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A NEW APPROACH OF ANALYSIS TO HALF-DIALLEL CROSSES WHERE PARENTAL LINES ARE INCLUDED

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ABSTRACT

The conventional type of diallel analysis [1] was compared with the method proposed by Lin [2] when the parents are divided into two groups and shown to give similar results. In addition, the proposed method provides estimates of hybrid vigour. Lin's method, in general, provided estimates for all parameters with more precision than the Griffing's method.

Key words: Diallel crosses, combining ability, hybrid vigour.

Plant breeders often use diallel cross design, for obtaining estimates of general and specific combining abilities (gca, sca), as an important tool in analysing the genetic potential of a line and for evaluating the best crossing material. Griffing [1] has presented four methods under fixed and random effects models in diallel crossing technique. In tobacco, it is observed that there is negligible variation in reciprocal crosses. Hence, breeders in tobacco generally consider only a set of crosses with selfs in their experiments and analyse the data using Griffings Method-2 under the random effects model [1]. Often, in a breeding experiment, crossing material comes from two different geographical sources or two different genetic backgrounds and the breeders are interested in the combining ability between two groups rather than in all crosses. Thus, a breeder includes material from two different groups in his trial to achieve a desired goal in improvement for quality and quantity. Analysis for this kind of situation is possible using a $a \times b$ factorial design, where a and b represent the number of lines in each group. If p is the number of parents used in the half diallel, the number of crosses including the parents will be $p + p(p-1)/2$ in Griffing's method, whereas in the present method, these are reduced to $ab + p$ where $a + b = p$.

METHOD

The layout of the experiment considered is a randomized block design with n replications under the same Model 2, Method 2 of Griffing. The least square estimates and the variances of the estimates for the parameters in the Lin's method are given below.

Parameter	*Estimate*	*Variance*
μ	$x_{..}/(ab + p)n$	$q_{00} \equiv \hat{\sigma}^2/(ab + p)n$
g_i	$\dfrac{x_{i.} + x_{ii}}{(b+4)n} - \dfrac{\sum_{i=1}^{a} (x_{i.} + x_{ii})}{a(b + 4)n}$	$q_1 \equiv \hat{\sigma}^2 (a-1)/[a(b+4)n]$
g_j	$\dfrac{x_{j.} + x_{jj}}{(a+4)n} + \dfrac{\sum_{j=a+1}^{p} (x_{j.} + x_{jj})}{b(a + 4)n}$	$q_2 \equiv \hat{\sigma}^2 (b-1)/[b(a+4)n]$
s_{ij}	$\dfrac{x_{ij}}{n} - \hat{g}_i - \hat{g}_j - \hat{\mu}$	$\dfrac{\hat{\sigma}^2}{n} - q_0 - q_1 - q_2$
H_{ij}	$\frac{1}{2}(2\hat{s}_{ij} - \hat{s}_{ii} - \hat{s}_{jj})$	$3\hat{\sigma}^2/2n$

and the analysis of variance table is

Source	*d.f.*	*s.s.*
Blocks	$(n-1)$	
gca of group 1(g_1)	$(a-1)$	$\dfrac{\sum_{i=1}^{a} (x_{i.} + x_{ii})^2}{(b+4)n} - \left[\dfrac{\sum_{i=1}^{a} (x_{i.} + x_{ii})}{a(b+4)n}\right]^2$
gca of group 2 (g_2)	$(b-1)$	$\dfrac{\sum_{j=a+1}^{p} (x_{j.} + x_{jj})^2}{(a+4)n} - \left[\dfrac{\sum_{j=a+1}^{p} (x_{j.} + x_{jj})}{b(a+4)n}\right]^2$
sca	$(ab+1)$	$1/n\left[\sum_{i=1}^{a} \sum_{j=a+1}^{p} x_{ij}^2 + \sum_{i=1}^{a} x_{ii}^2 + \sum_{j=a+1}^{p} x_{jj}^2\right] - SS(g_1) - SS(g_2) - \dfrac{x^2}{(ab+p)n}$
Error	$(n-1)\ (ab+p-1)$	By subtraction

The above elements and hybrid vigour are calculated using Lin's [2] procedure along with the estimates of the conventional Griffing's method for the cured leaf yield data [3].

Eight parents, NC 13, L 2178, GSH 3 (light cast varieties) Sp. G. 41, Cocker 213, McNair 14, M 43, S 94, and V 71 Giant (dark cast varieties), are categorised into two groups in this study. The main purpose of crossing is to incorporate the good characters of both light and dark cast varieties. All possible crosses between the parents along with a set of parents were grown in randomized block design with four replications and considered for Griffing's method. For Lin's method, only the corresponding crosses between the three light cast and five dark cast varieties along with all the eight parents are considered. The results for both types of analysis are presented in Tables 1 and 2.

RESULTS AND DISCUSSION

Table 1 shows that there was only a marginal increase in the error variance in the Lin's method for reduction in the degrees of freedom from 105 to 66. Though no significant difference for the gca effects among the dark cast varieties could be observed, the significant difference among the light cast varieties belonging to the first group resulted in significantly high sca effects for the crosses. Similar results were observed in the Griffing's Method 2 under random effects model. It can be further seen that in order to produce crosses with significant or highly significant sca effects, at least one group should contain divergent parents.

Table 1. Analysis of variance

Source	Griffing's Method 2 of random effect model					Lin's method				
	d.f.	S.S.	M.S.S.	F.	significance	d.f.	S.S.	M.S.S.	F	significance
Replications	3	1.30	0.43			3	0.73	0.24		
gca	7	1.45	0.21	2.42	Significant at 5%	—	—	—		
gca of group 1	—	—				2	0.56	0.28	3.33	Significant at 5%
gca of group 2	—	—				4	0.67	0.17	1.98	Not significant
sca	28	6.88	0,25	2.88	Highly significant	16	5.07	0.32	3.76	Highly significant
Error	105	8.97	0.09			66	5.56	0.08		
CV %					14.41					14.58

From Table 2, the trends of sca effects remain unchanged, except for the cross L 2178 × M 43 S 94 (s 27), where it is negative in Griffing's method and positive in Lin's method. The net results obtained in both methods are the same. In addition, hybrid vigour for each cross was also calculated from Lin's method (Table 2).

It can be further seen, that crosses GSH 3 × Cocker 213 (s 35) and GSH 3 × Mc Nair 14 (s 36) had high sca effects and gave higher yields. These two crosses are obtained from the parents taken from different groups. Though crosses McNair 14 × V 71 Gaint (s 68) and Cocker 213 × V 71 Gaint (s 58) gave better yield, they belong to the parents taken from the same group but their yields are lower than those of s 35 and s 36. This shows that omission of crosses from the same group, as in Lin's method, did not affect the breeder's objectives.

Table 2. Estimation of parameters and standard errors

Parameter	Griffing's Method 2 of random effect model		Lin's method	
	estimate	SE	estimate	SE
μ	2.03	0.29	1.99	0.03
g_1	0.09		0.05	
g_2	−0.08		−0.10	0.04
g_3	0.07		0.05	Group I
g_4	−0.03	0.43	0.05	
g_5	0.03		0.08	0.05
g_6	0.04		0.02	Group II
g_7	−0.11		−0.12	
g_8	−0.01		−0.03	
s_{12}	0.09			
s_{13}	0.15			
s_{14}	−0.40		0.40	
s_{15}	−0.21		−0.19	
s_{16}	−0.11		−0.02	
s_{17}	0.18		0.27	
s_{18}	−0.13		−0.04	
s_{23}	−0.02	0.12		
s_{24}	0.13		0.11	0.13
s_{25}	−0.31		−0.30	
s_{26}	0.11		0.19	
s_{27}	−0.02		0.05	
s_{28}	0.15		0.22	
s_{34}	−0.05		−0.07	
s_{35}	0.36		0.38	
s_{36}	0.22		0.30	
s_{37}	0.10		0.17	
s_{38}	−0.54		−0.46	
s_{45}	−0.36			
s_{46}	0.17			
s_{47}	0.14			
s_{48}	−0.03			
s_{56}	−0.00			
s_{57}	0.20			
s_{58}	0.26			
s_{67}	0.13			
s_{78}	0.04			
H_{14}		−0.59		
H_{15}		−0.31		
H_{16}		0.00		
H_{17}		0.30		
H_{18}		−0.21		
H_{24}		0.09		
H_{25}		−0.26		
H_{26}		+0.37	0.18	
H_{27}		0.24		
H_{28}		0.21		
H_{34}		−0.08		
H_{35}		0.43		
H_{36}		0.50		
H_{37}		0.37		
H_{38}		−0.45		

It can also be observed that estimates of standard error for the estimated parameters under Lin's method are smaller than the corresponding estimates under Griffing's method. This indicates that with fewer crosses, the trend of the parameters remaining the same, the gca and sca effects are estimated with more precision.

CONCLUSION

The main advantage in Lin's method is that the number of crosses are considerably reduced, resulting in economy of space, time and experimental material. The parents can be grouped by the breeder in conformity with his aim. Further, this method has the added advantage of including more parents in the study. The reduction in the number of crosses in Lin's method will reduce block size and thus improve efficiency of the experiment.

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