6	31·1	

		Harvest 28.viii.64	*Harvest* 23.xii.64
LSD 5%	Family main effects	1·2	2·6
LSD 5%	Generation main effects	1·1	2·2
LSD 5%	Individual effects	2·1	4·5

This constantly decreases with increasing generation. Seed production per plot, shown in Table 8, was not consistently influenced by generation.

TABLE 8

SEED YIELD OVER THE 1964–65 SUMMER—EXPERIMENT 3
g/plot

Generation	Bulk	Family			Main Effect
		1/6A Bulk	1/6F ex CP	1/6E Dark	
C3	0·2	4·9	4·3	3·0	3·1
C4	0·9	0·5	2·2	0·3	1·0
C5	4·1	1·8	5·3	1·2	3·1
Main effect	1·7	2·4	4·0	1·5	

LSD 5% Family main effect .. .. 3·0
LSD 5% Generation main effect .. .. 2·6
LSD 5% Family x Generation interaction .. .. 5·3

For experiment 4, the initial stands and persistence of the sown grasses to July 1968 are shown in Table 9. Except for 9–7–2 ryegrass and original Ronpha, adequate initial stands were obtained. Persistence, however, was not good and 26 months after planting only Priebe prairie grass, Demeter fescue and fertile amphidiploid 9N/9 had adequate populations. Three other lines, the amphidiploids 34 L/9 and C5 Bulk, and phalaris cv. Siro Seedmaster, had fair stands. Only the first three, however, gave adequate yields of dry matter throughout the period the experiment was harvested. (See Figures 1 and 2.)

TABLE 9

INITIAL STAND AND SUBSEQUENT PERSISTENCE OF GRASSES IN EXPERIMENT 4 WITH A PERFORMANCE RATING LATE IN THE FIRST SPRING (0–10 SCALE)

Identity	Plant/sq lk		% Persistence vi.66–vii.68	Rating (0–10) 4.xi.66
	21.vi.66	8.vii.68		
Priebe	2·23	1·12*	50·4	8·3
9 N/9	3·60	0·33	9·3	4·3
Demeter	3·78	0·33	8·9	6·0
34 L/9	5·17	0·25	5·1	3·3
C5 Bulk	5·27	0·18	3·5	5·3
Siro Seedmaster	6·12	0·17	2·7	7·3
9.7.2 Ryegrass	1·57	0·03	2·6	8·3
C4 Polycross—Gatton	3·87	0·08	2·3	4·0
C6 Polycross C6	2·43	0·05	2·1	2·6
H1 Ryegrass	3·93	0·07	1·8	9·3
C4 Polycross C4	3·05	0·05	1·7	2·6
C4 Polycross C5	4·40	0·08	1·7	4·0
11 0/7	3·77	0·07	1·6	3·0
Original Ronpha	0·07	0·15	—	2·6

* Seedlings present.

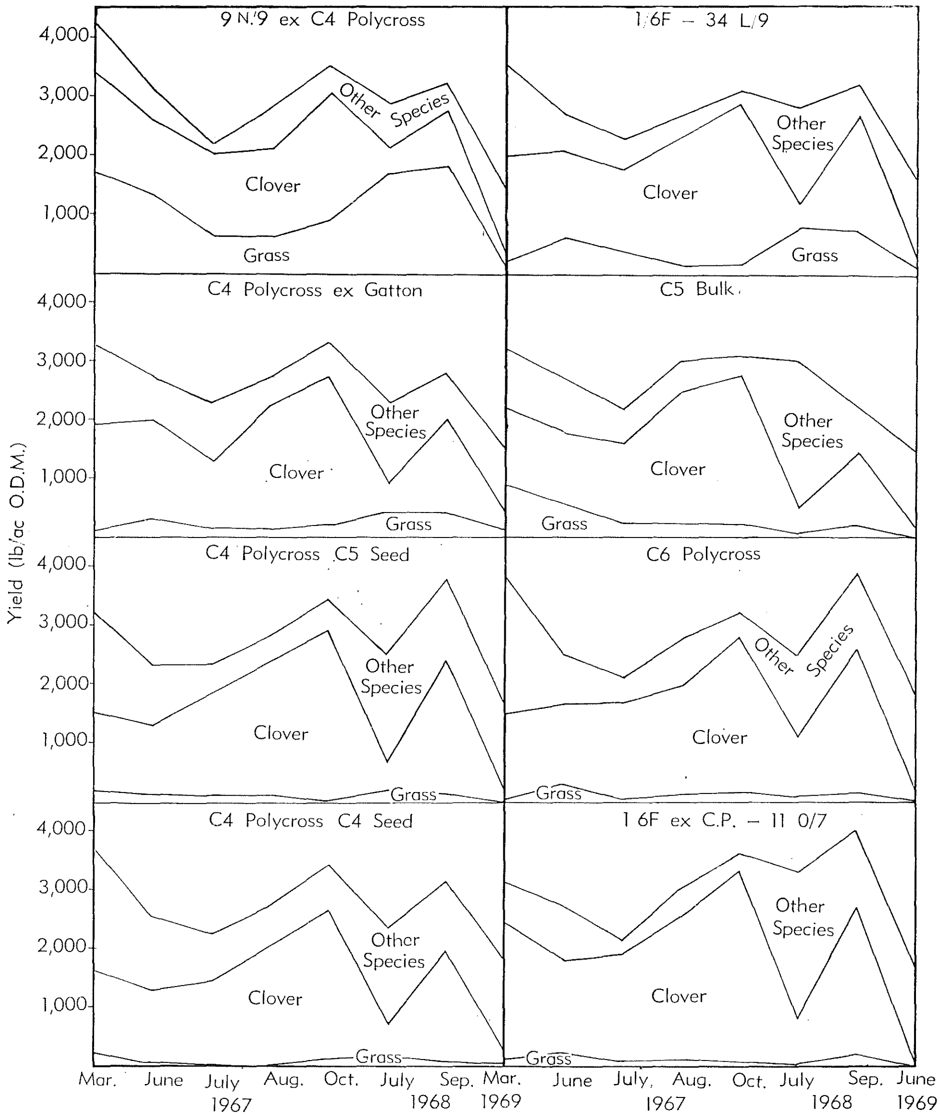

Fig. 1.—Total yield and yield of individual components from plots of the fertile Ronpha amphidiploids at each harvest taken from experiment 4.

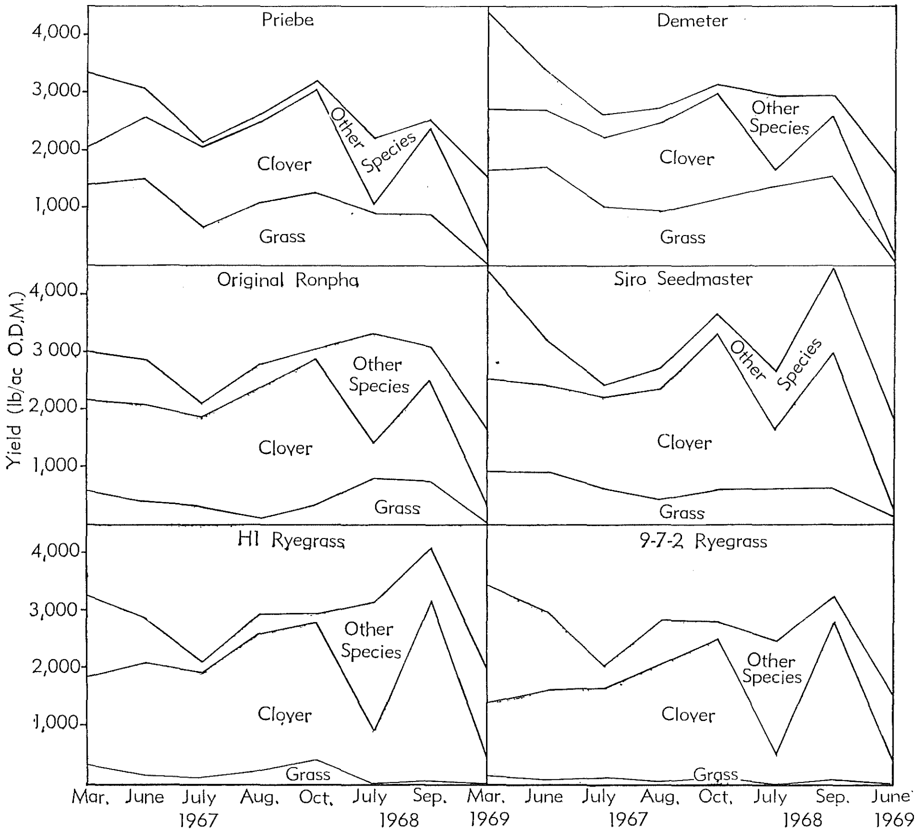

Fig. 2.—Total yield and yield of individual components from plots of other temperate species and cultivars planted in experiment 4, shown by harvests.

Despite the poor establishment of the vegetative portions of Ronpha grass in this experiment, 34 L/9 and Siro Seedmaster were the only lines to equal or approach its yield. Initially the two ryegrasses and C5 Bulk material grew well (Table 9).

Experiment 5 at Theodore showed a poor initial stand for the C4 polycross material and negligible contribution to yield. *Setaria sphacelata* cv. Nandi and *Panicum coloratum* var. *makarikariense* cv. Bambatsi both were far superior.

TABLE 10

MAIN EFFECT OF GRASS LINE ON GRASS STAND AND DRY-MATTER YIELD IN EXPERIMENT 5

Identity	Plant/sq lk			Grass Dry-matter Yield (lb/ac)					
	29.iii.67	16.x.68	17.x.69	8.xi.67	27.v.68	11.xii.68	3.ii.69	19.iii.69	8.i.70
Nandi	0·60	0·14	0·22	2,720	4,140	1,670	1,580	1,170	830
Bambatsi	1·40	0·33	0·39	1,680	1,250	2,660	2,400	1,150	1,310
C4 Polycross	0·10	0·03	0·00	280	70	240	20	20	0
LSD 5%	—	—	—	630	500	510	420	280	330

IV. DISCUSSION

The fertile amphidiploids selected and tested at Biloela were derived almost entirely from one parent (1/6). These, however, were far superior to lines from other parents such as 1/2 and 5/12 in spaced plants. The 1/6A, 1/6E and 1/6F lines provided the basis of almost all the material tested in the present programme.

These grew very vigorously as pregerminated seedlings placed out in wide rows and inter-row cultivated, 4 ft diameter of the lax spreading leaves in the vegetative phase not being uncommon in the most vigorous plants. When planted from seed in mixed swards the standard companion legume, Ladino white clover, was able to dominate them over the first and second spring. In several instances, experiments 1 and 2 in particular, stands were satisfactory by early September, but were quite weak by mid October.

Lack of persistence, beyond the first spring, of temperate grasses planted with Ladino white clover has been a major problem in developing a balanced irrigated pasture at Biloela (Cameron 1967). The fertile amphidiploids do not appear to be any better in this regard. Where adequate irrigation water was available, subsequent persistence appeared to be reasonable.

The possibility that there was a reduction in seedling vigour as generation increased was noted. Experiment 3 confirmed that this had occurred in the three families studied. A decline in seed yield, however, was not measured but may have been masked by the small populations used, only 10 plants per plot. One heavy seeder per plot may have been sufficient to determine the plot yield.

The only amphidiploid line to consistently perform well over a period was 9 N/9 of the C4 generation and this was only planted in one experiment. This material has also performed well in southern Queensland (Dorothy Davidson private communication). At this stage, however, it is not considered to warrant further development in Central Queensland.

It now appears possible that cultivars such as Demeter fescue, first planted in experiment 4 but subsequently showing further promise, and *Setaria sphacelata* cv. Narok, yet to be tested experimentally, may be of value for the uses originally foreseen for a fertile cultivar derived from Ronpha grass. As a result, development and testing of the present amphidiploid lines has been terminated.

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