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Application of Balanced Lattice Designs in CDC System IV

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SUMMARY

A method of construction of incomplete block designs for complete diallel cross system IV (Griffing (1956)) has been proposed for estimating general combining ability of lines through balanced lattice designs (Yates (1936)). This method is an alternative method of blocking in diallel cross system IV reported by Sharma (1996). The efficiency factor of these designs as compared to randomized block designs is equal to one.

Key words : Balanced lattice designs, Complete diallel cross, General combining ability, Mating design.

1. INTRODUCTION

Lattice designs are an important class of incomplete block designs, originally introduced by Yates (1936). Lattice designs for p = s^2 treatments are also partially balanced incomplete block designs based on latin square association scheme. Balanced lattice designs originated from group of lattice designs and are available only when the square root of the number of treatments or varieties is either a prime number or prime power. Balanced lattice are actually BIB designs.

Agarwal and Das ((1987), (1990)) constructed incomplete block designs for partial diallel cross (PDC) and for complete diallel cross (CDC) system IV of Griffing (1956) through PBIB designs when all crosses of a PDC and CDC are not accommodated in the blocks of a traditional randomized block design.

Sharma (1996) introduced blocking in CDC system IV using balanced lattice designs. In resulting designs the number of occurrences of the lines within blocks tend to be uneven, which decreases their efficiencies.

Optimal designs for complete diallel cross (CDC) system IV have been recently investigated by several authors e.g. Gupta and Kageyama (1984), Dey and Midha (1996), Mukerjee (1977), Das *et al.* (1998) and Parsad *et al.* (1999). These authors used Nested Balanced Incomplete Block (NBIB) designs of Preece (1967) for this purpose. In this article, we have given a method to obtain incomplete block designs for CDC system IV through balanced lattice designs. This method is an alternative method of blocking in CDC system IV. The incomplete block designs for CDC system IV obtained by this method obey universal optimality criteria of Kiefer (1975).

2. METHOD OF CONSTRUCTION

The method is simply stated as follows. Take for p lines under evaluation numbered randomly, a balanced lattice design with parameters $p = s^2$, $b = s(s+1)$, $r = s+1, k = s$ and $\lambda = 1$. The s lines in each block of each replication yield $s(s-1)/2$ distinct crosses when all the pair of lines or varieties within a block identified as crosses. Thus from each replication we get $[s \times s(s-1)/2]$ distinct crosses. The $(s+1)$ replications can be considered as blocks of incomplete block designs involving $p(p-1)/2$ crosses in $(s+1)$ blocks with block size $s^2(s-1)/2$.

It can easily be seen that each of the lines appears in each of the blocks exactly $s-1$ times. Further, following on the lines of Dey and Midha (1996), Das *et al.* (1998) and Parsad *et al.* (1999), the information matrix for estimating the linear function of general combining ability (gca) effects of lines is given by

$C = (p-2)$. Hence the design obtained is variance balanced block design for diallel crosses. Now using the Theorem of Parsad *et al.* (1999), it can easily be verified that the designs obtainable from above method are universally optimal over $D(p = s^2, b = s+1, k = p(s-1)/2)$, the class of connected block designs in which the crosses among the p lines are arranged in b blocks each of size k.

Example 2.1: For obtaining 9(9 – 1)/2 = 36 crosses for CDC system IV, we consider balanced lattice design with parameters (PLAN I) $v = 9$, $b = 12$, $r = 4$, $k = 3$ and $\lambda = 1$ and obtain CDC (PLAN II) by crossing all pairs of two lines in each block and taking columns as blocks as shown below:

PLAN I

	Rep I				Rep II		
B_1	1	2	3	B_4	1	4	7
B_2	4	5	6	B_5	2	5	8
B_3	7	8	9	B_6	3	6	9
	Rep III				Rep IV		
B_7	1	5	9	B_{10}	1	8	6
B_8	7	2	6	B_{11}	4	2	9
B_9	4	8	3	B_{12}	7	5	3

PLAN II

	B_1			B_2	
1 × 2	1 × 3	2 × 3	1 × 4	1 × 7	4 × 7
4 × 5	4 × 6	5 × 6	2 × 5	2 × 8	5 × 8
7 × 8	7 × 9	8 × 9	3 × 6	3 × 9	6 × 9
	B_3			B_4	
1 × 5	1 × 9	5 × 9	1 × 8	1 × 6	8 × 6
7 × 2	7 × 6	2 × 6	4 × 2	4 × 9	2 × 9
4 × 8	4 × 3	8 × 3	7 × 5	7 × 3	5 × 3

Table 1

S.N.	No. of parents p	No. of crosses per block k	No. of blocks b	Total no. of crosses n	Remarks
1.	4	2	3	6	Series 2, Gupta and Kegeyama (1994)
2.	9	9	4	36	AK
3.	16	24	5	120	N
4.	25	50	6	300	N

Note : AK and N denote already known and new respectively.

Table 1 exhibits the designs for $p \leq 30$ obtained by the above method.

The unique non-zero eigen value of information matrix C of the above designs is $p-2$ which is same as that of randomized block design for diallel crosses with number of replication of crosses, $r = 1$. Therefore, the efficiency factor of designs obtainable from this method is "1".

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