STATISTICS UNIT

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STATISTICAL COMPUTING IN AGRICULTURAL RESEARCH AT ICRISAT

(Volume 1)

COMPILED BY

Statistics Unit

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CONTENTS

PROGRAMS FOR BIOMETRICAL GENETICS

INTRODUCTION

In this volume, an attempt has been made to compile several computer programs developed by the staff of the Statistics Unit to meet the specific needs of ICRISAT scientists for their data analysis. The programs written in GENSTAT and FORTRAN cover four major areas namely, (1) Biometrical genetics; (2) Multilocational trails; (3) Incomplete block designs; and (4) Randomizations for incomplete block designs. The sample runs have been included in many cases. These programs can be easily copied for use with the help of the statistics unit. We welcome your comments and suggestions.

PROGRAM FOR GRIFFING'S APPROACH DIALLEL ANALYSIS
METHOD 1 - MODEL 1 AND 2

```
'REPE/NUMN=500,NID=500,PRINT=2' DIALLEL1
'UNIT' $ 192
'SCAL' DSIZE=8
'SCAL' NREP=3
'SCAL' NV=9
'INTE' NUMVAR=1...NV
'SCAL' MF,TOTSS,CF,REPSS,TSS,ESS,RDF,TDF,EDF,TOTDF,TOTMS,REPMS,EMS,FR,FTAB,
       GDF,SDF,REDF,TMS,MM,MS,IJ,JJ,MS
,MRCT(1...DSIZE),SSGCA,SSSCA,GT,SSREC,

TGCAE,TSCAE,TRECE,COMGCA,COMSCA,COMREC,MSGCA,MSSCA,MSREC,EMSP,RGCASCA
'FACT' REP $ NREP
'FACT' MALE $ DSIZE : FEMALE $ DSIZE
'INPU' 2
'READ/P' MALE,FEMALE,REP,TRS,VARIABLE(NUMVAR)
'CALC' MF=DSIZE*DSIZE
'INPU' 1
'HEAD' H1=
''SOURCE              DF                  SS              MS              FR''
'HEAD' H2='' REPLICATION''
'HEAD' H3='' TREATMENTS''
'HEAD' H4='' RESIDUAL''
'HEAD' H5='' TOTAL''
'HEAD' H6='' MEAN DATA OF FULL DIALLEL                                    ''
'HEAD' H7='' GCA          ''
'HEAD' H8='' SCA          ''
'HEAD' H9='' RECIPROCALS ''
'HEAD' H10='' RESIDUAL   ''
'HEAD' H14=
'' GCA EFFECTS (DIAGONAL VALUES), SCA EFFECTS (LOWER DIAGONAL VALUES ''
'HEAD' H15=
'' GCA EFFECTS (DIAGONAL VALUES), RECIPROCAL EFFECTS (LOWER DIAGONAL
VALUES) ''
'HEAD' H16='' VAR (G(I)) '' : H17='' SE G(I) ''
'HEAD' H18='' VAR (S(J,I)) '' : H19='' SE S(J,I) ''
'HEAD' H20='' VAR (S(I,J)) '' : H21='' SE S(I,J) ''
'HEAD' H22='' VAR (R(I,J)) '' : H23='' SE R((I,J)) ''
'HEAD' H24='' VAR (G(I)-G(J)) '' : H25='' SE (G(I)-G(J)) ''
'HEAD' H26='' VAR (S(I,I)-S(J,I)) '' : H27='' SE (S(I,I)-S(J,I)) ''
'HEAD' H28='' VAR (S(I,I)-S(I,J)) '' : H29='' SE S(I,I)-S(I,J) ''
'HEAD' H30='' VAR (S(I,I)-S(J,K)) '' : H31='' SE S(I,I)-S(J,K) ''
'HEAD' H32='' VAR (S(I,J)-S(I,K)) '' : H33='' SE S(I,I)-S(I,K) ''
'HEAD' H34='' VAR (S(I,J)-S(K,L)) '' : H35='' SE S(I,J)-S(K,L) ''
'HEAD' H36='' VAR (R(I,J)-R(K,L)) '' : H37='' SE R(I,J)-R(K,L) ''
'HEAD' HH1=
''SOURCE              DF                  MS          E(MS)        FR ''
'HEAD' H41='' RATIO OF GCA VARIANCE TO SCA VARIANCE ''
'R'
''            CALCULATION OF SUMS OF SQUARES                          ''
'VARI' REPTOT $ NREP
'POR' YSET=VARIABLE(NUMVAR) ; JJ1=1...NV
```

```
'FOR' I=1...NREP
'REST' YSET $ REP=I
'CALC' NN=SUM(YSET)
'COPY' REPTOT $ I=NN

'REST' YSET
'VARI' MFTOT,REPMEAN $ MF
'FOR' I=1...DSIZE : J=1...DSIZE
'REST' YSET $ MALE,FEMALE=I,J
'CALC' IJ=J+DSIZE*(I-1)
'CALC' JJ=SUM(YSET)
'CALC' NS=MEAN(YSET)
'COPY' MFTOT $IJ=JJ
'COPY' REPMEAN $ IJ=NS
'REPE' :
'REST' YSET
'CALC' RDF=NREP-1 : TDF=MF-1 : TOTDF=(NREP*MF)-1 : EDF=TOTDF-RDF-TDF
'CALC' CF=SUM(REPTOT) :  CF=(CF*CF)/(NREP*MF)
'CALC' TOTSS=SUM(YSET*YSET)
'CALC' TOTSS=TOTSS-CF : REPTOT=REPTOT*REPTOT
'CALC' REPSS=(SUM(REPTOT)/MF)-CF : MFTOT=MFTOT*MFTOT
'CALC' TSS=(SUM(MFTOT)/NREP)-CF   : ESS=TOTSS-TSS-REPSS
'CALC' TOTMS=TOTSS/TOTDF : REPMS=REPSS/RDF : EMS=ESS/EDF : TMS=TSS/TDF
'CALC' FR=TMS/EMS
'CAPT'
''
*** RBD ANALYSIS ***
''
'PRINT' H1
'LINE' 2
'PRINT/C,LABR=1,LABC=1  H2,RDF,REPSS,REPMS $ 0,1(10.0),20.3,15.3
'PRINT/C,LABC=1,LABR=1  H3,TDF,TSS,TMS,FR $ 0,1(11.0),20.3,15.3,13.3
'PRINT/C,LABR=1,LABC=1  H4,EDF,ESS,EMS    $ 0,1(13.0),20.3,15.3
'PRINT/C,LABR=1,LABC=1  H5,TOTDF,TOTSS     $ 0,16.0,20.3
'LINE' 5
'CALC' FTAB=FPROB(0.05 ; TDF ; EDF)
''        CALCULATION OF ANOVA FOR MODEL I METHOD I          ''
'MATR' PREPMAT,TREPMAT,REPMAT,RECREPMA,RECREPM,MATCT,MATRT,MATCRT,TMATCRT,
       MATCRTT,PREPMA,SCAE $ DSIZE,DSIZE
'EQUA' REPMAT=REPMEAN
'CALC' TREPMAT=TRANS(REPMAT)
'CALC' PREPMA=REPMAT+TREPMAT
'CALC' PREPMAT=REPMAT*PREPMA
'CALC' RECREPM=REPMAT-TREPMAT
'CALC' RECREPMA=RECREPM*RECREPM
'VARI' MRRCT,MRCT,MRRT,MR(1...DSIZE),GCAE $ DSIZE
'VARI' ABC,DEF $ MF
'EQUA' ABC=PREPMAT
'EQUA' DEF=RECREPMA
'EQUA' MR(1...DSIZE)=REPMAT
'CALC' MRRT=VSUM(MR(1...DSIZE))
'CALC' GT=SUM(MRRT)
'CALC' MRCT(1...DSIZE)=SUM(MR(1...DSIZE))
'CAPT'
''
```

```
*** TABLE OF MEANS ***
''
'LINE' 3
'PRINT/P,LABR=1,LABC=1' MR(1...DSIZE),MRRT $ (8.3)DSIZE,11.3
'LINE' 1
'PRINT/P,LABR=1,LABC=1' MRCT(1...DSIZE),GT $ (8.3)DSIZE,11.3
'EQUA' MRCT=MRCT(1...DSIZE)
'EQUA' MATCT=MRCT
'EQUA  MATRT=MRRT
'CALC  MATCT=TRANS(MATCT)
'CALC  MATRT=TRANS(MATRT)
'CALC  MATCRT=MATRT+MATCT
'CALC  TMATCRT=TRANS(MATCRT)
'CALC  MATCRTT=MATCRT+TMATCRT
'CALC  MRRCT=(MRCT+MRRT)*(MRCT+MRRT)
'CALC  SSGCA=(SUM(MRRCT)/(2*DSIZE))-((GT*GT*2)/(DSIZE*DSIZE))
'CALC  SSSCA=(SUM(ABC)/2)-(SUM(MRRCT)/(2*DSIZE))+((GT*GT)/(DSIZE*DSIZE))
'CALC  SSREC=SUM(DEF)/4
'CALC  GDF=DSIZE-1 : SDF=(DSIZE*(DSIZE-1))/2 : REDF=(DSIZE*(DSIZE-1))/2
'CALC  EMSP=EMS/NREP
'CALC  MSGCA=SSGCA/GDF
'CALC  MSSCA=SSSCA/SDF
'CALC  MSREC=SSREC/REDF
'CALC  TGCAE=MSGCA/(EMSP)
'CALC  TSCAE=MSSCA/(EMSP)
'CALC  TRECE=MSREC/(EMSP)
'CALC  COMGCA=(MSGCA-EMSP)/(2*DSIZE)
'CALC  COMSCA=(MSSCA-EMSP)
'CALC  COMREC=(MSREC-EMSP)/2
'CALC  RGCASCA=COMGCA/COMSCA
'LINE  5
'CAPT
''
*** ANALYSIS OF VARIANCE FOR GCA AND SCA ***

'PRINT' HH1
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H7,GDF,MSGCA,COMGCA,TGCAE $
       0,1(18.0),20.3,15.3,11.3
'PRINT/C,LABR=1,LABC=1' H8,SDF,MSSCA,COMSCA,TSCAE
        $ 0,1(18.0),20.3,15.3,11.3
'PRINT/C,LABR=1,LABC=1' H9,REDF,MSREC,COMREC,TRECE
         $ 0,1(10.0),20.3,15.3,11.3
'PRINT/C,LABR=1,LABC=1' H10,EDF,EMSP  $ 0,1(13.0),20.3
'LINE' 2
'PRINT/C,LABR=1' H41,RGCASCA $ 0,10.4
'LINE' 1
'CALC' GCAE=((MRCT+MRRT)/(2*DSIZE))-(GT/(DSIZE*DSIZE))
'DIAG' GCAM,DMAT $ DSIZE
'MATR' MAT $ DSIZE,DSIZE
'SYMM' SCAM,RECM $ DSIZE
'CALC' MAT=0
'CALC' RECREPM=RECREPM/2
'CALC' SCAE=(PREPMA/2)-(MATCRTT/(2*DSIZE))+(GT/MF)
'CALC' DMAT=SCAE
```

```
'CALC' SCAE=SCAE-DMAT
'COPY' GCAM=GCAE
'CALC' MAT=MAT+GCAM
'CALC' RECREPM=RECREPM+MAT
'CALC' SCAE=SCAE+MAT
'CALC' SCAM=SCAE
'CALC' RECM=RECREPM
'LINE' 2
'PRINT' H14
'PRINT/LABC=1,LABR=1' SCAM $ 8.3
'LINE' 2
'PRINT' H15
'PRINT/LABR=1,LABC=1' RECM $ 8.3
'SCAL' VARG,VARS1,VARS2,VARR,VARGG,VARSS1,VARSS2,VARSS3,VARSS4,VARSS5,VARR2
   ,SEG,SES1,SES2,SER,SEGG,SESS1,SESS2,SESS3,SESS4,SESS5,SER2,TGCA2,TSCA2,
   TREC2,COMGCA2,COMSCA2,COMREC2,RGS,SIGMA,SIGMD
'CALC' VARG=((DSIZE-1)/(2*DSIZE*DSIZE))*EMSP : SEG=SQRT(VARG)
'CALC' VARS1=((DSIZE-1)*(DSIZE-1)/(DSIZE*DSIZE))*EMSP : SES1=SQRT(VARS1)
'CALC' VARS2=(((DSIZE*DSIZE)-(2*DSIZE)+2)/(2*DSIZE*DSIZE))*EMSP
   :   SES2=SQRT(VARS2)
'CALC' VARR=(1/2)*EMSP : SER=SQRT(VARR)
'CALC' VARGG=(1/DSIZE)*EMSP : SEGG=SQRT(VARGG)
'CALC' VARSS1=((2*(DSIZE-2))/DSIZE)*EMSP : SESS1=SQRT(VARSS1)
'CALC' VARSS2=((3*DSIZE-2)/(2*DSIZE))*EMSP : SESS2=SQRT(VARSS2)
'CALC' VARSS3=((3*(DSIZE-2))/(2*DSIZE))*EMSP :SESS3=SQRT(VARSS3)
'CALC' VARSS4=((DSIZE-1)/DSIZE)*EMSP : SESS4=SQRT(VARSS4)
'CALC' VARSS5=((DSIZE-2)/DSIZE)*EMSP : SESS5=SQRT(VARSS5)
'EQUA' VARR2=EMSP 'CALC' SER2=SQRT(VARR2)
'CAPT'
''
*** STANDARD ERRORS *****
''
'PRINT/C,LABR=1' H16,VARG,H17,SEG $ 0,23.3,10,22.3
'PRINT/C,LABR=1' H18,VARS1,H19,SES1 $ 0,21.3,10,20.3
'PRINT/C,LABR=1' H20,VARS2,H21,SES2 $ 0,21.3,10,20.3
'PRINT/C,LABR=1' H22,VARR,H23,SER $ 0,21.3,10,18.3
'PRINT/C,LABR=1' H24,VARGG,H25,SEGG $ 0,18.3,10,15.3
'PRINT/C,LABR=1' H26,VARSS1,H27,SESS1 $ 0,14.3,10,11.3
'PRINT/C,LABR=1' H28,VARSS2,H29,SESS2 $ 0,14.3,10,13.3
'PRINT/C,LABR=1' H30,VARSS3,H31,SESS3 $ 0,14.3,10,13.3
'PRINT/C,LABR=1' H32,VARSS4,H33,SESS4 $ 0,14.3,10,13.3
'PRINT/C,LABR=1' H34,VARSS5,H35,SESS5 $ 0,14.3,10,13.3
'PRINT/C,LABR=1' H36,VARR2,H37,SER2 $ 0,14.3,10,13.3
'CALC' TGCA2=MSGCA/MSSCA
'CALC' TSCA2=MSSCA/EMSP
'CALC' TREC2=MSREC/EMSP
'CALC' COMGCA2=(MSGCA-(EMSP+DSIZE*(DSIZE-1)*MSSCA)/(DSIZE*DSIZE-DSIZE+1))/
              (2*DSIZE)
'CALC' COMSCA2=((DSIZE*DSIZE)/(2*(DSIZE*DSIZE-DSIZE+1)))*(MSSCA-EMSP)
'CALC' COMREC2=(MSREC-EMSP)/2
'CALC' SIGMA=2*COMGCA2 : SIGMD=COMSCA2
'CALC' RGS=COMGCA2/COMSCA2
'CAPT'
''
*** ANALYSIS OF VARIANCE FOR GCA AND SCA FOR MODEL 2 ***
```

```
''
'LINE' 1
'PRINT' HH1
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H7,GDF,MSGCA,COMGCA2,TGCA2 $ 0,18.0,20.3,15.3,11.3
'PRINT/C,LABR=1,LABC=1' H8,SDF,MSSCA,COMSCA2,TSCA2 $ 0,18.0,20.3,15.3,11.3
'PRINT/C,LABR=1,LABC=1' H9,REDF,MSREC,COMREC2,TREC2 $ 0,10.0 20.3,15.3,11.3
'PRINT/C,LABR=1,LABC=1' H10,EDF,EMSP  $ 0,13.0,20.3
'LINE' 2
'HEAD' H39='' SIGMA SQUARE A '' : H40='' SIGMA SQUARE D ''
'HEAD' H41='' RATIO OF GCA VARIANCE TO SCA VARIANCE ''
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H39,SIGMA $ 0,10.3
'PRINT/C,LABR=1,LABC=1' H40,SIGMD $ 0,10.3
'PRINT/C,LABR=1,LABC=1' H41,RGS $ 0,10.3
'HEAD' HX1='' * * * END OF ANALYSIS FOR VARIABLE  * * * ''
'LINE' 2
'PRINT/C,LABR=1' HX1,JJ1 $ 0,10.0
'LINE' 2
'DEVAL'
MF,TOTSS,CF,REPSS,TSS,ESS,RDF,TDF,EDF,TOTDF,TOTMS,REPMS,EMS,FR,FTAB,
       GDF,SDF,REDF,TMS,NN,NS,IJ,JJ,NS
,MRCT(1...DSIZE),SSGCA,SSSCA,GT,SSREC,

TGCAE,TSCAE,TRECE,COMGCA,COMSCA,COMREC,MSGCA,MSSCA,MSREC,EMSP,RGCASCA,
       PREPMAT,TREPMAT,REPMAT,RECREPMA,RECREPM,MATCT,MATRT,MATCRT,TMATCRT,

MATCRTT,PREPMA,SCAE,SCAM,RECM,MRRCT,MRCT,MRRT,MR(1...DSIZE),GCAE,ABC,
       DEF
'REPE'
'R'
'CLOS'
'STOP'
```

Output from Diallel Analysis Griffing's method 1

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
YIELD	40.64	90.75	142.84	256	0

*** RED ANALYSIS ***

SOURCE	DF	SS	MS	FR
REPLICATION	3	1037.000	345.667	
TREATMENTS	63	104925.000	1665.476	14.467
RESIDUAL	189	21758.500	115.124	
TOTAL	255	127720.500		

*** TABLE OF MEANS ***

85.645	87.010	90.505	114.945	120.290	68.550	107.640	52.640	727.225
80.690	98.260	111.575	88.170	99.930	73.265	97.640	85.650	735.180
102.230	104.555	74.070	100.645	94.285	100.885	111.540	117.735	805.945
119.115	89.310	102.675	91.640	85.285	105.795	64.450	46.855	705.125
111.290	102.890	88.265	83.390	54.100	84.150	81.935	94.820	700.840
68.835	71.295	99.575	108.665	87.965	100.390	121.610	53.740	712.075
109.265	87.820	108.445	57.650	78.750	115.670	90.960	125.270	773.830
48.720	83.145	115.400	46.740	93.320	60.240	118.170	82.000	647.735
725.790	724.285	790.510	691.845	713.925	708.945	793.945	658.710	5807.955

** ANALYSIS OF VARIANCE FOR GCA AND SCA ***

SOURCE	DF	MS	E(MS)	FR
GCA	7	543.661	32.180	18.890
SCA	28	787.875	759.094	27.375
RECIPROCALS	28	13.034	-7.874	0.453
RESIDUAL	189	28.781		

RATIO OF GCA VARIANCE TO SCA VARIANCE 0.0424

GCA EFFECTS (DIAGONAL VALUES), SCA EFFECTS (LOWER DIAGONAL VALUES

```
  0.064
 -7.431   0.467
 -3.475   7.819   9.029
 29.655   0.962   5.320  -3.439
 27.303  12.520  -6.177  -0.647  -2.326
-20.185 -17.001   2.387  21.855  -0.430  -1.936
 10.402  -5.723   2.977 -33.497 -15.317  22.590   7.237
-31.037   2.277  25.886 -31.417  14.744 -22.727  32.831  -9.096
```

GCA EFFECTS (DIAGONAL VALUES), RECIPROCAL EFFECTS (LOWER DIAGONAL VALUES)

```
  0.064
  3.160   0.467
 -5.863   3.510   9.029
 -2.085  -0.570  -1.015  -3.439
  4.500  -1.480   3.010   0.948  -2.326
 -0.142   0.985   0.655  -1.435  -1.908  -1.936
 -0.813   4.910   1.548   3.400   1.593   2.970   7.237
  1.960   1.252   1.167   0.058   0.750  -3.250   3.550  -9.096
```

**** STANDARD ERRORS *****

VAR (G(I))	1.574	SE G(I)	1.255
VAR (S(J,I))	22.036	SE S(J,I)	4.694
VAR (S(I,J))	11.243	SE S(I,J)	3.353
VAR (R(I,J))	14.391	SE R((I,J))	3.793
VAR (G(I)-G(J))	3.598	SE (G(I)-G(J))	1.897
VAR (S(I,I)-S(J,I))	43.172	SE (S(I,I)-S(J,I))	6.571
VAR (S(I,I)-S(I,J))	39.574	SE S(I,I)-S(I,J)	6.291
VAR (S(I,I)-S(J,K))	32.379	SE S(I,I)-S(J,K)	5.690
VAR (S(I,J)-S(I,K))	25.183	SE S(I,I)-S(I,K)	5.018
VAR (S(I,J)-S(K,L))	21.586	SE S(I,J)-S(K,L)	4.646
VAR (R(I,J)-R(K,L))	28.781	SE R(I,J)-R(K,L)	5.365

*** ANALYSIS OF VARIANCE FOR GCA AND SCA FOR MODEL 2 ***

SOURCE	DF	MS	E(MS)	FR
GCA	7	543.661	-14.431	0.690
SCA	28	787.875	426.158	27.375
RECIPROCALS	28	13.034	-7.874	0.453
RESIDUAL	189	28.781		

```
 SIGMA SQUARE A   -28.862
 SIGMA SQUARE D   426.158
 RATIO OF GCA VARIANCE TO SCA VARIANCE    -0.034
```

```
 229  'CLOS'
********* END OF DIALLEL1.  MAXIMUM OF 20234 DATA UNITS USED AT LINE
155 (307446 LEFT)
```

PROGRAM FOR GRIFFING'S APPROACH DIALLEL ANALYSIS
METHOD 2 - MODEL 1 AND 2

```
'REPE/NUMN=1000,NID=1000,PRINT=Z' DIALLEL2
'UNITS' $ 144
'SCAL' CRS=36 : NREP=4 : DSIZE=8 'SCAL' MF
'FACT' CROS $ CRS=(1...CRS)NREP : REP $ NREP=CRS!(1...NREP)
'CALC' MF=DSIZE*DSIZE
'SCAL' NV=1
'INTE' NUMVAR=1...NV
'INPUT' 2
'READ' VARIABLE(NUMVAR)
'INPUT' 1
'R'
'SCAL'
GT,CF,OBS,TOTSS,TSS,RSS,N,K,TOTDF,RDF,TDF,EDF,ESS,TMS,RMS,EMS,FCAL,FTAB
      ,GTS
'VARI' TRTOT,TRTMN $ CRS : RTOT $ NREP
'FOR' YSET=VARIABLE(NUMVAR)
'CALC' GT=SUM(YSET) : OBS=CRS*NREP : CF=GT*GT/OBS : TOTSS=SUM(YSET*YSET)-CF
'FOR' I=1...NREP
'REST' YSET $ REP=I
'CALC' N=SUM(YSET)
'COPY' RTOT $ I=N
'REPE'
'REST' YSET
'FOR' J=1...CRS
'REST' YSET $ CROS=J
'CALC' N=SUM(YSET) : K=MEAN(YSET)
'COPY' TRTOT $ J=N : TRTMN $ J=K
'REPE'
'REST' YSET
'CALC' TSS=(SUM(TRTOT*TRTOT)/NREP)-CF : RSS=(SUM(RTOT*RTOT)/CRS)-CF
'CALC' ESS=TOTSS-TSS-RSS : TOTDF=OBS-1 : RDF=NREP-1 : TDF=CRS-1 :
EDF=RDF*TDF
'CALC' TMS=TSS/TDF : RMS=RSS/RDF : EMS=ESS/EDF : FCAL=TMS/EMS
'HEAD' H1=
'' SOURCE                DF                SS                MS          F
''
'HEAD' H2=''REPLICATION ''
'HEAD' H3=''TREATMENTS  ''
'HEAD' H4=''RESIDUAL    ''
'HEAD' H5=''TOTAL       ''
'LINE' 3
'PRINT' H1
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H2,RDF,RSS,RMS $ 0,15.0,19.3,17.3
'PRINT/C,LABR=1,LABC=1' H3,TDF,TSS,TMS,FCAL $ 0,16.0,19.3,17.3,12.3
'PRINT/C,LABR=1,LABC=1' H4,EDF,ESS,EMS $ 0,18.0,19.3,17.3
'PRINT/C,LABR=1,LABC=1' H5,TOTDF,TOTSS $ 0,21.0,19.3
'CALC' FTAB=FRATIO(0.05 ; TDF ; EDF)
'VARI' REPMN $ MF
'SCAL' K1,K2,K3 'CALC' K1=1 : K2=1 : K3=1
'SCAL' IJ,IK1,IK2,IK3
```

```
'FOR' I=1...DSIZE : J=1...DSIZE
'CALC' IJ=J+DSIZE*(I-1)
'JUMP' LB1*(I.EQ.J)
'JUMP' LB2*(I.LT.J)
'JUMP' LB3*(I.GT.J)
'LABE' LB1
'EQUA' IK1=K1
'COPY' REPMN $ IJ=TRTMN $ IK1
'CALC' K1=K1+DSIZE-I+1
'JUMP' LB4
'LABE' LB2
'CALC' IK2=K2+1
'COPY' REPMN $ IJ=TRTMN $ IK2
'CALC' K2=K2+1
'JUMP' LB4
'LABE' LB3
'CALC' IK3=K3+1
'COPY' REPMN $ IJ=TRTMN $ IK3
'CALC' K3=K3+DSIZE-J
'LABE' LB4
'REPE'
'CALC' K2=K2+1 : K3=I
'REPE'
'VARI' Y1,Y2,YII,YIDOT,REPMNS(1...DSIZE) $ DSIZE
'SYMM' MATREP $ DSIZE
'MATR' REPMNMA,YIIMAT,YIIMATS,YIIMA $ DSIZE,DSIZE
'EQUA' REPMNMA=REPMN
'CALC' MATREP=REPMNMA
'HEAD' H12=   MEAN DATA OVER REPLICATIONS
'LINE' 5
'PRINT' H12
'LINE' 2
'PRINT/LABR=1 LABC=1  MATREP $ 8.3
'DIAG' YIIS $ DSIZE
'CALC' YIIS=REPMNMA
'EQUA' YII=YIIS
'EQUA' REPMNS(1...DSIZE)=REPMNMA
'CALC' YIDOT=VSUM(REPMNS(1...DSIZE))
'CALC' Y1=YIDOT YII : Y2=YIDOT+YII
'EQUA' YIIMAT=Y2
'CALC' YIIMATS=TRANS(YIIMAT)
'CALC' YIIMA=YIIMAT+YIIMATS
'SCAL' GCASS,SCASS,EMSP,GCADF,SCADF,TGCA,TSCA
'CALC' GTS=GT/NREP
'CALC' GCASS=(SUM(Y2*Y2)-(4*GTS*GTS)/DSIZE)/(DSIZE+2)
'CALC' SCASS=SUM(TRTMN*TRTMN)-SUM(Y2*Y2)/(DSIZE+2)+(2*GTS*GTS)
       /((DSIZE+1)*(DSIZE+2))
'CALC  EMSP=EMS/NREP : GCADF=DSIZE-1 : SCADF=DSIZE*(DSIZE-1)/2
'SCAL  GCAMS,SCAMS,COMGCA,COMSCA,RGCASCA
'CALC  GCAMS=GCASS/GCADF : SCAMS=SCASS/SCADF
'CALC  COMGCA=(GCAMS-EMSP)/(DSIZE+2) : COMSCA=(SCAMS-EMSP)
  :    RGCASCA=COMGCA/COMSCA
  :    TGCA=GCAMS/EMSP : TSCA=SCAMS/EMSP
 HEAD' H6=
'' SOURCE                DF                    MS                F
```

```
VARCOM''
'HEAD' H7='' GCA       ''
'HEAD' H8='' SCA       ''
'HEAD' H9='' RESIDUAL ''
'HEAD' H10='' RATIO OF GCA VARIANCE TO SCA VARIANCE IS='' 
'PRINT' H6
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H7,GCADF,GCAMS,TGCA,COMGCA $ 0,21.0,20.3,19.3,11.3
'PRINT/C,LABR=1,LABC=1' H8,SCADF,SCAMS,TSCA,COMSCA $ 0,21.0,20.3,19.3,11.3
'PRINT/C,LABR=1,LABC=1' H4,EDF,EMSP $ 0,17.0,20.3
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H10,RGCASCA $ 0,10.4
'VARI' GCAE $ DSIZE
'MATR' SCAE,MAT $ DSIZE,DSIZE
'CALC' GCAE=(Y2-((2*GTS)/DSIZE))/(DSIZE+2)
'CALC' SCAE=REPMNMA-(YIIMA/(DSIZE+2))+((2*GTS)/((DSIZE+1)*(DSIZE+2)))
'DIAG' GCAMAT,DSCA $ DSIZE
'COPY' GCAMAT=GCAE
'CALC' MAT=0
'CALC' MAT=MAT+GCAMAT
'CALC' DSCA=SCAE
'CALC' SCAE=SCAE-DSCA
'CALC' SCAE=SCAE+MAT
'SYMM' GCASCAE $ DSIZE
'CALC' GCASCAE=SCAE
'HEAD' H11='' GCA EFFECTS (DIAGONAL) AND SCA EFFECTS (OFF DIAGONAL) ''
'PRINT' H11
'LINE' 1
'PRINT/LABR=1,LABC=1' GCASCAE $ 8.3
'SCAL' SEG,SES1,SEGG,SES2,SESS1,SESS2,SESS3
'CALC' SEG=SQRT((EMSP*(DSIZE-1))/(DSIZE*(DSIZE+2)))
'CALC' SES1=SQRT(((DSIZE*DSIZE+DSIZE+2)*EMSP)/((DSIZE+1)*(DSIZE+2)))
'CALC' SEGG=SQRT((2*EMSP)/(DSIZE+2))
'CALC' SES2=SQRT((DSIZE*EMSP*(DSIZE-1))/((DSIZE+1)*(DSIZE+2)))
'CALC' SESS1=SQRT((2*EMSP*(DSIZE-2))/(DSIZE+2))
'CALC' SESS2=SQRT((2*EMSP*(DSIZE+1))/(DSIZE+2))
'CALC' SESS3=SQRT((2*EMSP*DSIZE)/(DSIZE+2))
'HEAD' H13='' SE OF G(I)           ''
'HEAD' H14='' SE OF S(I,I)         ''
'HEAD' H15='' SE OF G(I)-G(J)      ''
'HEAD' H16='' SE OF S(I,J)         ''
'HEAD' H17='' SE OF S(I,I)-S(J,J) ''
'HEAD' H18='' SE OF S(I,J)-S(I,K) ''
'HEAD' H19='' SE OF S(I,J)-S(K,L) ''
'LINE' 3
'PRINT/C,LABR=1,LABC=1' H13,SEG $ 0,19.3
'PRINT/C,LABR=1,LABC=1' H14,SES1 $ 0,17.3
'PRINT/C,LABR=1,LABC=1' H15,SEGG $ 0,14.3
'PRINT/C,LABR=1,LABC=1' H16,SES2 $ 0,17.3
'PRINT/C,LABR=1,LABC=1' H17,SESS1 $ 0,10.3
'PRINT/C,LABR=1,LABC=1' H18,SESS2 $ 0,10.3
'PRINT/C,LABR=1,LABC=1' H19,SESS3 $ 0,10.3
''              MODEL II
'SCAL'
COMGCA2,COMSCA2,RGCASCA2,SIGA,SCAL1,SCAL2,SCAL3,SCAL4,SEVCSCA,SEVCGCA,
```

```
      SEVCR
'CALC' COMGCA2=(GCAMS-SCAMS)/(DSIZE+2)
'CALC' COMSCA2=(SCAMS-EMSP)
'CALC' RGCASCA2=COMGCA2/COMSCA2
'CALC' SCAL1=(2*GCAMS*GCAMS)/((DSIZE-1)*(DSIZE+2)*(DSIZE+2))
'CALC' SCAL2=(4*SCAMS*SCAMS)/(DSIZE*(DSIZE-1)*(DSIZE+2)*(DSIZE+2))
'CALC' SCAL3=(4*SCAMS*SCAMS)/(DSIZE*(DSIZE-1))
'CALC' SCAL4=(2*EMSP*EMSP)/EDF
'CALC' SEVCGCA=SQRT((SCAL1+SCAL2))
'CALC' SEVCSCA=SQRT((SCAL3+SCAL4))
'CALC' SEVCR=SQRT((2*EMSP*EMSP)/EDF)
'LINE' 3
'PRINT' H6
'LINE' 1
'CAPT' '' FOR MODEL II''
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H7,GCADF,GCAMS,TGCA,COMGCA2 $ 0,21.0,20.3,19.3,11.3
'PRINT/C,LABR=1,LABC=1' H8,SCADF,SCAMS,TSCA,COMSCA2 $ 0,21.0,20.3,19.3,11.3
'PRINT/C,LABR=1,LABC=1' H4,EDF,EMSP $ 0,17.0,20.3
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H10,RGCASCA2 $ 0,10.4
'CALC' SIGA=2*COMGCA2
'HEAD' H20='' SIGMA A '' : H21='' SIGMA D ''
'PRINT/C,LABR=1,LABC=1' H20,SIGA $ 0,10.4
'PRINT/C,LABR=1,LABC=1' H21,COMSCA2 $ 0,10.4
'HEAD' HHHH1='' SE OF VARCOM DUE TO GCA ''
'HEAD' HHHH2='' SE OF VARCOM DUE TO SCA ''
'HEAD' HHHH3='' SE OF VARCOM DUE TO RES ''
'PRINT/C,LABR=1,LABC=1' HHHH1,SEVCGCA $ 0,10.4
'PRINT/C,LABR=1,LABC=1' HHHH2,SEVCSCA $ 0,10.4
'PRINT/C,LABR=1,LABC=1' HHHH3,SEVCR $ 0,10.4
'DEVAL' GCAMAT,DSCA,MAT,DSCA,SCAE,GCASCAE
'REPE'
'R'
'CLOS'
'STOP'
```

Output from Diallel Analysis Griffing's method 2

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
VARIABLE(1)	40.64	90.66	142.84	144	0

SOURCE	DF	SS	MS	F
REPLICATION	3	867.750	289.250	
TREATMENTS	35	15473.125	442.089	0.865
RESIDUAL	105	53690.000	511.333	
TOTAL	143	70030.875		

MEAN DATA OVER REPLICATIONS

```
105.835
 92.960  99.395
 89.780 100.710 101.280
 93.680  94.005 109.805  81.210
 97.120 108.880 107.975  68.675  90.080
 89.590  91.105  99.365  81.465  85.630  81.695
 92.405  98.705 107.680  78.650  82.415  71.335  86.170
 89.540  89.150  82.385  82.760  89.965  84.160  74.900  83.415
```

SOURCE	DF	MS	F	VARCOM
GCA	7	303.471	2.374	17.564
SCA	28	62.284	0.487	-65.549
RESIDUAL	105	127.833		

RATIO OF GCA VARIANCE TO SCA VARIANCE IS= -0.2679

GCA EFFECTS (DIAGONAL) AND SCA EFFECTS (OFF DIAGONAL)

```
  4.078
 -7.614   5.834
-13.390  -4.216   8.429
  3.390   1.959  15.164  -4.451
  1.894  11.898   8.398 -18.022   0.485
 -0.158  -0.399   5.266   0.246  -0.525  -4.993
  1.418   5.962  12.342  -3.808  -4.979 -10.581  -3.754
  0.427  -1.719 -11.079   2.176   4.445   4.118  -6.381  -5.628
```

SE OF G(I)	3.344
SE OF S(I,I)	10.252
SE OF G(I)-G(J)	5.056
SE OF S(I,J)	8.919
SE OF S(I,I)-S(J,J)	12.385
SE OF S(I,J)-S(I,K)	15.169
SE OF S(I,J)-S(K,L)	14.302

FOR MODEL II

SOURCE	DF	MS	F	VARCOM
GCA	7	303.471	2.374	24.119
SCA	28	62.284	0.487	-65.549
RESIDUAL	105	127.833		

RATIO OF GCA VARIANCE TO SCA VARIANCE IS= -0.3679

SIGMA A	48.2375
SIGMA D	-65.5493
SE OF VARCOM DUE TO GCA	16.3064
SE OF VARCOM DUE TO SCA	24.2561
SE OF VARCOM DUE TO RES	17.6427

```
 191  'CLOS'
********* END OF DIALLEL2.  MAXIMUM OF 16604 DATA
  UNITS USED AT LINE 118 (311076 LEFT)
```

PROGRAM FOR GRIFFING'S APPROACH DIALLEL ANALYSIS
METHOD 3 - MODEL 1 AND 2

```
'REFE/NUMN=300,NID=300,PRINT=2' DIALLEL3
'UNITS' $ 224
'SCAL' NREP=4 : CRS=56 : DSIZE=8 'SCAL' MP,MPP
'SCAL' NV=1
'INTE' NUMVAR=1...NV
'FACT' CROS $ CRS=NREP!(1...CRS) : REP $ NREP=(1...NREP)CRS
'CALC' MP=DSIZE*DSIZE
'CALC' MPP=(DSIZE*(DSIZE+1))/2
'INPUT' 2
'READ' VARIABLE(NUMVAR)
'INPUT' 1
'R'
'SCAL'
GT,CF,OBS,TOTSS,TSS,RSS,N,K,TOTDF,RDF,TDF,EDF,ESS,TMS,RMS,EMS,FCAL,FTAB
      ,GTS
'VARI' TRTOT,TRTMN $ CRS : RTOT $ NREP
'FOR' VSET=VARIABLE(NUMVAR)
'CALC' GT=SUM(VSET) : OBS=CRS*NREP : CF=GT*GT/OBS : TOTSS=SUM(VSET*VSET)-CF
  :    GTS=GT/4
'FOR' I=1...NREP
'REST' VSET $ REP=I
'CALC' N=SUM(VSET)
'COPY' RTOT $ I=N
'REPE'
'REST' VSET
'FOR' J=1...CRS
'REST' VSET $ CROS=J
'CALC' N=SUM(VSET) : K=MEAN(VSET)
'COPY' TRTOT $ J=N : TRTMN $ J=K
'REPE'
'REST' VSET
'CALC' TSS=(SUM(TRTOT*TRTOT)/NREP)-CF : RSS=(SUM(RTOT*RTOT)/CRS)-CF
'CALC' ESS=TOTSS-TSS-RSS : TOTDF=OBS-1 : RDF=NREP-1 : TDF=CRS-1 :
EDF=RDF*TDF
'CALC' TMS=TSS/TDF : RMS=RSS/RDF : EMS=ESS/EDF : FCAL=TMS/EMS
'HEAD' H1=''
SOURCE                    DF                    SS                    MS
FR
''
'HEAD' H2=''REPLICATION  ''
'HEAD' H3=''TREATMENTS   ''
'HEAD' H4=''RESIDUAL     ''
'HEAD' H5=''TOTAL        ''
'LINE' 3
'PRINT' H1
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H2,RDF,RSS,RMS $ 0,14.0,22.3,21.3
'PRINT/C,LABR=1,LABC=1' H3,TDF,TSS,TMS,FCAL $ 0,15.0,22.3,21.3,12.3
'PRINT/C,LABR=1,LABC=1' H4,EDF,ESS,EMS $ 0,17.0,22.3,21.3
'PRINT/C,LABR=1,LABC=1' H5,TOTDF,TOTSS $ 0,20.0,22.3
'CALC' FTAB=FRATIO(0.05 : TDF : EDF)
```

```
'JUMP' LB10*(FCAL.LE.FTAB)
'VARI' REPMN $ MF
'VARI' MNREP $ MFF
'SCAL' K1 'CALC' K1=0
'SCAL' IJ,IK
'FOR' I=1...DSIZE : J=1...DSIZE
'CALC' IJ=J+DSIZE*(I-1)
'JUMP' LB1*(I.EQ.J)
'JUMP' LB2*(I.NE.J)
'LABE' LB1
'COPY' REPMN $ IJ=0
'JUMP' LB3
'LABE' LB2
'CALC' IK=K1+1
'COPY' REPMN $ IJ=TRTMN $ IK
'CALC' K1=K1+1
'LABE' LB3
'REPE'
'REPE'
'MATR' REPMNMA,MATREP1,MATREPS,MATREP,YIJDOTM1,YIJDOTM2,YIJDOTMA $
DSIZE,DSIZE
'SYMM' SYREPMN $ DSIZE
'EQUA' REPMNMA=REPMN
'CALC' MATREP1=TRANS(REPMNMA)
'CALC' MATREPS=REPMNMA+MATREP1
'CALC' MATREP=REPMNMA-MATREP1
'CALC' SYREPMN=MATREPS
'EQUA' MNREP=SYREPMN
'HEAD' H6='' MEAN DATA OVER REPLICATION ''
'PRINT' H6
'LINE' 1
'PRINT/LABR=1,LABC=1' REPMNMA $ 10.2
'VARI' REPMNS(1...DSIZE) $ DSIZE
'EQUA' REPMNS(1...DSIZE)=REPMNMA
'VARI' YIDOT,YJDOT,YIJDOT  $ DSIZE 'CALC' YIDOT=VSUM(REPMNS(1...DSIZE))
'SCAL' YJ(1...DSIZE) 'CALC' YJ(1...DSIZE)=SUM(REPMNS(1...DSIZE))
'EQUA' YJDOT=YJ(1...DSIZE)
'CALC' YIJDOT=YIDOT+YJDOT
'EQUA' YIJDOTM1=YIJDOT
'CALC' YIJDOTM2=TRANS(YIJDOTM1)
'CALC' YIJDOTMA=YIJDOTM1+YIJDOTM2
'SCAL'
SSGCA,SSSCA,SSREC,MGT,GCAMS,SCAMS,RECMS,EMSP,GCADF,SCADF,RECDF,COMGCA
       ,COMSCA,COMREC,TGCA,TSCA,TREC
'CALC' EMSP=EMS/NREP
'CALC' GCADF=DSIZE-1 : SCADF=(DSIZE*(DSIZE-3))/2 : RECDF=DSIZE*(DSIZE-1)/2
'CALC' MGT=SUM(YIDOT)
'CALC' SSGCA=SUM(YIJDOT*YIJDOT)/(2*(DSIZE-2))-((2*MGT*MGT)/(DSIZE*
        (DSIZE-2)))
'CALC' SSSCA=(SUM(MNREP*MNREP)/2)-(SUM(YIJDOT*YIJDOT)/(2*(DSIZE-2)))
            +((MGT*MGT)/((DSIZE-1)*(DSIZE-2)))
'CALC' SSREC=SUM(MATREP*MATREP)/4
'CALC' GCAMS=SSGCA/GCADF : SCAMS=SSSCA/SCADF : RECMS=SSREC/RECDF
'CALC' COMGCA=(GCAMS-EMSP)/(2*(DSIZE-2))
'CALC' COMSCA=(SCAMS-EMSP)/2
```

```
'CALC' COMREC=(RECMS-EMSP)/2
'CALC' TGCA=GCAMS/EMSP
'CALC' TSCA=SCAMS/EMSP
'CALC' TREC=RECMS/EMSP
'HEAD' H7=''
SOURCE                    DF                  MS                  E(MS)
FR
''
'HEAD' H8='' GCA          ''
'HEAD' H9='' SCA          ''
'HEAD' H10='' RECIPROCALS ''
'HEAD' H11='' RESIDUAL    ''
'PRINT' H7
'LINE' 1
'PRINT/C,LABR=1,LABC=1' H8,GCADF,GCAMS,COMGCA,TGCA $ 0,22.0,22.3,20.3,10.3
'PRINT/C,LABR=1,LABC=1' H9,SCADF,SCAMS,COMSCA,TSCA $ 0,22.0,22.3,20.3,10.3
'PRINT/C,LABR=1,LABC=1' H10,RECDF,RECMS,COMREC,TREC $ 0,15.0,22.3,20.3,10.3
'PRINT/C,LABR=1,LABC=1' H11,EDF,EMSP $ 0,18.0,22.3
'SCAL' RGCASCA
'CALC' RGCASCA=COMGCA/COMSCA
'HEAD' H12='' RATIO OF GCA VARIANCE TO SCA VARIANCE =''
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H12,RGCASCA $ 0,10.4
'VARI' GCAE $ DSIZE
'MATR' SCAE,RECE $ DSIZE,DSIZE
'CALC' GCAE=(DSIZE*YIJDOT-2*MGT)/(2*DSIZE*(DSIZE-2))
'CALC'
SCAE=(MATREPS/2)-(YIJDOTMA/(2*(DSIZE-2)))+(MGT/((DSIZE-1)*(DSIZE-2)))
'CALC' RECE=MATREP/2
'CALC' RECE=-RECE
'HEAD' H13='' GCA EFFECTS (DIAGONAL) SCA EFFECTS ( OFF DIOGONAL) ''
'HEAD' H14='' GCA EFFECTS (DIAGONAL) RECIPROCAL EFFECTS ( OFF DIOGONAL) ''
'DIAG' GCAM,DMAT $ DSIZE
'MATR' MAT $ DSIZE,DSIZE
'SYMM' SCAM,RECM $ DSIZE
'CALC' MAT=0
'COPY' GCAM=GCAE
'CALC' DMAT=SCAE
'CALC' SCAE=SCAE-DMAT
'CALC' MAT=MAT+GCAM
'CALC' RECE=RECE+MAT
'CALC' SCAE=SCAE+MAT
'CALC' SCAM=SCAE
'CALC' RECM=RECE
'LINE' 3
'PRINT' H13
'PRINT/LABR=1,LABC=1' SCAM $ 8.3
'LINE' 3
'PRINT' H14
'PRINT/LABR=1,LABC=1' RECM $ 8.3
'SCAL' SEG,SES,SER,SEG1,SES1,SES2
'CALC' SEG=SQRT(((DSIZE-1)*EMSP)/(2*DSIZE*(DSIZE-2)))
'CALC' SES=SQRT(((DSIZE-1)*EMSP)/(2*(DSIZE-1)))
'CALC' SER=SQRT(EMSP/2)
'CALC' SEG1=SQRT(EMSP/(DSIZE-2))
```

```
'CALC' SES1=SQRT(((DSIZE-3)*EMSP)/(DSIZE-2))
'CALC' SES2=SQRT(((DSIZE-4)*EMSP)/(DSIZE-2))
'HEAD' H15='' SE OF G(I) '' : H16='' SE OF S(I,I) '' : H17='' SE OF R(I,J)
''
   :   H18='' SE OF G(I)-G(J) ''  : H19='' SE OF S(I,J)-S(I,K) ''
   :   H20='' SE OF S(I,J)-S(K,L) ''
'PRINT/C,LABR=1,LABC=1' H15,SEG $ 0,19.3
'PRINT/C,LABR=1,LABC=1' H16,SES $ 0,17.3
'PRINT/C,LABR=1,LABC=1' H17,SER $ 0,17.3
'PRINT/C,LABR=1,LABC=1' H18,SEG1 $ 0,14.3
'PRINT/C,LABR=1,LABC=1' H19,SES1 $ 0,10.3
'PRINT/C,LABR=1,LABC=1' H20,SES2 $ 0,10.3
''              MODEL    II           ''
'SCAL' COMGCA1,COMSCA1,COMREC1,SIGMA,RGCASCA1
'CALC' COMGCA1=(GCAMS-SCAMS)/(2*(DSIZE-2)) : COMSCA1=(SCAMS-EMSP)/2
'CALC' COMREC1=(RECMS-EMSP)/2
'CALC' RGCASCA1=COMGCA1/COMSCA1
'PRINT' H7
'LINE' 1
'PRINT/C,LABR=1,LABC=1' H8,GCADF,GCAMS,COMGCA1,TGCA $ 0,22.0,22.3,20.3,10.3
'PRINT/C,LABR=1,LABC=1' H9,SCADF,SCAMS,COMSCA1,TSCA $ 0,22.0,22.3,20.3,10.3
'PRINT/C,LABR=1,LABC=1' H10,RECDF,RECMS,COMREC1,TREC $
0,15.0,22.3,20.3,10.3
'PRINT/C,LABR=1,LABC=1' H11,EDF,EMSP $ 0,18.0,22.3
'CALC' SIGMA=2*COMGCA1
'HEAD' H21='' SIGMA A '' : H22='' SIGMA D ''
'LINE' 1
'PRINT/C,LABR=1,LABC=1' H21,SIGMA  $ 0,10.3
'LINE' 1
'PRINT/C,LABC=1,LABR=1' H22,COMSCA1 $ 0,10.3
'LINE' 1
'PRINT/C,LABR=1,LABC=1' H12,RGCASCA1 $ 0,10.4
'LABE' LB10
'REPE'
'R'
'CLOS'
'STOP'
```

Output from Diallel Analysis Griffing's method 3

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
VARIABLE(1)	40.64	91.62	142.84	224	0

SOURCE	DF	SS	MS	FR
REPLICATION	3	907.125	302.375	
TREATMENTS	55	97256.250	1768.295	14.573
RESIDUAL	165	20021.500	121.342	
TOTAL	223	118184.875		

MEAN DATA OVER REPLICATION

0.00	87.01	90.50	114.94	120.29	68.55	107.64	52.64
80.69	0.00	111.58	88.17	99.93	73.27	97.64	85.65
102.23	104.56	0.00	100.65	94.29	100.89	111.54	117.74
119.11	89.31	102.68	0.00	85.29	105.80	64.45	46.86
111.29	102.89	88.26	83.39	0.00	84.15	81.94	94.82
68.83	71.29	99.58	108.67	87.97	0.00	121.61	53.74
109.26	87.82	108.44	57.65	78.75	115.67	0.00	125.27
48.72	83.15	115.40	46.74	93.32	60.24	118.17	0.00

SOURCE	DF	MS	E(MS)	FR
GCA	7	801.964	64.302	26.436
SCA	20	916.769	443.217	30.221
RECIPROCALS	28	13.034	-8.651	0.430
RESIDUAL	165	30.336		

RATIO OF GCA VARIANCE TO SCA VARIANCE = 0.1451

GCA EFFECTS (DIAGONAL) SCA EFFECTS (OFF DIOGONAL) .

-0.083							
-6.042	-1.648						
-8.972	4.291	13.799					
31.243	4.518	1.990	-5.753				
22.263	9.448	-16.134	-3.520	1.987			
-17.641	-12.488	0.014	26.567	-2.346	-5.207		
8.318	-5.839	-4.024	-33.415	-21.862	23.629	8.594	
-29.170	6.112	22.835	-27.383	12.150	-17.736	33.192	-11.690

GCA EFFECTS (DIAGONAL) RECIPROCAL EFFECTS (OFF DIOGONAL)

-0.083							
3.160	1.648						
-5.863	3.510	13.799					
-2.085	0.570	-1.015	-5.753				
4.500	-1 480	3.010	0.948	1.987			
-0.142	0.985	0.655	-1.435	-1.908	5.207		
-0.813	4.910	1.548	3.400	1.593	2.970	8.594	
1.960	1.252	1.167	0.058	0.750	3.250	3.550	-11.690

SE OF G(I)	1.487
SE OF S(I,I)	3.292
SE OF R(I,J)	3.895
SE OF G(I)-G(J)	2.249
SE OF S(I,J)-S(I,K)	5.028
SE OF S(I,J)-S(K,L)	4.497

SOURCE	DF	MS	E(MS)	FR
GCA	7	801.964	-9.567	26.436
SCA	20	916.769	443.217	30.221
RECIPROCALS	28	13.034	-8.651	0.430
RESIDUAL	165	30.336		

SIGMA A -19.134

SIGMA D 443.217

RATIO OF GCA VARIANCE TO SCA VARIANCE -0.0216

187 'CLOS'
******** END OF DIALLEL3. MAXIMUM OF 14910 DATA UNITS USED AT LINE 126 (312770 LEFT)

PROGRAM FOR GRIFFING'S APPROACH DIALLEL ANALYSIS
METHOD 4 - MODEL 1 AND 2

```
'REPE/NUMN=1000,NID=1000,PRINT=2' DIALLEL4
'UNITS' $ 112
'SCAL' CRS=28 : NREP=4 : DSIZE=8 'SCAL' MP
'SCAL' NV=1
'INTE' NUMVAR=1...NV
'FACT' CROS $ CRS=(1...CRS)NREP : REP $ NREP=CRS!(1...NREP)
'CALC' MP=DSIZE*DSIZE
'INPUT' 2
'READ/P' VARIABLE(NUMVAR)
'INPUT' 1
'R'
'SCAL'
GT,CF,OBS,TOTSS,TSS,RSS,N,K,TOTDF,RDF,TDF,EDF,ESS,TMS,RMS,EMS,FCAL,FTAB
      ,GTS
'VARI' TRTOT,TRTMN $ CRS : RTOT $ NREP
'FOR' VSET=VARIABLE(NUMVAR) ; SETNO=1...NV
'CALC' GT=SUM(VSET) : OBS=CRS*NREP : CF=GT*GT/OBS : TOTSS=SUM(VSET*VSET)-CF
'FOR' I=1...NREP
'REST' VSET $ REP=I
'CALC' N=SUM(VSET)
'COPY' RTOT $ I=N
'REPE'
'REST' VSET
'FOR' J=1...CRS
'REST' VSET $ CROS=J
'CALC' N=SUM(VSET) : K=MEAN(VSET)
'COPY' TRTOT $ J=N : TRTMN $ J=K
'REPE'
'REST' VSET
'CALC' TSS=(SUM(TRTOT*TRTOT)/NREP)-CF : RSS=(SUM(RTOT*RTOT)/CRS)-CF
'CALC' ESS=TOTSS-TSS-RSS : TOTDF=OBS-1 : RDF=NREP-1 : TDF=CRS-1 :
EDF=RDF*TDF
'CALC' TMS=TSS/TDF : RMS=RSS/RDF : EMS=ESS/EDF : FCAL=TMS/EMS
'HEAD' VARNO='' * * * ANALYSIS FOR THE VARIABLE * * * ''
'HEAD' H1=''
SOURCE              DF                    SS                    MS
FR
''
'HEAD' H2=''REPLICATION ''
'HEAD' H3=''TREATMENTS  ''
'HEAD' H4=''RESIDUAL    ''
'HEAD' H5=''TOTAL       ''
'LINE' 2
'PRINT/C' VARNO,SETNO $ 0,5.0
'LINE' 3
'PRINT' H1
'LINE' 1
'PRINT/C,LABR=1,LABC=1' H2,RDF,RSS,RMS $ 0,12.0,22.3,22.3
'PRINT/C,LABR=1,LABC=1' H3,TDF,TSS,TMS,FCAL $ 0,13.0,22.3,22.3,12.3
'PRINT/C,LABR=1,LABC=1' H4,EDF,ESS,EMS $ 0,15.0,22.3,22.3
'PRINT/C,LABR=1,LABC=1' H5,TOTDF,TOTSS $ 0,18.0,22.3
```

```
'CALC' FTAB=FRATIO(0.05 ; TDF ; EDF)
'VARI' REPMN $ MF
'SCAL' K2,K3 'CALC' K2=0 : K3=0
'SCAL' IJ,IK2,IK3
'FOR' I=1...DSIZE : J=1...DSIZE
'CALC' IJ=J+DSIZE*(I-1)
'JUMP' LB1*(I.EQ.J)
'JUMP' LB2*(I.LT.J)
'JUMP' LB3*(I.GT.J)
'LABE' LB1
'COPY' REPMN $ IJ=0
'JUMP' LB4
'LABE' LB2
'CALC' IK2=K2+1
'COPY' REPMN $ IJ=TRTMN $ IK2
'CALC' K2=K2+1
'JUMP' LB4
'LABE' LB3
'CALC' IK3=K3+1
'COPY' REPMN $ IJ=TRTMN $ IK3
'CALC' K3=K3+DSIZE-J-1
'LABE' LB4
'REPE'
'CALC' K2=K2 : K3=I-1
'REPE'
'VARI' REPMNS(1...DSIZE) $ DSIZE
'SYMM' MATREP $ DSIZE
'MATR' SCAE,REPMNMA,YIIMAT,YIIMATS,YIIMA,MAT $ DSIZE,DSIZE
'CALC' MAT=0
'EQUA' REPMNMA=REPMN
'CALC' MATREP=REPMNMA
'VARI' GCAE,TREPMN,REPMNS(1...DSIZE) $ DSIZE
'EQUA' REPMNS(1...DSIZE)=REPMNMA
'CALC' TREPMN=VSUM(REPMNS(1...DSIZE))
'EQUA' YIIMAT=TREPMN
'CALC' YIIMATS=TRANS(YIIMAT)
'CALC' YIIMA=YIIMAT+YIIMATS
'HEAD' H21='' MEAN DATA OVER REPLICATIONS
'LINE' 3
'PRINT' H21
'LINE' 1
'PRINT/LABR=1,LABC=1' MATREP $ 8.3
'SCAL' SSGCA,SSSCA,MGT,GCAMS,SCAMS,EMSP,GCADF,SCADF,COMGCA,COMSCA,TGCA,TSCA
       ,RGCASCA
'CALC' MGT=SUM(REPMN)/2
'CALC' SSGCA=(SUM(TREPMN*TREPMN)/(DSIZE-2))
-((4*MGT*MGT)/(DSIZE*(DSIZE-2)))
'CALC' SSSCA=SUM(TRTMN*TRTMN)-(SUM(TREPMN*TREPMN)/(DSIZE-2))+((2*MGT*MGT)
            /((DSIZE-1)*(DSIZE-2)))
'CALC' GCADF=DSIZE-1 : SCADF=DSIZE*(DSIZE-3)/2
'CALC' GCAMS=SSGCA/GCADF : SCAMS=SSSCA/SCADF : EMSP=EMS/NREP
'CALC' TGCA=GCAMS/EMSP : TSCA=SCAMS/EMSP
'CALC' COMGCA=(GCAMS-EMSP)/(DSIZE-2)
'CALC' COMSCA=(SCAMS-EMSP)
'CALC' RGCASCA=COMGCA/COMSCA
```

```
'HEAD' H6='' 
SOURCE                DF                    MS                F
VARCOM
''
'HEAD' H7='' GCA  ''
'HEAD' H8='' SCA  ''
'HEAD' H9='' RESIDUAL ''
'LINE' 2
'PRINT' H6
'LINE' 1
'PRINT/C,LABC=1,LABR=1' H7,GCADF,GCAMS,TGCA,COMGCA $ 0,20.0,22.3,18.3,12.3
'PRINT/C,LABC=1,LABR=1' H8,SCADF,SCAMS,TSCA,COMSCA $ 0,20.0,22.3,18.3,12.3
'PRINT/C,LABC=1,LABR=1' H9,EDF,EMSP $ 0,15.0,22.3
'HEAD' H10='' RATIO OF GCA VARIANCE TO SCA VARIANCE  ''
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H10,RGCASCA $ 0,10.4
'LINE' 2
'CALC' GCAE=((TREPMN*DSIZE)-(2*MGT))/(DSIZE*(DSIZE-2))
'DIAG' GCAM,DMAT $ DSIZE
'COPY' GCAM=GCAE
'CALC' SCAE=REPMNMA-(YIIMA/(DSIZE-2))+((2*MGT)/((DSIZE-1)*(DSIZE-2)))
'CALC' DMAT=SCAE
'CALC' SCAE=SCAE-DMAT
'CALC' MAT=MAT+GCAM
'CALC' SCAE=SCAE+MAT
'SYMM' SCAM $ DSIZE
'CALC' SCAM=SCAE
'HEAD' H11='' GCA EFFECTS (DIAGONAL) SCA EFFECTS (OFF DIAGONAL) ''
'LINE' 2
'PRINT' H11
'LINE' 1
'PRINT/LABC=1,LABR=1' SCAM $ 8.3
'SCAL' SEG,SES,SEG1,SES1,SES2
'CALC' SEG=SQRT(((DSIZE-1)*EMSP)/(DSIZE*(DSIZE-2)))
'CALC' SES=SQRT(((DSIZE 3)*EMSP)/(DSIZE-1))
'CALC' SEG1=SQRT((2*EMSP)/(DSIZE-2))
'CALC' SES1=SQRT((2*(DSIZE 3)*EMSP)/(DSIZE 2))
'CALC' SES2=SQRT((2*(DSIZE 4)*EMSP)/(DSIZE-2))
'HEAD' H12='' SE OF G(I) '' : H13='' SE OF S(I,J) ''
'HEAD' H14='' SE OF G(I)-G(J) '' : H15='' SE OF S(I,J)-S(I,K) ''
'HEAD' H16='' SE OF S(I,J)-S(K,L) ''
'PRINT/C,LABR=1,LABC=1' H12,SEG $ 0,19.4
'PRINT/C,LABR=1,LABC=1' H13,SES $ 0,17.4
'PRINT/C,LABR=1,LABC=1' H13,SEG1 $ 0,17.4
'PRINT/C,LABR=1,LABC=1' H14,SES1 $ 0,14.4
'PRINT/C,LABR=1,LABC=1' H16,SES2 $ 0,10.4
''                    MODEL II
'SCAL' COMGCA1,COMSCA1,RGCASCA1,TGCA1,TGCA2,SIGMA,VCOMGCA1,VCOMSCA1,VEMSP,
       SECOMG,SECOMS,SEMSP,SCAL1,SCAL2
'CALC' COMGCA1=(GCAMS-SCAMS)/(DSIZE-2)
'CALC' COMSCA1=(SCAMS-EMSP)
'CALC' RGCASCA1=COMGCA1/COMSCA1
'CALC' SIGMA=2*COMGCA1
'CALC' SCAL1=((2*GCAMS*GCAMS)/((DSIZE-1)*(DSIZE-2)*(DSIZE-2)))
'CALC' SCAL2=((4*SCAMS*SCAMS)/(DSIZE*(DSIZE-2)*(DSIZE-2)*(DSIZE-3)))
```

```
'CALC' VCOMGCA1=SCAL1+SCAL2
'CALC' VCOMSCA1=((4*SCAMS*SCAMS)/(DSIZE*(DSIZE-3)))+(2*EMSP*EMSP)/EDF
'CALC' VEMSP=(2*EMSP*EMSP)/EDF
'CALC' SECOMG=SQRT(VCOMGCA1) : SECOMS=SQRT(VCOMSCA1) : SEMSP=SQRT(VEMSP)
'HEAD' SCOMGH='' SE OF VARIANCE COMPONENTS OF G ''
'HEAD' SCOMSH='' SE OF VARIANCE COMPONENTS OF S ''
'HEAD' SCOMEH='' SE OF VARINACE COMPONENTS OF E ''
'LINE' 3
'CAPT' '' * * * ANALYSIS FOR MODEL II * * * ''
'LINE' 2
'PRINT' H6
'LINE' 1
'PRINT/C,LABC=1,LABR=1' H7,GCADF,GCAMS,TGCA,COMGCA1 $ 0,20.0,22.3,18.3,12.3
'PRINT/C,LABC=1,LABR=1' H8,SCADF,SCAMS,TSCA,COMSCA1 $ 0,20.0,22.3,18.3,12.3
'PRINT/C,LABC=1,LABR=1' H9,EDF,EMSP $ 0,15.0,22.3
'LINE' 2
'PRINT/C,LABR=1,LABC=1' H10,RGCASCA1 $ 0,10.4
'LINE' 2
'HEAD' H17='' SIGMA A '' : H18='' SIGMA D ''
'PRINT/C,LABC=1,LABR=1' H17,SIGMA $ 0,10.4
'LINE' 2
'PRINT/C,LABC=1,LABR=1' H18,COMSCA1 $ 0,10.4
'LINE' 2
'PRINT/C,LABR=1' SCOMGH,SECOMG $ 0,10.4
'PRINT/C,LABR=1' SCOMSH,SECOMS $ 0,10.4
'PRINT/C,LABR=1' SCOMEH,SEMSP $ 0,10.4
'REPE'
'R'
'CLOS'
'STOP'
```

output from Diallel Analysis Griffing's method 4

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
VARIABLE(1)	40.64	92.39	142.84	112	0

* * * ANALYSIS FOR THE VARIABLE * * * 1

SOURCE	DF	SS	MS	FR
REPLICATION	3	1545.875	515.292	
TREATMENTS	27	8268.000	306.222	0.491
RESIDUAL	81	50555.250	624.139	
TOTAL	111	60369.125		

MEAN DATA OVER REPLICATIONS

0.000							
87.390	0.000						
92.615	91.500	0.000					
77.020	104.545	99.030	0.000				
82.700	102.725	99.775	88.790	0.000			
104.835	96.450	111.375	92.250	83.160	0.000		
82.425	104.630	96.315	86.740	94.635	93.105	0.000	
84.950	95.930	95.730	88.290	82.300	90.150	77.450	0.000

SOURCE	DF	MS	F	VARCOM
GCA	7	145.813	0.934	-1.704
SCA	20	52.316	0.335	-103.719
RESIDUAL	81	156.035		

RATIO OF GCA VARIANCE TO SCA VARIANCE 0.0164

GCA EFFECTS (DIAGONAL) SCA EFFECTS (OFF DIAGONAL)

-5.795							
-5.279	6.078						
-0.583	-13.570	6.606					
-7.899	7.754	1.711	-1.673				
-1.789	6.364	2.886	0.180	-2.103			
14.140	-6.118	8.279	-2.567	-11.227	4.104		
-2.266	8.066	-0.777	-2.073	6.252	-1.484	-1.900	
3.676	2.783	2.055	2.894	-2.666	-1.023	-7.719	-5.317

SE OF G(I)	4.7702
SE OF S(I,J)	10.5571
SE OF S(I,J)	7.2119
SE OF G(I)-G(J)	16.1263
SE OF S(I,J)-S(K,L)	14.4238

* * * ANALYSIS FOR MODEL II * * *

SOURCE	DF	MS	F	VARCOM
GCA	7	145.813	0.934	15.583
SCA	20	52.316	0.335	-103.719
RESIDUAL	81	156.035		

RATIO OF GCA VARIANCE TO SCA VARIANCE -0.1502

SIGMA A 31.1656

SIGMA D -103.7191

SE OF VARIANCE COMPONENTS OF G	13.2794
SE OF VARIANCE COMPONENTS OF S	29.5778
SE OF VARIANCE COMPONENTS OF E	24.5185

185 'CLOSE'
******** END OF DIALLEL4. MAXIMUM OF 15258 DATA UNITS USED AT LINE 122 (312422 LEFT)

PROGRAM FOR HAYMAN'S APPROACH DIALLEL ANALYSIS

```
'REPE/NUNN=500,NID=500' DIALLEL
'UNIT' $ 200
'SCAL' NREP=2: DSIZE=10
'FACT' REP $ NREP
'FACT' MALE $ 10 : FEMALE $ 10
'INPU/RECL=132' 2
'READ' FEMALE,MALE,REP,VV(1...14)
'SCAL' TVAL,MF,NN,CF,ESS,REPSS,TSS,TOTSS,RMS,TMS,EMS,REPF,TFF
'CALC' MF=DSIZE*DSIZE
'INPU' 1
'RUN'
'VARI' REPTOT $ NREP
'SET' YSET=VV(1)
'FOR' I=1...NREP
'REST' YSET $ REP=I
'CALC' NN=SUM(YSET)
'COPY' REPTOT $ I=NN
'REPE'
'REST' YSET
'VARI' MFTOT1,MFTOT $ MF
'FOR' I=1...DSIZE : J=1...DSIZE
'REST' YSET $ MALE,FEMALE=I,J
'SCAL' IJ,JJ
'CALC' IJ=J+DSIZE*(I 1)
'CALC' JJ=SUM(YSET)
'COPY' MFTOT $IJ=JJ
'REPE' :
'REST' YSET
'CALC' CF=SUM(REPTOT) :  CF=(CF*CF)/(NREP*MF) :TOTSS=SUM(YSET*YSET)
'CALC' TOTSS=TOTSS-CF : REPTOT=REPTOT*REPTOT
'CALC' REPSS=(SUM(REPTOT)/MF)-CF : MFTOT1=MFTOT*MFTOT
'CALC' TSS=(SUM(MFTOT1)/NREP)-CF   : ESS=TOTSS-TSS-REPSS : TVAL=NVAL(YSET)
'CALC' TVAL=TVAL-1: RDF=NREP-1:TDF=MF-1: EDF=TVAL-RDF-TDF
'CALC' RMS=REPSS/RDF : TMS=TSS/TDF : EMS=ESS/EDF :REPF=RMS/EMS :
TFF=TMS/EMS
'OUTP' 2
'CAPT'
'' *** ANALYSIS OF VARIANCE ***
 SOURCE                D.F.          S.S.          M.S.          F
'HEAD' TITLE1='' REPLICATION '' :TITLE2='' TREATMENT ''
'HEAD' TITLE3='' ERROR '' : TITLE4='' TOTAL ''
'PRIN/C,LABR=1,LABC=1' TITLE1,RDF,REPSS,RMS,REPF $ 0,15,(15.4)3
'PRIN/C,LABC=1,LABR=1' TITLE2,TDF,TSS,TMS,TFF $ 0,17,3(15.4)
'PRIN/C,LABC=1,LABR=1' TITLE3,EDF,ESS,EMS $ 0,21,3(15.4)
'PRIN/C,LABC=1,LABR=1' TITLE4,TVAL,TOTSS $ 0,21,15.4  'LINE' 1
''
            FULL DIALLEL PROGRAM STARTS FROM HERE
''
'SCAL' WR(1...DSIZE),PRT(1...DSIZE),WR1M,VWR,VVR,COVWV,CC,MDD,GEF,PDR,MFR,

GGN,COR2,COR2SQ,DD,FF,H1H,H2H,DOM2,E2,ERROR,D,F,HH1,HH2,DOMEPF,N2,N3,
```

```
N4,N5,SED,SEF,SEH1,SEH2,SEDOM,SEE,HERIT,VD VR1 VA1 VD T1,T2 TT,YD,YRR,
       GTOTAL,PRM,GM,TDF,EDF,RDF
'MATRI' X3,X1,X2 $ DSIZE,DSIZE
'EQUA' X1=MFTOT
'CALC' X2=TRANS(X1) : X3=(X1+X2)/(2*NREP)
'DIAGMAT' PR $ DSIZE
'CALC' PR=X1/NREP
'VARI' VM,MVA,PRT,PARENTS,P(1...DSIZE) $ DSIZE
'EQUA' P(1...DSIZE)=X3    'SYMM' MEANS $ DSIZE
'CALC' MEANS=X3  'EQUA' PARENTS=PR
''
          Estimation of Variances and Covariances
                    of parents and arrays
''
'SCAL' PRS 'CALC' PRS=SUM(PARENTS)
'SCAL' PRV,VR(1...DSIZE) 'CALC' PRV,VR(1...DSIZE)=VAR(PARENTS,P(1...DSIZE))
'SCAL' PRTOT(1...DSIZE) 'CALC' PRTOT(1...DSIZE)=SUM(P(1...DSIZE))
'SCAL' PRMN(1...DSIZE)  'CALC' PRMN(1...DSIZE)=MEAN(P(1...DSIZE))
'EQUA' PRT=PRTOT(1...DSIZE)
'CALC' GTOTAL=SUM(PRT)  : PRM=MEAN(PARENTS)
'CALC' GM=GTOTAL/DSIZE 'EQUA' VM=PRMN(1...DSIZE) : MVA=VR(1...DSIZE)
'HEAD' H1='' *** MEAN DATA OVER REPLICATIONS AND RECIPROCALS ***  ''
'HEAD' H2='' TOTAL'' : H3='' MEAN '' :H4='' PARENTAL MEAN''
'HEAD' H5='' VARIANCE OF PARENTS''
'PRIN' H1
'PRIN/LHM=5,LABC=1' MEANS $ 10.3    'LINE' 1
'PRIN/C,LABR=1,LABC=1' H2,PRTOT(1...DSIZE) $ 0,13.3,(10.3)DSIZE
'PRIN/C,LABR=1,LABC=1' H3,PRMN(1...DSIZE) $  0,14.3,(10.3)DSIZE  'LINE' 1
'PRIN/C,LABR=1,LABC 1' H4,PRM $ 0,20.3
'PRIN/C,LABR=1,LABC=1' H5,PRV $ 0,20.3
''
             variance of the mean arrays
''
'SCAL' VMA    'CALC' VMA=VAR(VM) 'SCAL' MVA1    'CALC' MVA1=MEAN(MVA)
''
          Covariance between parents and off-spring = Wr.
''
'VARI' FR,WRVR1,WRVR2,WR,W1(1...DSIZE),FITTED,WRI $ DSIZE
'CALC' W1(1...DSIZE)=P(1...DSIZE)*PARENTS
'CALC' PRT(1...DSIZE)=(PRTOT(1...DSIZE)*PRS)/DSIZE
'CALC' WR(1...DSIZE) (SUM(W1(1...DSIZE)) PRT(1...DSIZE))/(DSIZE-1)
'EQUA' WR=WR(1...DSIZE) 'CALC' : WRVR1=WR+MVA : WRVR2=WR-MVA  :
WR1M=MEAN(WR)
'VARI' ARRAY $ DSIZE-1...DSIZE
'HEAD' H6=
''
** ARRAY VARIANCES AND COVARIANCES **
------ ----       .       --  ---  ----  ---------------
ARRAY      WR         VR         WR VR     WR+VR        YR
----------                        -       . --  ---------------''
'HEAD' H66=
''
----------                  .      --  ----------------------''
'PRIN' H6
'PRIN/P,LABR=1.LABC=1' ARRAY,WR,MVA,WRVR2,WRVR1,PARENTS $ 5,(10.3)5
```

```
'PRIN/C,LABR=1,LABC=1' H3,VR1M,MVA1,PRM $ 0,10.3,10.3,30.3
'PRIN' H66
''
        Difference between the mean of parents and the mean of their
                                    nxn progeny
''
'SCAL' MLO  'CALC' MLO=((GM-PRS)/DSIZE)*((GM-PRS)/DSIZE)
''
                        TESTING THE VALIDITY OF HYPOTHESIS
''
'CALC' VVR=VAR(VR) : VVR=VAR(MVA) :
COVVV=(SUM(VR*MVA)-(MVA1*VR1M))/(DSIZE-1)
''
                               VR-VR GRAPH
''
'HEAD' HX='' VR '' : HY=''VR'' : HH=''SP''
''
             CALCULATION OF INTERCEPT
''
'HEAD' H7='' INTERCEPT VALUE  A= ''
'SCAL' B,INTCPT
'TERMS' VR,MVA
'Y' VR
'FIT' MVA; COEF=CC1; FVAL=FITTED
'COPY' INTCPT = CC1 $ 1 : B =CC1 $ 2
'GRAPH/ATX=HX,ATY=HY' FITTED,VR;MVA $ HH
'CAPT'
 ''
*** ESTIMATION OF COMPONENTS OF VARIATION ***
''
'HEAD' H8='' EXPECTED ENVIRONMENTAL COMPONENT OF VARIATON (E) = ''
'HEAD' H9='' VARIATION DUE TO ADDITIVE EFFECT (D) = ''
'HEAD' H10='' MEAN OF 'FR' OVER ARRAYS (F) = ''
'HEAD' H11='' COMPONENT OF VARIATION DUE TO DOMINANCE EFF. OF GENES ='
'HEAD' H12='' DOMINANCE EFFECT (h2) =  ''
'CALC' ERROR=((ESS+REPSS)/(EDF+RDF))/NREP
'CALC' D=PRV-ERROR : F=(2*PRV)-(4*VR1M)-(2*(DSIZE-2)*ERROR/DSIZE)
'CALC' HH1=PRV-(4*VR1M)+(4*MVA1)-((3*DSIZE-2)*ERROR/DSIZE)
'CALC' HH2=(4*MVA1)-(4*VMA)-(2*ERROR)
'CALC' DOMEFF=(4*MLO)-(4*DSIZE-1)*ERROR/(DSIZE*DSIZE)
'PRIN/C,LABR=1,LABC=1' H8,ERROR $ 0,20.3 : H9,D $ 0,20.3 :H10,F $ 0,20.3
'PRIN/C' H11,HH1 $ 6.3 : H11,HH2 $ 6.3
'PRIN/C,LABC=1,LABR=1' H12,DOMEFF $ 0,8.3 'LINE' 1
''
          CALCULATION OF STANDARD ERRORS FOR TESTING COMPONENTS
                                OF VARIATION
''
'SCAL' COMLTPL 'CALC' COMLTPL=(VAR(VRVR2))/2
''
                CALCULATION OF SPECIFIC MULTIPLIERS
''
'CALC' N2=DSIZE*DSIZE: N3=DSIZE*DSIZE*DSIZE: N4=N2*N2 : N5=N4*DSIZE
'CALC' DD=(N5+N4)/N5 : FF=((4*N5)+(20*N4)-(16*N3)+(16*N2))/N5
'CALC' H1H=(N5+(41*N4)-(12*N3)+(4*N2))/N5 : E2=N4/N5
'CALC' H2H=(36*N4)/N5 : DOM2=((16*N4)+(16*N2)-(32*DSIZE)+16)/N5
```

```
'CALC' SED=SQRT(DD*COMLTPL) : SEP=SQRT(PP*COMLTPL)
'CALC' SEH1=SQRT(H1H*COMLTPL) : SEH2=SQRT(H2H*COMLTPL)
'CALC' SEDOM=SQRT(DOM2*COMLTPL) : SEE=SQRT(E2*COMLTPL)
'HEAD' HEAD2='' SE(D) = '' :HEAD3='' SE(P) = '' : HEAD4='' SE(H1) ='
'HEAD' HEAD5='' SE(H2) = '':HEAD6='' SE(DOMEPP) = ''
'HEAD' HEAD7='' SE(E) = ''   'LINE' 1
'CAPT'
''*** STANDARD ERRORS OF DIFFERENT PARAMETERS *** ''  'LINE' 1
'PRIN/C,LABR=1,LABC=1' HEAD2,SED $ 0,10.3 : HEAD3,SEP $ 0,10.3
'PRIN/C,LABR=1,LABC=1' HEAD4,SEH1 $ 0,10.3: HEAD5,SEH2 $ 0,10.3
'PRIN/C,LABR=1,LABC=1' HEAD6,SEDOM $ 0,10.3 :HEAD7,SEE $ 0,10.3  'LINE' 1
'HEAD' HZ1=''MEAN DEGREE OF DOMINANCE = ''
'HEAD' HZ2=''PROPORTIONOF GENES WITH + AND - EFFECTS IN THE PARENTS = ''
'HEAD' HZ3=''PROPORTION OF DOMINANT AND RECESSIVE GENES IN PARENTS = ''
'HEAD' HZ4=
''COEFFICINT OF CORRELATION (SMALL R) BETWEEN
  THE PARENTAL ORDER OF DOMINANCE (VR+VR) AND
  PARENTAL MEASUREMENT YR = ''
'HEAD' HZ5=''PREDICTION FOR MEASUREMENT OF DOMINANT AND RECESSIVE PARENTS =
''
'HEAD' HZ6=''NO. OF GROUPS OF GENES WHICH CONTROL THE CHARACTER AND
           EXHIBIT THE DOMINANCE = ''
'HEAD' HZ7=''THE COVARIANCE OF ADDITIVE  DOMINANCE EFFECTS IN A SINGLE
ARRAY''
'HEAD' HZ8='' MEAN OF FR '' :HZ9='' HERITABILITY ''
'CALC' MDD=SQRT(HH1/D) : GEP=HH2/(4*HH1)
'CALC' PDR=(SQRT(4*D*HH1)+F)/(SQRT(4*D*HH1)-F)
'SYMM' COR1 $ 2  'DSSP' COR $ VRVR1,PARENTS
'SSP/PRINT=Z' COR
'CALC' COR1=CORMAT(COR)  'EQUA' COR2=COR1 $ X,1,2X
'CALC' COR2SQ=COR2*COR2
'CALC' FR=2*(PRV-VR1M+MVA1-VRVR1)-2*(DSIZE-2)*(ERROR/DSIZE)
'CALC' MFR=MEAN(FR) : GGN=DOMEFF/HH2  'LINE' 1
'PRIN/C,LABR=1,LABC=1' HZ1,MDD $ 0,5.3 : HZ2,GEF $ 0,5.3
'PRIN/C,LABR=1,LABC=1' HZ3,PDR $ 0,5.3  'LINE'1
'PRIN/C,LABR=1,LABC=1' HZ4,COR2 $0,5.3  'LINE' 1
'PRIN/C,LABR=1,LABC=1' HZ5,COR2SQ $0,5.3 : HZ6,GGN $ 0,5.3 : HZ7
'PRIN/C,LABR=1,LABC=1' FR $ 10.3 : HZ8,MFR $ 0,8.3  'LINE' 1
''
                CALCULATION OF HERITABILITY
''
'CALC' HERIT=(D/4)/((D/4)+(HH1/16)-(F/8)+ERROR)
'PRIN/C,LABR=1,LABC=1' HZ9,HERIT $ 0,8.3
'CAPT'
''
** ESTIMATION OF MOST DOMINANT AND RECESSIVE PARENT **
''
'CALC' TT=(PRV+SQRT((PRV*PRV)-(4*PRV*(VR1M-MVA1))))/(2*PRV)
'CALC' T1=TT-1 : T2=1-T1
'CALC' VD=PRV*(T2*T2) : WD=PRV*T2 : VR1=PRV*(T1*T1)
'CALC' VA1=PRV*T1 : YD=PRM+B*((WD+VD)-(VR1M+MVA1))
'CALC' YRR=PRM+B*((VA1+VR1)-(VR1M+MVA1))
'HEAD' HL1='' VALUE OF COMPLETELY DOMINANT PARENT YD = ''
'HEAD' HL2='' VALUE OF COMPLETELY RECESSIVE PARENT YR = ''
'PRIN/C,LABR=1,LABC=1' HL1,YD $ 0,10.3 : HL2,YRR $ 0,10.3
'RUN'
'CLOSE'
'STOP'
```

RESULTS FOR HAYMAN'S APPROACH DIALLEL ANALYSIS

*** ANALYSIS OF VARIANCE ***

SOURCE	D.F.	S.S.	M.S.	F
REPLICATION	3	1037.0000	345.6667	3.0026
TREATMENT	63	104925.0000	1665.4762	14.4668
ERROR	189	21758.5000	115.1243	
TOTAL	255	127720.5000		

*** MEAN DATA OVER REPLICATIONS AND RECIPROCALS ***

1	85.645							
2	83.850	98.260						
3	96.368	108.065	74.070					
4	117.030	88.740	101.660	91.640				
5	115.790	101.410	91.275	84.338	54.100			
6	68.693	72.280	100.230	107.230	86.058	100.390		
7	108.453	92.730	109.993	61.050	80.343	118.640	90.960	
8	50.680	84.398	116.568	46.798	94.070	56.990	121.720	82.000
	726.508	729.733	798.227	698.485	707.383	710.510	783.888	653.223
	90.813	91.217	99.778	87.311	88.423	88.814	97.986	81.653

PARENTAL MEAN 84.633
VARIANCE OF PARENTS 224.986

** ARRAY VARIANCES AND COVARIANCES **

ARRAY	WR	VR	WR-VR	WR+VR	YR
1	-124.142	546.907	-671.049	422.766	85.645
2	-98.412	129.310	227.722	30.897	98.260
3	97.340	171.925	-74.585	269.266	74.070
4	39.070	549.498	-510.428	588.568	91.640
5	155.804	317.612	161.809	473.416	54.100
6	43.122	455.954	-412.833	499.076	100.390
7	44.363	428.021	383.658	472.384	90.960
8	-160.305	824.103	984.408	663.797	82.000
MEAN	-0.395	427.916			84.633

***** REGRESSION ANALYSIS *****

Y-VARIATE: WR

*** REGRESSION COEFFICIENTS ***

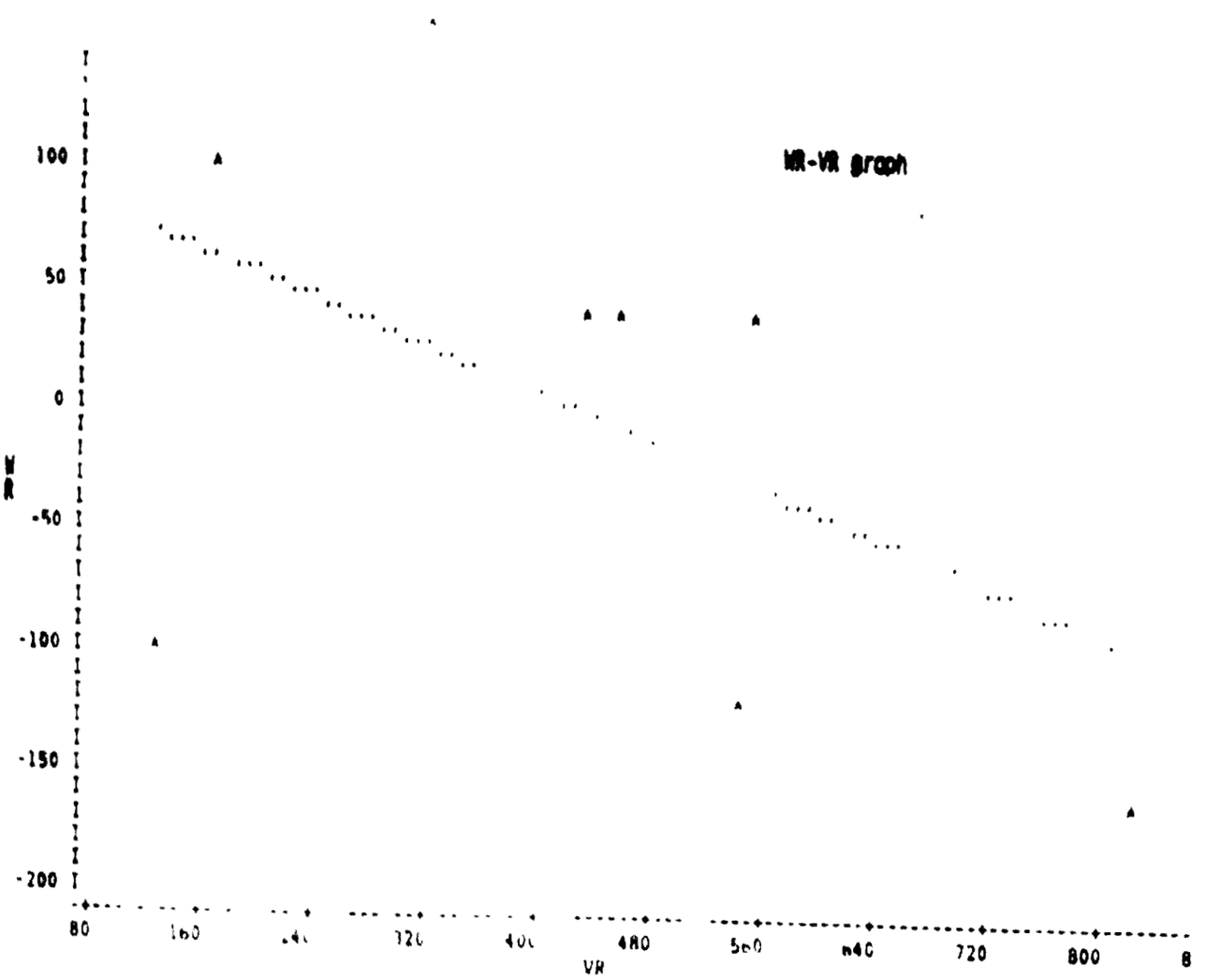
	ESTIMATE	S.E.	T
CONSTANT	102.5	86.3	1.19

MVA	-0.241	0.181	-1.33

*** ANALYSIS OF VARIANCE ***

	DF	SS	MS
REGRESSN	1	20453	20453
RESIDUAL	6	69444	11574
TOTAL	7	89897	12842
CHANGE	-1	-20453	20453

PERCENTAGE VARIANCE ACCOUNTED FOR 9.9



*** ESTIMATION OF COMPONENTS OF VARIATION ***

EXPECTED ENVIRONMENTAL COMPONENT OF VARIATON (E) = 29.682
VARIATION DUE TO ADDITIVE EFFECT (D) = 195.305
MEAN OF 'FR' OVER ARRAYS (F) = 407.031
COMPONENT OF VARIATION DUE TO DOMINANCE EFF. OF GENES = HH1 1856.608
COMPONENT OF VARIATION DUE TO DOMINANCE EFF. OF GENES = HH2 1516.390
DOMINANCE EFFECT (h2) = 135.253

*** STANDARD ERRORS OF DIFFERENT PARAMETERS ***

SE(D) = 222.038
SE(F) = 524.656
SE(H1) = 510.433
SE(H2) = 444.077
SE(DOMEFF) = 297.817
SE(E) = 74.013

MEAN DEGREE OF DOMINANCE = 3.083
PROPORTIONOF GENES WITH + AND - EFFECTS IN THE PARENTS = 0.204
PROPORTION OF DOMINANT AND RECESSIVE GENES IN PARENTS = 2.021

COEFFICINT OF CORRELATION (SMALL R) BETWEEN
THE PARENTAL ORDER OF DOMINANCE (WR+VR) AND
PARENTAL MEASUREMENT YR =-0.155

PREDICTION FOR MEASUREMENT OF DOMINANT AND RECESSIVE PARENTS = 0.024
NO. OF GROUPS OF GENES WHICH CONTROL THE CHARACTER AND
EXHIBIT THE DOMINANCE = 0.089
THE COVARIANCE OF ADDITIVE DOMINANCE EFFECTS IN A SINGLE ARRAY
416.542
1200.279
723.542
84.938
315.241
263.921
317.307
-65.521

MEAN OF FR 407.031

HERITABILITY 0.136

** ESTIMATION OF MOST DOMINANT AND RECESSIVE PARENT **

VALUE OF COMPLETELY DOMINANT PARENT YD 185.647
VALUE OF COMPLETELY RECESSIVE PARENT YR 84.443

PROGRAM FOR GENERATION MEAN ANALYSIS

```
'REPE/NUNN=2000,NID=2000' GENERATIONMEANANALYSIS
''ASSIGNED ARE REPLICATE SIZES IN PROGRAMME FILE IN ORDER N1 N2 N3
  READ VALUES FROM DSMURTY.TXT  X(1),X(2),X(3)
  CROSSES  GENERATIONS ARE AS UNDER
    CROSS  GENERATION  1( : P1)   8  10  13
                       2( : P2)
                       3( : P1)
                       4( : P2)
                       5( : BC1)
                       6( : BC2)
          NOTE THAT WE SET P1 AS BETTER(HIGHER IN MAGNITUDE) PARENT
THAN P2
      DOES THE FOLLOWING
           0. HOMOGENEITY TEST FOR PER PLANT VARIATION OVER
              BLOCKS
           1. REPLICATE WISE AND POOLED MEAN,VARS,SKEW,KURT
           2. GENERATION WISE MEAN,SE USING  8 SCHEMES
           3. FITS MODELS ON EACH REP,POOLED
           4. FITS MODELS ON 8 SCHEMES MEANS,VAR
''
'SCAL' NREP=3
'SCAL' NG,P1,P2,BETA1,BETA2,ALFA1,ALFA2
'SCAL' N,XMN,XVAR,SKEW,KURT,GSKEW,GKURT,PRSKEW,PRKURT,SDEV,SESK,SEKR
'SCAL' REPGEN
'SCAL' H1,H2,H3,H4,H5,H6,H7,H8,H9,H10
'SCAL'
R1,R11,R2,NR2,A,M,K,L,B,H1,H2,C,SIG,MU,JJ,A1,A2,A3,A4,M1,M2,M3,M4
 : MM,H(1...10)
'SCAL' H(11,12)
'CALC' P1=.1 : BETA1=.8313 : ALFA1=.6896 : P2=.1 : BETA2=.8313
   : ALFA2=.6896
   :    NG=6
'RUN'
'SCAL'  N1S(1...NG),N2S(1...NG),N3S(1...NG),NNS(1...NG)
'INPU' 2
'HEAD' HEAD='' **** CROSS NUMBER '' : HEAD1='' **** ''
'FOR' SETS=1...6
'PRIN/C,LHM=25' HEAD,SETS,HEAD1 $ 0,5
'LINE' 2
'FOR' N1=N1S(1...NG) ; N2=N2S(1...NG) ; N3=N3S(1...NG) ;
NN=NNS(1...NG);
      DMN1=GMN(1...NG); DVR1=GVR(1...NG);
GENSET=1...NG;DFAC=BLOK(1...NG)
'READ/P,NUN=0' N1,N2,N3 $$ ,2X,3,/
'CALC' NN=N1+N2+N3
'PRIN/P' N1,N2,N3 $ 5
'VARI' ZF1$N1 :ZF2$N2 :ZF3 $N3 : ZF$NN
'CALC' ZF1=1 :ZF2 = 2 :ZF3=
'EQUA' ZF=ZF1,ZF2,ZF3
'GROUP' DFAC=INTPT(ZF)
'VARI' X(1)$ N1 : X(2)$ N2 : X(3)$ N3 : XX$ NN
  : MN,VR $ 8
```

```
'READ/S,PRIN=D,NUN=Q' X(1...3)
'EQUAT' XX=X(1...3)
'CALC' X(1...3),XX=ANG(X(1...3),XX)
'VARI' GMN(1...NG),GVR(1...NG)  $ 8
'VARI' GMN1(1...NG),GVR1(1...NG)  $ 8
'NAME' GNAM=P1,P2,F1,F2,B1,B2
'FACT' GENAM$GNAM=4(1...NG)
'NAME' BNAM=1,2,3,A
'FACT' BLOCK$BNAM=(1...4)NG
'VARI' SSIZE,VSIGMA2,VSK,VKR,XBAR,SEXBAR,SEMUC,VRXBAR,VMUC,
                VRMUC,PRSK,PRKR $ 24
'SCAL' FVAL,FPRGT
'HEAD' BT1='' DEGREES OF FREEDOM ''
'HEAD' BT2='' F-VALUE ''
'HEAD' BT3='' PROBABILITY ''
''                    COMPUTES BLOCKS CONTRIBUTIONS
                                AND
             TEST OF HOMOGENITY OF PER PLANT VARIANCES
''
'TREAT' DFAC
'ANOVA/PR=00010'XX
'LINE' 2
''       TEST FOR HOMOGENEITY IN CASE OF 2 REPLICATIONS
'SCAL' H(1...6),NGG,DF1,DF2
'CALC' H(1,2)=VAR(X(1,2))
'CALC' FVAL=H(1)/H(2)
'CALC' DF1=N1-1 : DF2=N2-1
'CALC' FPRGT=1-FPROB(FVAL;DF1;DF2)
'PRIN/C,LABR=1,LABC=1' BT2,FPRGT $ 0,10.4
'PRIN/C,LABR=1,LABC=1' BT1,DF1,DF2 $ 0,8,8
''
''
    TEST FOR HOMOGENEITY IN CASE OF 3 OR MORE REPLICATIONS
''
'HEAD' BT2='' CHI SQUARE VALUE ''
'VARI' DFSET,VARIANCES $ NREP
'CALC' H(1...3)=MEAN(X(1...3))
'CALC' H(4,5,6)=VAR(X(1...3))
'EQUA' DFSET=N1,N2,N3 : VARIANCES=H(4,5,6)
'CALC' DFSET=DFSET-1
'SCAL' Q,PROB,NGG
'CALC' Q=1+(SUM(1/DFSET)-1/SUM(DFSET))/3/(NREP-1)
'CALC' Q=(SUM(DFSET)*LOG(SUM(DFSET*VARIANCES)/SUM(DFSET))-
        SUM(DFSET*LOG(VARIANCES)))/Q
'CALC' NGG=NREP-1
'CALC' PROB=1-CPROB(Q;NGG)
'CAPT'
'' *** TEST FOR HOMOGENEITY OF VARIANCES *** ''
'LINE' 2
'PRIN/VAR=1' VARIANCES $ 10.4
'PRIN/VAR=1' DFSET $ 10
'LINE' 2
'PRIN/C,LABR=1,LABC=1' BT1,NGG $ 0,8
'PRIN/C,LABR=1,LABC=1' BT2,Q $ 0,10.3
'PRIN/C,LABR=1,LABC=1' BT3,PROB $ 0,10.5
```

```
                COMPUTE MEAN VARS SKEW  KURT
''
'FOR' X=X(1...3),XX;REPSET=1...4
'CALC' REPGEN=4*(GENSET-1)+REPSET
'CALC' N=NVAL(X)
'COPY' SSIZE$REPGEN=N
'CALC' SESK=SQRT(6*N*(N-1)/((N-2)*(N+1)*(N+3)))
 : SEKR=(N-1)*SQRT(24*N/((N-2)*(N-3)*(N+3)*(N+5)))
 : XMN=MEAN(X)
 : XVAR=SUM(X*X)/N
 : SKEW=SUM(X*X*X)/N : KURT=SUM(X**4)/N
 : KURT=KURT-4*SKEW*XMN+6*XVAR*XMN*XMN-3*XMN**4
 : SKEW=SKEW-3*XVAR*XMN+2*XMN**3
 : XVAR=XVAR-XMN*XMN : SKEW=SKEW/SQRT(XVAR**3) :
KURT=KURT/(XVAR*XVAR)-3
 : GSKEW=SKEW/SESK : GKURT=KURT/SEKR
 : PRSKEW=(GSKEW .GT. 0.0)+NPI(GSKEW)*((GSKEW .LE. 0.0)-(GSKEW .GT.
0.0))
 : PRKURT= (GKURT .GT. 0.0)+NPI(GKURT)*((GKURT .LE. 0.0)-(GKURT .GT.
0.0))
 : XVAR=N*XVAR/(N-1)
 : SDEV=SQRT(XVAR)    :XVAR=XVAR/N
'COPY' VSK$REPGEN=SKEW :VKR$REPGEN=KURT : XBAR$REPGEN=XMN
:       VRXBAR$REPGEN=XVAR
: PRSK $ REPGEN=PRSKEW
: PRKR $ REPGEN=PRKURT
'REPE'
        ''       CLASSICAL ESTIMATES  OF GENERATION MEANS VARS ''
'CALC' H1=MEAN(X(1)) : H2=VAR(X(1))/N1
 :        H3=MEAN(X(2)) : H4=VAR(X(2))/N2
 :        H5=MEAN(X(3)) : H6=VAR(X(3))/N3
 :        H8=1/(1/H2+1/H4+1/H6) : H7=(H1/H2+H3/H4+H5/H6)*H8
'COPY' MN$1=H7   :  VR $1=H8
'CALC' H7=(N1*H1+N2*H3+N3*H5)/NN
 :        H8=(N1*N1*H2+N2*N2*H4+N3*N3*H6)/(NN*NN)
'COPY' MN$2=H7   : VR$2=H8
'CALC' H8=((N1 1)*N1*H2+(N2-1)*N2*H4+(N3-1)*N3*H6)/((NN-3)*NN)
'COPY' MN$3=H7 : VR$3=H8
'CALC' H7=MEAN(XX) : H8=VAR(XX)/NN
'COPY' MN$4=H7 : VR$4=H8
''
              ROBUST  ESTIMATES  OF  GENERATION  MEANS  VARS
''
'FOR' X=X(1...3),XX
;MNDM=H(1),H(3),H(5),H(9);VRDM=H(2),H(4),H(6),H(10)
                    ;ADM=A1,A2,A3,A4;MDM=M1,M2,M3,M4 ;REPSET=1...4
'VARI' XORD $X
'CALC' N=NVAL(X)
'CALC' REPGEN=4*(GENSET 1)+REPSET
'CALC' XORD=ORDER(X)
'CALC' R1=INTPT(P1*N+.5) : R2=INTPT(P2*N+.5) : NR2=N-R2
 :        A=N R1 P2   : M=A+R1*BETA1+R2*BETA2
 :        ADM=A    : MDM=M
 : H1=0 :   H2=0 :  I1=R1   : R11=R1+1
```

```
'LABE' LB3
'CALC' JJ=JJ+1
'COPY' H3=XORD $JJ
'CALC' H1=H1+H3  :  H2=H2+H3*H3
'JUMP' LB3*(JJ.LT.NR2)
'COPY' H4=XORD $R11  : H5=XORD $NR2
'CALC' K=(H1+R1*BETA1*H4+R2*BETA2*H5)/M
 :       L=(R2*ALFA2-R1*ALFA1)/M
 :       B=R2*ALFA2*(H5-K)-R1*ALFA1*(H4-K)
 :       C=H2+R1*BETA1*H4*H4+R2*BETA2*H5*H5-M*K*K
 :       SIG=(B+SQRT(B*B+4*A*C))/2/SQRT(A*(A-1))
 :       MU=K+L*SIG
'CALC' MNDM=MU  : VRDM=SIG*SIG/M
'COPY' VMUC$REPGEN=MU : VRMUC$REPGEN=VRDM
'REPE'
'CALC'
H8=1/(1/H(2)+1/H(4)+1/H(6)):H7=(H(1)/H(2)+H(3)/H(4)+H(5)/H(6))*H8
'COPY' MN$5=H7 : VR$5=H8
'CALC' MM=M1+M2+M3
'CALC' H7=(M1*H(1)+M2*H(3)+M3*H(5))/MM
 :       H8=(M1*M1*H(2)+M2*M2*H(4)+M3*M3*H(6))/(MM*MM)
'COPY' MN$6=H7  : VR$6=H8
'CALC' H8=(A1-1)*M1*H(2)+(A2-1)*M2*H(4)+(A3-1)*M3*H(6)
 :       H8=H8/(MM*(A1+A2+A3-3))
'COPY  MN$7=H7  : VR$7=H8
'COPY  MN$8=H(9) : VR$8=H(10)
'CALC  DMN1=MN:DVR1=VR
'REPE
'CALC  VSIGMA2=SSIZE*VRXBAR
          SEXBAR=SQRT(VRXBAR)     SEMUC=SQRT(VRMUC)
''          PRINT  OUTPUT 1                              ''
'PRINT/P' GENAM,BLOCK,SSIZE,VSIGMA2,VSK,PRSK,VKR,PRKR,XBAR,
         SEXBAR,VMUC,SEMUC$5.0
,5.0,6.0,7.3,7.3,7.3,7.2,6.3,11.3,8.4,11.3,8.4
'FACT' SCHM $ 8=2(1,2...8)
'VARI'  GMNSE(1...NG) $16
'FOR' DGMN=GMN(1...NG);DGVR=GVR(1...NG);DGMNSE=GMNSE(1...NG)
'FOR' J=1...8
'CALC' H2=2*J : H3=H2-1
'COPY' H1=DGVRSJ :DGMNSE$H3=DGMNSJ
'CALC' H1=SQRT(H1)
'COPY'  DGMNSE $ H2 H1
'REPE'
'REPE'
''            PRINT OUTPUT 2                             ''
'PRINT/P' SCHM,GMNSE(1...8) $ 10.0,6(10.4)
'VARI' REP(1)=1,5...21 :REP(2)=2,6...22 :REP(3)=3,7...23
:REP(4)=4,8...24
'VARI'  PM=6(1) :PD=1, 1.0,0,.5,-.5 :PH=0,0,1,.5,.5,.5
:PI=2(1,0,.25): PJ=4(0),.25,-.25 :PL=0,0,1,3(.25)
'VARI' YMN,YVR,YWT,FIT,RES $ 6
''            PRINT OUTPUT 3
      FITTING MODELS REPWISE,POOLED AND CLASSICAL ,ROBUST ESTIMATES
''
 FOR' DDM=XBAR,VMUC  ; DDV=VRXBAR,VRMUC :II=1,2
```

```
'FOR' DREP=REP(1...4);JJJ=1...4
'PRINT/P' II,JJJ $ 2(10.0)
'COPY' YMN = DDM$DREP :YVR=DDV$DREP
'CALC' YWT=1/YVR
'TERM/WT=YWT' YMN,PM,PD,PH,PI,PJ,PL
'Y/SCALE=1' YMN
'FIT' PD;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N' PM,PD,PH ;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N' PM,PD,PH,PI;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PJ;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PL;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PI,PJ;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PI,PL;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PJ,PL;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PI,PJ,PL;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'REPE'
'REPE'
''              PRINT OUTPUT 4
     FITTING MODELS OVER EACH SCHEME AND CROSS
''
'FOR' J=1...8
'HEAD' HHX='' SCHEME NUMBER - ''
'PRINT/C' HHX,J $ 10.0
'COPY'H(1...6)=GMN(1...6) $ J
:       H(7,8...12)=GVR(1...6) $ J
'EQUAT' YMN=H(1...6):YVR=H(7,8...12)
'CALC' YWT=1/YVR
'TERM/WT=YWT' YMN,PM,PD,PH,PI,PJ,PL
'Y/SCALE=1' YMN
'FIT' PD;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N' PM,PD,PH ;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N' PM,PD,PH,PI;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PJ;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PL;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PI,PJ;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PI,PL;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PJ,PL;FVAL=FIT;RES=RES
'PRINT/P' YMN,FIT,YVR,YWT,RES $10.4
'FIT/INT=N'  PM,PD,PH,PI,PJ,PL;FVAL=FIT;RES=RES
```

```
'PRINT/P'  YMN,FIT,YVR,YVT,RES S10.4
'REPE'
'LINE' 1
'REPE'
'INPU' 1
'RUN'
'CLOSE'
'STOP'
```

Output from Generation Mean Analysis

**** CROSS NUMBER 1 ****

N1S(1) 5 N2S(1) 5 N3S(1) 5

2	60.0	68.8	49.6	64.0	51.2
3	41.6	71.2	64.8	42.0	70.0
4	68.0	54.0	59.2	70.4	68.4

****** ANALYSIS OF VARIANCE ******

VARIATE: XX

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
UNITS STRATUM					
BLOK(1)	2	36.79	7.29	18.40	0.472
RESIDUAL	12	467.64	92.71	38.97	
TOTAL	14	504.44	100.00	36.03	
GRAND TOTAL	14	504.44	100.00		

GRAND MEAN 51.0
TOTAL NUMBER OF OBSERVATIONS 15

**** TEST FOR HOMOGENEITY OF VARIANCES ****

VARIANCE	23.2040	76.1356	17.5712
DFSET	4	4	4

DEGREES OF FREEDOM 2
CHI-SQUARE VALUE 2.323
PROBABILITY 0.31301

GM	BL	SZ	VSIGMA2	VSK	PRSK	VKR	PRKR	XBAR	SEXBAR	VMUC	SEMUC
P1	1	5	23.204	0.015	0.493	-1.53	0.222	50.080	2.1543	49.700	2.8997
P1	2	5	76.136	-0.326	0.361	-1.80	0.184	49.700	3.9022	49.669	6.5135
P1	3	5	17.571	-0.542	0.276	-1.39	0.243	53.196	1.8746	53.585	2.2608
P1	A	15	36.031	-0.629	0.139	-0.95	0.197	50.992	1.5499	51.559	1.6971
P2	1	5	32.291	0.059	0.474	-1.39	0.243	28.003	2.5413	27.253	2.9629
P2	2	5	33.596	0.545	0.275	-0.92	0.322	25.451	2.5921	24.339	2.4158
P2	3	5	8.086	0.835	0.180	-0.53	0.396	27.112	1.2717	26.658	0.7111
P2	A	15	22.333	0.269	0.321	-0.83	0.229	26.855	1.2202	26.621	1.3105
F1	1	5	34.715	-1.201	0.094	-0.05	0.490	61.957	2.6350	63.582	0.4431
F1	2	5	24.171	0.441	0.315	-1.27	0.263	64.645	2.1987	64.173	2.5356
F1	3	5	92.534	-0.847	0.177	-0.82	0.341	59.741	4.3020	61.952	4.2031
F1	A	15	47.570	-1.204	0.019	1.03	0.180	62.114	1.7808	62.916	1.4761
F2	1	22	60.043	0.224	0.324	-0.25	0.398	57.696	1.6520	57.977	1.6460
F2	2	28	210.285	-0.746	0.045	0.24	0.392	47.932	2.7405	47.943	2.6965
F2	3	25	77.855	0.059	0.449	-0.73	0.208	54.114	1.7647	54.180	1.8969
F2	A	75	135.688	-1.003	0.000	1.85	0.000	52.857	1.3451	53.616	1.2108
B1	1	12	35.595	-0.744	0.122	1.37	0.133	63.447	1.7223	63.893	1.1358
B1	2	14	32.446	0.049	0.468	-1.55	0.090	59.618	1.5224	59.676	1.6502
B1	3	16	79.835	-0.055	0.461	-0.63	0.283	57.074	2.2338	57.508	2.2052
B1	A	42	55.845	-0.427	0.121	-0.15	0.419	59.743	1.1531	59.848	1.1476
B2	1	16	45.172	-0.369	0.256	0.85	0.219	60.224	1.6803	60.279	1.3970
B2	2	16	55.131	0.115	0.419	-0.92	0.200	53.408	1.8563	53.427	2.1805
B2	3	11	34.587	-0.317	0.316	-0.96	0.227	58.290	1.7732	58.786	1.8058
B2	A	43	53.331	-0.251	0.243	-0.39	0.293	57.193	1.1137	57.308	1.1471

Schm	Gmnse1	Gmnse2	Gmnse3	Gmnse4	Gmnse5	Gmnse6
1	51.6035	26.9933	63.0343	54.7104	60.4238	57.5295
1	1.3295	1.0414	1.5715	1.1039	1.0159	1.0193
3	50.9923	26.8551	62.1143	52.8570	59.7428	57.1929
3	1.6118	1.2821	1.8344	1.2771	1.1080	1.0372
4	50.9923	26.8551	62.1143	52.8570	59.7428	57.1929
4	1.5499	1.2202	1.7808	1.3451	1.1531	1.1137
5	51.9460	26.5124	63.5818	54.8730	61.7705	58.4345
5	1.7197	0.6648	0.4341	1.1290	0.8613	0.9856
6	50.9848	26.0833	63.2356	52.9719	60.0688	57.3521
6	2.4932	1.2962	1.6429	1.2825	1.0511	1.0677
7	50.9848	26.0833	63.2356	52.9719	60.0688	57.3521
7	2.4932	1.2962	1.6429	1.2822	1.0405	1.0661
8	51.5590	26.6211	62.9155	53.6160	59.8476	57.3076
8	1.6971	1.3105	1.4761	1.2108	1.1476	1.1471

METHOD 1 REP 1

224.....

***** REGRESSION ANALYSIS *****

Y-VARIATE: YMN
WEIGHT VARIATE: YWT

*** REGRESSION COEFFICIENTS ***

	ESTIMATE	S.E.	T
CONSTANT	55.702	0.799	69.73
PD	6.60	1.36	4.85

* STANDARD ERRORS BASED ON SCALE PARAMETER WITH VALUE 1.000

*** ANALYSIS OF VARIANCE ***
SCALE PARAMETER IS 1.000

	DF	SS	MS
REGRESSN	1	23.6	23.55
RESIDUAL	4	136.5	34.14
TOTAL	5	160.1	32.02
CHANGE	-1	-23.6	23.55

RESIDUAL VARIANCE EXCEEDS VARIANCE OF Y-VARIATE

YMN	FIT	YVR	YWT	RES
50.0800	62.2973	4.6409	0.2155	-5.6712
28.0026	49.1067	6.4582	0.1548	-8.3044
61.9566	55.7020	6.9431	0.1440	2.3737
57.6960	55.7020	2.7292	0.3664	1.2070
63.4465	58.9996	2.9662	0.3371	2.5820
60.2239	52.4043	2.8233	0.3542	4.6538

------ SIMILARLY OTHER MODEL FOR EACH REPLICATIONS AND
EACH METHOD WILL BE DONE

SCHEME NUMBER - 1

267.....

***** REGRESSION ANALYSIS *****

Y-VARIATE: YMN
WEIGHT VARIATE: YWT

*** REGRESSION COEFFICIENTS ***

	ESTIMATE	S.E.	T	
CONSTANT	52.271	0.467	111.88*	
PD	12.356	0.717	17.23	

* STANDARD ERRORS BASED ON SCALE PARAMETER WITH VALUE 1.000

*** ANALYSIS OF VARIANCE ***
SCALE PARAMETER IS 1.000

	DF	SS	MS
REGRESSN	1	296.8	296.8
RESIDUAL	4	431.4	107.8
TOTAL	5	728.1	145.6
CHANGE	-1	-296.8	296.8

PERCENTAGE VARIANCE ACCOUNTED FOR 25.9

YMN	FIT	YVR	YWT	RES
51.6035	64.6268	1.7677	0.5657	-9.7953
26.9933	39.9148	1.0845	0.9220	-12.4076
63.0343	52.2708	2.4696	0.4049	6.8492
54.7104	52.2708	1.2185	0.8207	2.2101
60.4238	58.4488	1.0320	0.9690	1.9441
57.5295	46.0928	1.0390	0.9625	11.2200

SIMILARLY FOR OTHER SCHEMES AND MODELS WILL BE DONE.

PROGRAM FOR ESTIMATION OF LINKAGE

```
'REPE' LINKAGEANALYSIS
'UNITS ' $ 12
'SCAL' TOT=12
'VARI' CASE=1...TOT
'NAME' PHASENM=R,C
'FACTOR' PHASE $ PHASENM
''
          BEFORE USING THIS PROGRAM MAKE SURE U UNDERSTAND THE THINGS
BEING
          DONE HERE.
          INPUTS IN ORDER ARE
            A(1) :   OF AABB types
            A(2) :   OF AAbb types
            A(3) :   OF aaBB types
            A(4) :   of aabb types
          PHASENM : R , C (for Repulsion or Coupling )
          PHASE    : VECTOR OF PHASENAMES
          OUTPUTS   ARE
            CHIA =Chi-square for A:a :: 3:1 (d.f.=1)
            CHIB =Chi-square for B:b :: 3:1 (d.f. =1)
            CHIL =Chi-square for linkage  (d.f. =1)
            P     = Estimates of rcombination fraction
            SEP  = Standard error of P
''
'READ/P' A(1...4),PHASE
'CALC'   N=A(1)+A(2)+A(3)+A(4)
:        CHIA=(A(1)+A(2)-3*(A(3)+A(4)))**2 : CHIA=CHIA/(3*N)
:        CHIB=(A(1)+A(3)-3*(A(2)+A(4)))**2 : CHIB=CHIB/(3*N)
:        CHIL=(A(1)-3*A(2)-3*A(3)+9*A(4))**2 :CHIL=CHIL/(9*N)

:        Q=A(1)*A(4)/(A(2)*A(3))    : THETA=(1+Q-SQRT(1+3*Q))/(Q-1)
:        VTHETA=2*THETA*(1-THETA)*(2+THETA)/(N*(1+2*THETA))
''
              FOR REPULSION PHASE USE    P= SQRT( THETA)
                  COUPLING               P= 1-SQRT(THETA)
''
'CALC'       P=100*SQRT(THETA)
:            SEP=100*SQRT(VTHETA/THETA)/2
:            P=P*(PHASE.EQ.1)+(100-P)*(PHASE.EQ.2)
'PRINT/P' CASE,A(1...4),N,THETA,VTHETA,CHIA,CHIB,CHIL,P,SEP ,PHASE
                                $6(5.0),2(10.4),3(10.3),2(12.6),8
'RUN'
'EOD'
'CLOS'
'STOP'
```

RESULTS FROM LINKAGE ESTIMATION ANALYSIS

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
A(1)	264.0	561.2	894.0	12	0
A(2)	66.0	166.4	273.0	12	0
A(3)	68.0	213.5	517.0	12	0
A(4)	24.00	63.58	102.00	12	0

CASE	A(1)	A(2)	A(3)	A(4)	N	THETA	VTHETA	CHIA	CHIB	CHIL	P	SEP	PHASE
1	267	66	94	35	462	0.3102	0.0013	2.104	2.427	2.502	44.302429	3.262335	C
2	493	89	328	53	963	0.2346	0.0006	108.938	54.007	9.111	51.560951	2.458437	C
3	894	145	517	66	1622	0.2174	0.0003	103.596	124.390	16.989	53.373848	1.930883	C
4	558	208	187	71	1024	0.2526	0.0006	0.021	2.755	0.016	49.741215	2.337002	C
5	794	273	235	98	1400	0.2778	0.0004	1.101	1.680	1.834	47.297020	1.943470	C
6	612	196	214	72	1094	0.2570	0.0005	0.762	0.147	0.091	49.307495	2.250021	C
7	566	203	185	70	1024	0.2576	0.0006	0.005	1.505	0.111	49.248154	2.324099	C
8	789	261	248	102	1400	0.2814	0.0004	0.000	0.644	2.571	46.951748	1.935566	C
9	614	194	207	76	1091	0.2715	0.0005	0.514	0.037	0.919	47.894699	2.216984	C
10	307	87	92	33	519	0.2841	0.0011	0.232	0.977	0.961	53.296669	3.169618	R
11	576	195	187	63	1021	0.2493	0.0006	0.144	0.040	0.001	49.932419	2.348953	R
12	264	80	68	24	436	0.2718	0.0013	3.535	0.306	0.330	52.137684	3.505649	R

58 'CLOS'

******** END OF LINKAGE. MAXIMUM OF 1440 DATA UNITS USED AT LINE 41 (326240 LEFT)

PROGRAM FOR LINE X TESTER ANALYSIS

```
'REFE/NUMM=1000,NID=1000' LINEXTESTERANALYSIS
''
                        INPUT
         NR:  NUMBER OF REPLICATIONS
         NE:  TOTAL NUMBER OF ENTRIES
         NL:  NUMBER OF LINES
         NT:  NUMBER OF TESTERS
''
'SCAL' NL=5 : NT=3 : NR=4  : NE=23 : NN,NOBS
'CALC' NN=NL*NT
'CALC' NOBS=NR*NE
'R'
'MATR' M $ NL,NT
'VARI' LINES=1...NL : TESTER=1...NT :
LXT=16,26,36,46,56,17,27,37,47,57,18,28,
  38,48,58
'VARI' GCALS $ NL : GCATS $ NT : SCALT $ NN : SCALTS(1...NT) $ NL
'SCAL' MSE,MSL,MST,MSLT,SEGCAL,SEGCAT,SESCA,SEDL,SEDT,SED,SSC,CCL,CCT,CCLT
   :
COVHSL,COVHST,COVHSA,COVFS1,COVFS2,COVPS,SSQA0,SSQA1,SSQD0,SSQD1,SCASQ
   :   COVHSA1
'UNITS' $ NOBS
'INPUT' 2
'READ' YLD
'INPUT' 1
'R'
'FACT' REP $ NR=NE!(1...NR)
'FACT' TREAT $ NE=(1...NE)NR
'FACT' PLOTS $ NE=(1...NE)NR
''
 Enter your parents,lines and testers accordingly.
''
'INTE' I0=1...14,-15,16,17...22,-23
'INTE' I2=1...14,-15,-16,-17...-23
'INTE' I0I1=1,4,7,10,-13,2,5,8,11,-14,3,6,9,12,-15,16,17...22,-23
'INTE' I0I2=1,2,-3,4,5,-6,7,8,-9,10,11,-12,13,14,-15,16,17...22,-23
'HEAD' H1='' GCA EFFECTS FOR LINES              ''
'HEAD' H2='' GCA EFFECTS FOR TESTERS            ''
'HEAD' H3='' SCA EFFECTS                        ''
'HEAD' H4='' STANDARD ERROR (GCA FOR LINE)      ''
'HEAD' H5='' STANDARD ERROR (GCA FOR TESTER)    ''
'HEAD' H6='' STANDARD ERROR (SCA EFFECTS)       ''
'HEAD' H7='' STANDARD ERROR (G(I)-G(J)) LINE    ''
'HEAD' H8='' STANDARD ERROR (G(I)-G(J)) TESTER  ''
'HEAD' H9='' STANDARD ERROR                     ''
'HEAD' H10='' COV H.S. (LINE)                   ''
'HEAD' H11='' COV H.S. (TESTER)                 ''
'HEAD' H12='' COV H.S. (AVERAGE)                ''
'HEAD' H13='' COV F.S.                          ''
'HEAD' H14='' SIGMA SQUARE A WHEN F=0           ''
'HEAD' H15='' SIGMA SQUARE A WHEN F=1           ''
'HEAD' H16='' SIGMA SQUARE D WHEN F=0           ''
```

```
 HEAD' H17    SIGMA SQUARE D WHEN F=1
'HEAD' H18    CONTRIBUTION OF LINES
'HEAD' H19    CONTRIBUTION OF TESTERS
'HEAD' H20    CONTRIBUTION OF LINE X TESTER
'HEAD' H21    VARIANCE RATIO OF GCA TO LINE   TERSTER '
'HEAD' H22    VARIANCE RATIO OF SCA TO LINE   TERSTER '
'GROUP' IPXC=GROUP(TREAT ; I0)
 GROUP' IP=GROUP(TREAT ; I2)
'GROUP' IT=GROUP(TREAT ; I0I1)
'GROUP' IL=GROUP(TREAT ; I0I2)
'BLOC' REP/PLOTS
'TREAT' IPXC/IP+IPXC.IL+IPXC.IT+IPXC.IL.IT
'ANOV/SE=M,PR=00010' YLD : OUT=AOV1
'EXTR' AOV1 ; REP.PLOTS $ SS=SSE ; DF=DFE
'EXTR' AOV1 ; IPXC.IL $ EFF=GCAL ; SS=SSL ; DF=DFL
'EXTR' AOV1 ; IPXC.IT $ EFF=GCAT ; SS=SST ; DF=DFT
'EXTR' AOV1 ; IPXC.IL.IT $ EFF=SCA ; SS=SSLT ;DF=DFLT
'SCAL' VRGCA,VRSCA 'CALC' VRGCA=(SSL/DFL)/(SSLT/DFLT)
'CALC' VRSCA=(SST/DFT)/(SSLT/DFLT)
'PRINT/C' H21,VRGCA $ 0,10.3
'PRINT/C' H22,VRSCA $ 0,10.3
'PRINT' GCAL $ 10.2
'PRINT' GCAT $ 10.2
'PRINT' SCA $ 10.2
'EQUA' GCALS=GCAL : GCATS=GCAT : M=SCA : SCALTS(1. .NT)=M $ (1,3X)5,X
'EQUA' SCALT=SCALTS(1 ..NT)
'CALC' MSE=SSE/DFE : MSL=SSL/DFL : MST=SST/DFT : MSLT=SSLT/DFLT
'CALC' SEGCAL=SQRT(MSE (NR*NT))
'CALC' SEGCAT=SQRT(MSE (NR*NL))
'CALC' SESCA=SQRT(MSE/NR)
'CALC' SEDL=SQRT(2)*SEGCAL
'CALC' SEDT=SQRT(2)*SEGCAT
'CALC' SED=SQRT(2)*SESCA
'SCAL' F0=0 : F1 1
'CALC' COVHSL=(MSL MSLT) (NR*NT) : COVHST=(MST MSLT) (NR*NL)
'CALC' COVHSA1=((NL 1)*MSL+(NT 1)*MST) (NL+NT 2)
'CALC' COVHSA=(COVHSA1 MSLT) (NR*(2*NL*NT NL NT))
'CALC' COVFS1 ((MSL MSE)+(MST MSE)+(MSLT MSE) 6*NR
'CALC' COVFS2 6*NR*COVHSA NR*(NL+NT)*COVHSA
 CALC' COVFS=COVFS1+COVFS2
'CALC' SSQA0=COVHSA*(  (2+F )
'CALC' SSQA1=COVHSA*  (  +F1))
'CALC' SCAS0=(MSL MSE) NR
'CALC' SSQD0 SCAS0*  (2 (1+F )
'CALC' SSQD1=SCAS  (2 (1+F1)
'CALC' SSC=SSL+SS
'CALC' CCL=(SS
'CALC' CCT=(SST SSC)*100
'CALC' CCLT=(SSL SSC)*100
'PRINT' H1
'PRINT P.LABC=1   INE  GCALS 2 1  .10.4
'PRINT' H2
'PRINT/P.LABC 1' TESTER.GCATS 2 1  .10.4
'PRINT' H3
'PRINT/P.LABC=1' .XT  GCALT  2 10.4 1 .4
```

```
'PRINT/C,LABC=1,LABR=1' H4,SBGCAL $ 15.4
'PRINT/C,LABC=1,LABR=1' H5,SBGCAT $ 13.4
'PRINT/C,LABC=1,LABR=1' H6,SBSCA  $ 16.4
'PRINT/C,LABC=1,LABR=1' H7,SEDL $ 13.4
'PRINT/C,LABC=1,LABR=1' H8,SEDT $ 11.4
'PRINT/C,LABC=1,LABR=1' H9,SED $ 30.4
'PRINT/C,LABC=1,LABR=1' H10,COVHSL $ 29.4
'PRINT/C,LABC=1,LABR=1' H11,COVHST $ 27.4
'PRINT/C,LABC=1,LABR=1' H12,COVHSA $ 26.4
'PRINT/C,LABC=1,LABR=1' H13,COVFS $ 36.4
'PRINT/C,LABC=1,LABR=1' H14,SSQA0 $ 21.4
'PRINT/C,LABC=1,LABR=1' H15,SSQA1 $ 21.4
'PRINT/C,LABC=1,LABR=1' H16,SSQD0 $ 21.4
'PRINT/C,LABC=1,LABR=1' H17,SSQD1 $ 21.4
'PRINT/C,LABC=1,LABR=1' H18,CCL $ 23.4
'PRINT/C,LABC=1,LABR=1' H19,CCT $ 21.4
'PRINT/C,LABC=1,LABR=1' H20,CCLT $ 15.4
'R'
'CLOS'
'STOP'
```

Output from Line x Tester Analysis

***** ANALYSIS OF VARIANCE *****

VARIATE: YLD

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
REP STRATUM	3	83.18	0.22	27.73	
REP.PLOTS STRATUM					
IPXC	1	53.04	0.14	53.04	0.582
IPXC.IP	7	6303.70	16.31	900.53	9.881
IPXC.IL	4	10318.36	26.69	2579.59	28.304
IPXC.IT	2	1718.93	4.45	859.46	.430
IPXC.IL.IT	8	14162.37	36.64	1770.30	19 4.4
RESIDUAL	66	6015.14	15.56	91.14	
TOTAL	88	38571.54	99.78	438.3.	
GRAND TOTAL	91	38654.71	100.00		

GRAND MEAN 85.68
TOTAL NUMBER OF OBSERVATIONS 92

VARIANCE RATIO OF GCA TO LINE X TERSTER VRGCA 1.457
VARIANCE RATIO OF SCA TO LINE X TERSTER VRSCA 0.485

GCAL

IL / IPXC	1	2	3	4	5	6
1	-9.96	-0.72	23.82	-13.87	0.73	0.00
2	0.00	0.00	0.00	0.00	0.00	0.00

GCAT

IT / IPXC	1	2	3	4
1	0.29	6.40	-6.70	0.00
2	0.00	0.00	0.00	0.00

SCA

IPXC	IT / IL	1	2	3	4
1	1	-8.02	24.96	-16.94	0.00
	2	-12.55	5.72	6.83	0.00
	3	-9.46	-4.92	14.38	0.00
	4	33.14	-14.32	-18.82	0.00
	5	-3.11	-11.44	14.55	0.00
	6	0.00	0.00	0.00	0.00
2	1	0.00	0.00	0.00	0.00
	2	0.00	0.00	0.00	0.00
	3	0.00	0.00	0.00	0.00
	4	0.00	0.00	0.00	0.00
	5	0.00	0.00	0.00	0.00
	6	0.00	0.00	0.00	0.00

GCA EFFECTS FOR LINES

1	-9.9600
2	-0.7183
3	23.8167
4	-13.8700
5	0.7317

GCA EFFECTS FOR TESTERS

1	0.2923
2	6.4043
3	-6.6967

SCA EFFECTS

16	-8.0190
26	-12.5457
36	-9.4607
46	33.1360
56	24.9590
17	6.8283
27	14.3783
37	-18.8150
47	0.0000
57	0.0000
18	33.1360
28	24.9590
38	5.7173
48	-4.9177
58	-14.3210

STANDARD ERROR (GCA FOR LINE)	2.7559
STANDARD ERROR (GCA FOR TESTER)	2.1347
STANDARD ERROR (SCA EFFECTS)	4.7733
STANDARD ERROR (G(I)-G(J)) LINE	3.8974
STANDARD ERROR (G(I)-G(J)) TESTER	3.0189
STANDARD ERROR	6.7505
COV H.S. (LINE)	67.4412
COV H.S. (TESTER)	-45.5417
COV H.S. (AVERAGE)	2.6809
COV F.S.	3375.2590
SIGMA SQUARE A WHEN F=0	10.7236
SIGMA SQUARE A WHEN F=1	5.3618
SIGMA SQUARE D WHEN F=0	1679.1575
SIGMA SQUARE D WHEN F=1	419.7894
CONTRIBUTION OF LINES	39.3836
CONTRIBUTION OF TESTERS	6.5609
CONTRIBUTION OF LINE X TESTER	54.0555

129 'CLOS'
******** END OF LINEXT. MAXIMUM OF 12000 DATA UNITS USED AT LINE 68 (315680 LEFT)

PROGRAM FOR GENETIC CORRELATIONS

```
'REPE/NUNN=300,NID=300' GENOTYPIC_CORRELATIONS
'UNIT' $ 24
'SCAL' NREP=6: NTREAT=4: NVAR=3
'FACT' REP $ 6=4(1,2),2(3),4(4),2(3),2(6),4(5),2(6): TREAT $ 4
 INPU/RECL=132' 2
'READ/F' TREAT,V(1...NVAR) $ S ,3,6X,1,1X,/
'CALC' V(1...NVAR)=V(1...NVAR)/4
'INPU' 1
'VARI' TMN(1,2...NVAR) $ NTREAT
'BLOCKS' REP/TREAT
'TREAT' TREAT
'FOR' Z=V(1,2...NVAR); MND=TMN(1,2...NVAR);RD=R(1,2...NVAR)
'ANOVA/PR=0' Z; RES=RD; OUT=DOUT
'EXTR' DOUT; TREAT $ MEAN=XD
'EQUA' MND=XD
'REPE'
'SYMM' GENVAR,FENVAR,ERRVAR,GENCOR,FENCOR,ERRCOR $ NVAR
'DSSP' M$R(1...NVAR)
'SSP' M
'EQUA' ERRVAR=M
'CALC' ERRVAR=ERRVAR/(NREP-1)/(NTREAT-1)
'CALC' ERRCOR=CORMAT(ERRVAR)
'DSSP' MM $ TMN(1,2...NVAR)
'SSP' MM
'EQUA' FENVAR=MM
'CALC' FENVAR=NREP*FENVAR/(NTREAT-1)
'CALC' FENCOR=CORMAT(FENVAR)
'CALC' GENVAR=(FENVAR-ERRVAR)/NREP
'CALC' GENCOR=CORMAT(GENVAR)
'CAPT'
''
  GENOTYPIC, PHENOTYPIC, ENVIRONMENTAL VARIANCES
  CORRELATIONS PHYNOTYPIC FROM TREATMENT SS IN
  ANALYSIS OF VARIANCE
''
'PRIN/S' GENVAR,FENVAR,ERRVAR,GENCOR,FENCOR,ERRCOR $ 8 3
'CALC' FENVAR=GENVAR+ERRVAR
'CALC' FENCOR=CORMAT(FENVAR)
'CAPT'
''
    PHYNOTYPIC VARIANCES, CORRELATIONS FROM ERROR AND
    GENOTYPIC VALUES
''
'PRIN/S' FENVAR,FENCOR $ 8 3
'RUN'
'CLOSE'
'STOP'
```

RESULTS FROM GENETIC CORRELATIONS PROGRAM

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
V(1)	214.0	244.6	264.0	24	0
V(2)	452.0	763.3	1081.0	24	0
V(3)	256	1765	3793	24	0

GENOTYPIC, PHENOTYPIC, ENVIRONMENTAL VARIANCES
CORRELATIONS PHYNOTYPIC FROM TREATMENT SS IN
ANALYSIS OF VARIANCE

GENVAR

1	5.389		
2	39.912	2370.630	
3	-47.018	6726.693	29991.584
	1	2	3

PENVAR

1	36.135		
2	236.085	14389.852	
3	-472.113	41217.066	214368.047
	1	2	3

ERRVAR

1	3.803		
2	-3.389	166.069	
3	-190.003	856.905	34418.543
	1	2	3

GENCOR

1	1.000		
2	0.353	1.000	
3	-0.117	0.798	1.000
	1	2	3

PENCOR

1	1.000		
2	0.327	1.000	
3	-0.170	0.742	1.000
	1	2	3

[redacted]

1	1.000		
2	-0.135	1.000	
3	-0.525	0.398	1.000

1	2	3

[redacted]

[redacted]

1	9.182		
2	36.523	2536.700	
3	-237.022	7983.998	64410.129

1	2	3

[redacted]

1	1.000		
2	0.239	1.000	
3	-0.308	0.593	1.000

1	2	3

PROGRAM FOR PATH COEFFICIENT ANALYSIS

```
'REFE/PRIN=2,NID=1000,NUMN=1000' PATHANALYSIS
''
                    NO. OF OBSERVATIONS (N)
                      Y IS THE DEPENDENT VARIABLE
                  NO. OF  INDEPENDENT VARIABLES (NIV)
''
'SCAL' N=8: NIV=3 :NIV1:RESDSQ,MEANXV(1...NIV),VARXV(1...NIV),
                MEANY,VARY,NIV2
'CALC' NIV1=NIV+1 : NIV2=NIV*(NIV+1)/2
'HEAD' H1='' MEAN '' :H2='' VARIANCE''
'R'
'UNIT' $ NIV
'VARI' OBS=1...N :Y,V(1...NIV) $ N
'INPU/RECL=132' 2
'READ' Y,V(1...NIV)
'INPU' 1
'VARI' BB $ NIV1
'SYMM' B,CONT,RI $ NIV: CORRMAT $ NIV1
'MATR' A,C,UNVEC,TOT $ NIV,1 : CORRMT $ NIV1,NIV1
'MATR' EFFECT $ NIV,NIV: EF $ NIV1,NIV : EFFECTS $ NIV,NIV1
'DIAG' DPATH,DD $ NIV
'R'
'CALC' MEANXV(1...NIV),MEANY=MEAN(V(1...NIV),Y)
'CALC' VARXV(1...NIV),VARY=VAR(V(1...NIV),Y)*(N-1)/N
'DSSP' COT $ V(1...NIV),Y
'SSP' COT
'CALC' CORRMAT=CORMAT(COT)
'EQUA' B,BB=CORRMAT: CC=BB
'CALC' PATH=PDT(INV(B) ; CC)
'EQUA' DPATH=PATH : UNVEC=1
'CALC' EFFECT=PDT(B ;DPATH): RESDSQ=1-SUM(PATH*CC)
   : TOT=PDT( EFFECT ;UNVEC )
'CALC' EFFECT=TRANS(EFFECT)
'EQUA' EF=EFFECT,TOT
'CALC' EFFECTS =TRANS(EF)
'EQUA' DD=(1)NIV
'CALC' RI=2*B-DD : CONT=PDT(DPATH ; RI) : CONT=PDT(CONT ;DPATH)
'PRIN/P' OBS,V(1...NIV),Y $ 12,20(12.4)
'LINE' 1
'PRIN/C,LABR=1,LABC 1' H1,MEANXV(1...NIV),MEANY  $ 12.4
'LINE' 1
'PRIN/C,LABR=1,LABC=1  H2,VARXV(1...NIV),VARY $ 12.4
'LINE' 2
'PRIN/LHM=8' CORRMAT $ 12.4
'LINE' 1
'CAPT'
''
  I'TH ROW GIVES THE DIRECT AND INDIRECT EFFECTS OF X(I) ON Y
  DIAGONAL-PATHCOEFFFFCIENTS (OR) DIRECT EFFECTS
  (LAST COLUMN IS TOTAL EFFECT )
''
'PRIN/LHM=11' EFFECT' $ 12.4
```

```
'LINE' 2
'CAPT'
''
  CONTRIBUTIONS : (DIRECT-DIOGONAL:INDIRECT-NONDIOGONAL)
''
'PRIN/LHM=20'  CONT $ 12.4
'LINE' 1
'PRIN/LHM=11' RESDSQ  $ 12.4
'LINE' 3
'RUN'
'CLOS'
'STOP'
```

Output from Path Coefficient Analysis

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
Y	1217	1262	1296	8	0
V(1)	1215	1275	1296	8	0
V(2)	1217	1266	1300	8	0
V(3)	1253	1279	1299	8	0

OBS	V(1)	V(2)	V(3)	Y
1	1214.5000	1284.3000	1277.0000	1276.5000
2	1288.0000	1216.5000	1289.8000	1218.7000
3	1280.0000	1271.3000	1277.5000	1269.5000
4	1280.8000	1216.5000	1283.3000	1295.9000
5	1260.0000	1252.5000	1253.0000	1251.0000
6	1296.4000	1298.8000	1299.1000	1217.2000
7	1291.4000	1299.7000	1283.3000	1289.5000
8	1291.8000	1284.8000	1270.0000	1281.5000
MEAN	1275.3627	1265.5500	1279.1250	1262.4751
VARIANCE	640.1254	1001.1356	165.0945	819.1682

CORRMAT

1	1.0000			
2	-0.0370	1.0000		
3	0.3914	0.0598	1.0000	
4	-0.2110	0.1028	-0.3516	1.0000
	1	2	3	4

I'TH ROW GIVES THE DIRECT AND INDIRECT EFFECTS OF X(I) ON Y
DIAGONAL-PATHCOEFFECIENTS (OR) DIRECT EFFECTS
(LAST COLUMN IS TOTAL EFFECT)

EFFECTS

	1	2	3	4
1	-0.0782	0.0044	-0.1284	-0.2110
2	0.0029	0.1195	-0.0196	0.1028
3	-0.030[illegible]	0.0071	-0.3281	-0.3516

CONTRIBUTIONS : (DIRECT-DIOGONAL:INDIRECT-NONDIOGONAL)

CONT

1	0.00[illegible]		
2	0.000[illegible]	0.0143	
3	0.02[illegible]	-0.0047	0.1077
	1	2	3

RESDSQ 0.8559

```
  67  'CLOS'
******** END OF PATHANA.  MAXIMUM OF 9690 DATA UNITS USED
    AT LINE 42 (317990 LEFT)
```

PROGRAM FOR SCALING TEST FOR BIVARIATE CHARACTERS

```
'REFE/NUNN=300,NID=300' JOINTSCALINGTEST
'UNIT' $ 6
'READ/P' AMN,BMN,AVAR,BVAR,ABCOV
'CALC' W1=1/AVAR: W2=1/BVAR
'VARI' CORELESN $ 6
'CALC' CORELESN=ABCOV/SQRT(AVAR*BVAR)
'PRIN/P' AMN,BMN,AVAR,BVAR,ABCOV $ 12.4
'PRIN/P' W1,W2,CORELESN $ 12.4
'VARI' RESIDU1,FITED1 $ 6: BETA1 $ 3
'SCAL' Q
'SYMM' S1 $ 3
'SYMM' D $ 6=21(0)
'VARI' IRZ $ 6=1,3,6,10,15,21
'COPY' D $ IRZ=W1
'MATRI' RESM1 $ 6,1: RESM2 $ 6,1
'MATRI' X1 $ 6,3=1,1,0,1,.5,.5,1,0,1,1,0,.5,1,-.5,.5,1,-1,0
'CALC' S1=RSYMRI(TRANS(X1);D)
'CALC' S1=INV(S1)
'CALC' BETA1=PDT(TPDT(X1;D);AMN)
'CALC' BETA1=PDT(S1;BETA1)
'CALC' FITED1=PDT(X1;BETA1)
'CALC' RESIDU1=AMN-FITED1
'EQUA' RESM1=RESIDU1
'CALC' Q=RSYMRI(TRANS(RESM1);D)
'PRIN/P' BETA1 $ 10.4
'PRIN/P' S1 $ 10.4
'PRIN/P' AMN,FITED1,RESIDU1 $ 10.4
'PRIN/P' Q $ 10.4
''
                    FOR THE SECOND TRAIT
''
'VARI'  RESIDU2, FITED2 $ 6: BETA2 $ 3
'SYMM' S2 $ 3
'SYMM' D $ 6=21(0)
'COPY' DS IRZ=W2
'MATRI' X2 $ 6,3=1,1,0,1,.5,.5,1,0,1,1,0,.5,1,-.5,.5,1,-1,0
'CALC' S2=RSYMRI(TRANS(X2);D)
  :    S2=INV(S2)
  :    BETA2=PDT(TPDT(X2;D);BMN)
  :    BETA2=PDT(S2;BETA2)
  :    FITED2=PDT(X2;BETA2)
  :    RESIDU2=BMN-FITED2
'EQUA' RESM2=RESIDU2
'CALC' Q= RSYMRI(TRANS(RESM2);D)
'PRIN/P' BETA2 $ 10.4
'PRIN/P' S2 $ 10.4
'PRIN/P' BMN,FITED2,RESIDU2 $ 10.4
'PRIN/P' Q $ 10.4
''
                SIMULTANEOUS ANALYSIS
                 COMPUTE W INVERSE
```

```
'VARI' H,H11,H12,H22 $ 6
'CALC' H=AVAR*BVAR-ABCOV**2
'CALC' H11=BVAR/H : H12=-ABCOV/H: H22=AVAR/H
'SYMM' W11 $ 6-21(0): W12 $ 6-21(0): W22 $ 6-21(0)
'COPY' W11 $IRZ-H11: W12 SIRZ-H12: W22$IRZ-H22
'PRIN/P' W11 $ 10.4
'PRIN/P' W12 $ 10.4
'PRIN/P' W22 $ 10.4
''
                    COMPUTE Z TV-INVZOINV
''
'CALC' S1=RSYMRI(TRANS(X1);W11)
'CALC' S1=INV(S1)
'MATR' XWX $ 3,3
'CALC' XWX=TPDT(X1;PDT(W12;X2))
'PRIN/P' XWX $ 10.4
'CALC' S2=RSYMRI(TRANS(X2);W22)-RSYMRI(TRANS(XWX);S1)
'CALC' S2=INV(S2)
'MATRIX' P11,P12,P22 $ 3,3
'CALC' P11=S1+RSYMRI(PDT(S1;XWX);S2)
'CALC' P12=-PDT(S1;PDT(XWX;S2))
'CALC' P22=S2
'PRIN/P' P11 $ 10.4
'PRIN/P' P12 $ 10.4
'PRIN/P' P22 $ 10.4
''
                    COMPUTE Z-TR W-INV Y
''
'VARI' U1,U2 $ 3
'CALC' U1=TPDT(X1;PDT(W11;AMN))+TPDT(X1;PDT(W12;BMN))
'CALC' U2=TPDT(X2;PDT(W12;AMN))+TPDT(X2;PDT(W22;BMN))
''
                          COMPUTE BETA'S
''
'CALC' BETA1=PDT(P11;U1)+PDT(P12;U2)
'CALC' BETA2=PDT(TRANS(P12);U1)+PDT(P22;U2)
''
                          COMPUTE Q
''
'CALC' Q=TPDT(AMN;PDT(W11;AMN))+2*TPDT(AMN;PDT(W12;BMN))
'CALC' Q=Q+TPDT(BMN;PDT(W22;BMN))
'CALC' Q=Q-TPDT(BETA1;U1)-TPDT(BETA2;U2)
'CALC' FITED1=PDT(X1;BETA1)
'CALC' RESIDU1=AMN-FITED1
'CALC' FITED2=PDT(X2;BETA2)
'CALC' RESIDU2=BMN-FITED2
'PRIN/P' BETA1,BETA2  $ 10.4
'PRIN/P' AMN,FITED1,RESIDU1,BMN,FITED2,RESIDU2  $ 10.4
'PRIN/P' Q $ 10.4
'CALC' Q=TPDT(RESIDU1;PDT(W11;RESIDU1))+2*TPDT(RESIDU1;PDT(W12;RESIDU2))
'CALC' Q=Q+TPDT(RESIDU2;PDT(W22;RESIDU2))
'PRIN/P' Q $ 10.4
'RUN'
1.2170E2 1.1338E1 7.6340E0 8.3710E-2 2.7655E-1
1.2233E2 1.1709E1 3.3083E1 4.1743E-1 1.0924E0
```

```
1.2200E2 1.0960E1 8.0533E1 1.0085E0 4.7102E0
1.2230E2 1.1468E1 9.3890E0 1.4552E-1 1.1739E-2
1.0430E2 1.0039E1 1.3570E1 1.2133E0 1.5129E0
9.3700E1 1.0999E1 3.0900E0 5.7530E-2 9.8215E-2
'EOD'
'CLOSE'
'STOP'
```

RESULTS FROM SCALING TEST FOR BIVARIATE CHARACTERS

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
AMN	93.7	114.4	122.3	6	0
BMN	10.04	11.09	11.71	6	0
AVAR	3.09	24.55	80.53	6	0
BVAR	0.0575	0.4877	1.2133	6	0
ABCOV	0.012	1.284	4.710	6	0

AMN	BMN	AVAR	BVAR	ABCOV
121.7000	11.3380	7.6340	0.0837	0.2766
122.3300	11.7090	33.0830	0.4174	1.0924
122.0000	10.9600	80.5330	1.0085	4.7102
122.3000	11.4680	9.3890	0.1455	0.0117
104.3000	10.0390	13.5700	1.2133	1.5129
93.7000	10.9990	3.0900	0.0575	0.0982

V1	V2	CORELESN
0.1310	11.9460	0.3459
0.0302	2.3956	0.2940
0.0124	0.9916	0.5227
0.1065	6.8719	0.0100
0.0737	0.8242	0.3729
0.3236	17.3822	0.2329

BETA1
108.0291
14.5176
17.9925

S1

1	2.5942		
2	1.0550	2.5177	
3	-4.5166	-1.4877	23.3011

1 2 3

AMN	FITED1	RESIDU1
121.7000	122.5467	-0.8467
122.3300	124.2842	-1.9542
122.0000	126.0216	-4.0216
122.3000	117.0254	5.2746
104.3000	109.7666	-5.4666
93.7000	93.5116	0.1884

0 5.5871

BETA2

11.1900
0.2023
0.2262

S2

1	0.0344		
2	0.0061	0.0343	
3	-0.0597	-0.0143	0.3887

1 2 3

BMN	FITED2	RESIDU2
11.3380	11.3923	-0.0543
11.7090	11.4042	0.3048
10.9600	11.4162	-0.4562
11.4680	11.3031	0.1649
10.0390	11.2020	-1.1630
10.9990	10.9877	0.0113

Q 1.7678

W11

1	0.1488					
2	0.0000	0.0331				
3	0.0000	0.0000	0.0171			
4	0.0000	0.0000	0.0000	0.1065		
5	0.0000	0.0000	0.0000	0.0000	0.0856	
6	0.0000	0.0000	0.0000	0.0000	0.0000	0.3422

1 2 3 4 5 6

W12

1	-0.4916					
2	0.0000	-0.0866				
3	0.0000	0.0000	-0.0798			
4	0.0000	0.0000	0.0000	-0.0086		
5	0.0000	0.0000	0.0000	0.0000	-0.1067	
6	0.0000	0.0000	0.0000	0.0000	0.0000	-0.5842

1 2 3 4 5 6

W22

1	13.5701					
2	0.0000	2.6222				
3	0.0000	0.0000	1.3642			
4	0.0000	0.0000	0.0000	6.8726		
5	0.0000	0.0000	0.0000	0.0000	0.9573	
6	0.0000	0.0000	0.0000	0.0000	0.0000	18.3796

1 2 3 4 5 6

XVX

	1	2	3
1	-1.3575	0.1027	-0.1807
2	0.1027	-1.1241	0.0050
3	-0.1807	0.0050	-0.1303

P11

	1	2	3
1	2.5935	1.0553	-4.5038
2	1.0553	2.5136	-1.4630
3	-4.5038	-1.4630	22.3667

P12

	1	2	3
1	0.0913	0.0421	-0.1867
2	0.0410	0.0889	-0.0803
3	-0.1749	-0.0711	0.8270

P22

	1	2	3
1	0.0343	0.0060	-0.0591
2	0.0060	0.0343	-0.0141
3	-0.0591	-0.0141	0.3696

BETA1	BETA2
108.0130	11.1972
14.4836	0.2105
18.6692	0.3510

AMN	FITED1	RESIDU1	BMN	FITED2	RESIDU2
121.7000	122.4967	-0.7967	11.3380	11.4077	-0.0697
122.3300	124.5895	-2.2595	11.7090	11.4779	0.2311
122.0000	126.6823	-4.6823	10.9600	11.5482	-0.5882
122.3000	117.3477	4.9523	11.4680	11.3727	0.0953
104.3000	110.1058	-5.8058	10.0390	11.2675	-1.2285
93.7000	93.5294	0.1706	10.9990	10.9868	0.0122

Q 6.3965

Q 6.3965

113 'CLOSE'

******** END OF JOINTSC. MAXIMUM OF 4346 DATA UNITS USED AT

PROGRAMS FOR MULTI-LOCATIONAL TRIALS

PROGRAM FOR STABILITY ANALYSIS (EBERHART & RUSSELL MODEL)

```
'REPE/NUMM=400,NID=400,PRINT=2' STABILITYANALYSIS
'UNIT' $ 150
'SCAL' NV=10; NL=5; NREP=3; NGROUPS=5
'FACT' VARIETY $ NV : LOCATION $ NL
'FACT' REP $ NREP
'INPUT' 2
'READ/P,NUM=0' REP,VARIETY,LOCATION,V(1)
'INPUT' 1
'SCAL' JJ
'CALC' JJ=NV*NL
'RUN'
'FOR' YSET=V(1)
'HEAD' HJ='' ------------ ***  END OF VARIABLE *** ------------''
'VARI' LOCSD,TRTMEAN,STABPARM,LOC(1...NL),DEV1,DEV2,ENTRY,DEDF$ NV
'VARI' VRSET,DFSET $ NL
'VARI' ENTRY=1...NV
'HEAD' SOURCE=
''Source of Variation          DF             SS             MS ''
'HEAD' H0='' REPLICATION ''
'HEAD' H1='' VARIETIES''
'HEAD' H2='' ENVIRONMENT ''
'HEAD' H3='' REPLICATIONS WITHIN ENVIRONMENTS ''
'HEAD' H4='' VARIETIES X ENVIRONMENTS ''
'HEAD' H5='' RESIDUAL ''
'HEAD' H6='' TOTAL ''
'HEAD' H7='' GRAND MEAN ''
'LINE' 3
'CAPT'
''
                    Environment-wise Analysis of Variance
''
'LINE' 1
'PRIN' SOURCE
'FOR' LL=1...NL
'REST' YSET $ LOCATION=LL
'BLOCK' REP/VARIETY
'TREAT' VARIETY
'ANOVA/PR=0' YSET; OUT=AOV1
'EXTR' AOV1; REP+VARIETY+REP.VARIETY $ SS=SS1,SS2,SS3;
                    DF=DF1,DF2,DF3
'CALC' ELEM(VRSET;LL)=SS3: ELEM(DFSET;LL)=DF3
'SCAL' VMS,EMS,TDF,TSS
'CALC' VMS=SS2/DF2: EMS=SS3/DF3: TDF= DF1+DF2+DF3: TSS=SS1+SS2+SS3
'PRIN/C,LABR=1,LABC=1' H2,LL $ 0,5.0
'PRIN/C,LABR=1,LABC=1' H0,DF1,SS1 $  0,28,2(15.3)
'PRIN/C,LABR=1,LABC=1' H1,DF2,SS2,VMS $ 0,30,2(15.3)
'PRIN/C,LABR=1,LABC=1' H5,DF3,SS3,EMS $ 0,31,2(15.3)
'PRIN/C,LABR=1,LABC=1' H6,TDF,TSS $ 0,34,2(15.3)
'DEVA' SS1,DF1,SS2,DF2,VMS,EMS,TDF,TSS,SS3,DF3
'LINE' 1
'REPE'
'REST' YSET
```

```
'HEAD' BQ=
''
        *** BARTLETT'S TEST FOR HOMOGENEITY OF VARIANCE ***
''
'HEAD' BQ1='' DEGREES OF FREEDOM ''
'HEAD' BQ2='' CHI-SQUARE VALUE ''
'HEAD' BQ3='' PROBABILITY''
'SCAL' Q,PROB,NG
'CALC' Q=1+(SUM(1/DFSET)-1/SUM(DFSET))/3/(NGROUPS-1)
'CALC' Q=(SUM(DFSET)*LOG(SUM(DFSET*VRSET)/SUM(DFSET))
          -SUM(DFSET*LOG(VRSET)))/Q
'CALC' NG=NGROUPS-1
'CALC' PROB=1-CPROB(Q;NG)
'PRIN' BQ
'PRIN/C,LABR=1,LABC=1' BQ1,NG $ 0,30.0
'PRIN/C,LABR=1,LABC=1' BQ2,Q $ 0,32.4
'PRIN/C,LABR=1,LABC=1' BQ3,PROB $ 0,37.4
'BLOCK'
'TREAT'
'TREAT' VARIETY+LOCATION+REP.LOCATION+LOCATION.VARIETY
          +REP.LOCATION.VARIETY
'ANOVA/PR=0' YSET; OUT=AOV1
'EXTR' AOV1; VARIETY $ SS=SSV; DF=VDF
'EXTR' AOV1; LOCATION $ SS=SSEN; DF=LDF
'EXTR' AOV1; REP.LOCATION $ SS=SSRE; DF=RDF
'EXTR' AOV1; LOCATION.VARIETY $ SS=SSVE; DF=VEDF; MEAN=MN1
'EXTR' AOV1; REP.LOCATION.VARIETY $ SS=SSE; DF=EDF
'SCAL' VMS,TDF,VEMS,LMS,RMS,EMS,TSS,PESS
'CALC' VMS=SSV/VDF:VEMS=SSVE/VEDF: LMS=SSEN/LDF: RMS=SSRE/RDF
'CALC' EMS=SSE/EDF:TDF=VDF+LDF+RDF+VEDF+EDF
'CALC' TSS=SSV+SSEN+SSRE+SSVE+SSE: PESS=SSE/NREP
'VARI' LOCMEAN $ JJ
'EQUA' LOCMEAN=MN1
'EQUA' LOC(1...NL)=LOCMEAN
'PAGE' 1
'LINE' 5
'TREAT'
'CAPT'
''
                    Analysis of Variance of Pooled data
''
'LINE' 1
'PRIN' SOURCE
'PRIN/C,LABR=1,LABC=1' S1,VDF,SSV,VMS $ 0,30,2(15.3)
'PRIN/C,LABR=1,LABC=1' S2,LDF,SSEN,LMS $ 0,28,2(15.3)
'PRIN/C,LABR=1,LABC=1' S3,RDF,SSRE,RMS $ 0,7,2(15.3)
'PRIN/C,LABR=1,LABC=1' S4,VEDF,SSVE,VEMS $ 0,15,2(15.3)
'PRIN/C,LABR=1,LABC=1' S5,EDF,SSE,EMS $ 0,31,2(15.3)
'PRIN/C,LABR=1,LABC=1' S6,TDF,TSS $ 0,34,2(15.3)
'REST' YSET
'SCAL' LM(1...NL)
'CALC' LM(1...NL)=MEAN(LOC(1...NL))
'CALC' LOCSD=SQRT(VVAR(LOC(1...NL)))
'LINE' 2
'CAPT' '' ** Mean data averaged over replications ** ''
```

```
'PRIN/P,LEN=5' ENTRY,LOC(1...NL),LOCSD $ 5.0,20.2,20(10.2)
'PRIN/P,LEN=5,LABR=1,LABC=1' LN(1...NL) $ 25.2,20(10.2)
''
              Variety means
''
'FOR' E=1...NV
'REST' YSET $ VARIETY=E
'CALC' ELEM(TRTMEAN;E)=MEAN(YSET)
'REPE'
'SCAL' GMEAN
'CALC' GMEAN=MEAN(TRTMEAN)
'REST' YSET
'SCAL' SS1,SS3,SS3,DF1,DF2,DF3,SS1MS,SS2MS,SS3MS,TDFF,TSS1
'FACT' ENTRIES $ NV=(1...NV)NL : ENVIRON $ NL=NV!(1...NL)
'FACT' GENO $ NV,NV=1...NV
'TREAT' ENTRIES+ENVIRON+ENTRIES.ENVIRON
'ANOVA/PR=0' LOCMEAN ; OUT=AOV
'EXTR' AOV; ENTRIES $ SS=SS1; DF=DF1
'EXTR' AOV; ENVIRON $ SS=SS2; DF=DF2
'EXTR' AOV; ENTRIES.ENVIRON $ SS=SS3; DF=DF3
'CALC' SS1MS=SS1/DF1: SS2MS=SS2/DF2: SS3MS=SS3/DF3
    :  TDFF=DF1+DF2+DF3
'CALC' TSS1=SS1+SS2+SS3
''
              Computation of Environmental Index
''
'SCAL' EI(1...NL),CPF
'CALC' CPF=SUM(LOCMEAN)/JJ
'CALC' EI(1...NL)=MEAN(LOC(1...NL))-CPF
'CALC' EI(1...NL)=EI(1...NL)
'LINE' 1
'CAPT'
''ENVIRONMENTAL INDEX ''
'PRINT/P,LABC=1,LABR=1' EI(1...NL) $ 14.4
'LINE' 1
'VARI' X(1...NL) $ NV
'FOR' Z=LOC(1...NL); Z1=EI(1...NL); XX=X(1...NL)
'VARI' XX $ NV
'CALC' XX=Z*Z1
'REPE'
''
              Computing regression coefficients for each variety
''
'VARI' TT $ NV
'CALC' TT=VSUM(X(1...NL))
'VARI' BETA $ NL
'EQUA' BETA=EI(1...NL)
'SCAL' BETA1
'CALC' BETA1=SUM(BETA**2)
'VARI' REGCOF $ NV
'CALC' REGCOF=TT/BETA1
'CAPT'
''   CORRELATION BETWEEN REGRESSION COEFFICIENT
    AND STD.DEV OF ENTRIES ''
'TERMS/C' LOCSD,REGCOF
```

```
''
            Variances of means over different locations with
            regard to individual varieties
''
'VARI' VM1,VM(1...NL),VM $ NV
'CALC' VM(1...NL)=(LOC(1...NL)**2)
'CALC' VM=VSUM(VM(1...NL))
'CALC' VM1=VSUM(LOC(1...NL))
'VARI' VARMEAN $ NV
'CALC' VARMEAN=VM-((VM1**2)/NL)
'CALC' DEV1=TT*REGCOF
'CALC' DEV2=VARMEAN-DEV1
'SCAL' SDEV1,SDEV2
'CALC' SDEV1=SUM(DEV1): SDEV2=SUM(DEV2)
''
            SS due to environment (linear)
''
'SCAL' L(1...NL),SSELIN,SSVLL
'CALC' L(1...NL)=SUM(LOC(1...NL))
'VARI' LS $ NL
'EQUA' LS=L(1...NL)
'CALC' SSELIN=(1/NV)*(SUM(LS*BETA)**2)/BETA1
'CALC' SSVLL=SDEV1-SSELIN
'SCAL' PDMS,EVDF,EVSS,SSVLLMS,PDFF,PEDF,DDF,PEMS1
'CALC' EVDF=DF2+DF3: EVSS=SS2+SS3
'SCAL' SSELDF=1
'CALC' SSVLLMS=SSVLL/DF1: PDFF=NV*(NL-2): PEDF=NL*(NREP-1)*(NV-1)
'CALC' PDMS=SDEV2/PDFF: DDF=NL-2 : PEMS1=PESS/PEDF
'CALC' DEDF=DDF
'HEAD' TITLE=


Source of Variation                DF          SS              MS

''
'HEAD' TTL=
''


''
'HEAD  H(5)='' ENV+(VARIETIES X ENVIROMENTS) ''
'HEAD  H(6)='' ENVIRONMENT (LINEAR) ''
'HEAD  H(7)='' VARIETY X ENVIRONMENT (LINEAR) ''
'HEAD  H(8)='' POOLED DEVIATION ''
'HEAD  H(10)='' POOLED ERROR ''
'HEAD  HH='' ANALYSIS OF VARIANCE ''
'PAGE  1
'PRIN  HH
'PRIN  TITLE
'PRIN/C,LABR=1,LABC=1' H1,DF1,SS1,SS1MS $ 0,30,2(15.3)
'PRIN/C,LABR=1,LABC=1' H(5),EVDF,EVSS $ 0,10,2(15.3)
'PRIN/C,LABR=1,LABC=1,LHM=3' H(6),SSELDF,SSELIN $ 0,16,2(15.3)
'PRIN/C,LABR=1,LABC=1,LHM=3' H(7),VDF,SSVLL $ 0,6,2(15.3)
'PRIN/C,LABR=1,LABC=1,LHM=3' H(8),PDFF,SDEV2,PDMS $ 0,20,2(15.3)
'PRIN/LHM=10' H1
'PRIN/P,LABC=1,LABR=1,LHM=10' ENTRY,DEDF,DEV2 $ 10.0,20,2(15.3)
```

```
'PRIN/C,LABR=1,LABC=1' H(10),PEDF,PEMS,PEMS1 $ 0,27,2(15.3)
'PRIN' TTL
''
          ESTIMATING STABILITY PARAMETERS FOR EACH VARIETY
''
'CALC' STABPARM=(DEV2/DDF)-PEMS1
'CAPT'
'' TEST OF PERFORMANCE (PREDICTED) OF ENTRIES AT EACH LOCATION **
'VARI' PROVRAL,PR(1...NL) $ NV
'CALC' PR(1...NL)=TRTMEAN+REGCOF*(LM(1...NL)-GMEAN)
'CALC' PROVRAL=VMEAN(PR(1,..NL))
'PRIN/P' ENTRY,PR(1...NL),PROVRAL $ 5.0,20(8.2)
'SCAL' PRL(1,,.NL)
'CALC' PRL(1...NL)=MEAN(PR(1...NL))
'PRIN/P,LABR=1,LABC=1' PRL(1...NL) $ 13.2,20(8.2)
'PAGE' 1
'CAPT'
''*** TABLE OF STABLITY PARAMETERS *** ''
'LINE' 1
'PRIN/P' ENTRY,TRTMEAN,REGCOF,STABPARM $ 10,(10.3)3
'LINE' 1
'PRIN/C,LABR=1,LABC=1' M7,GMEAN $ 0,10.4
'SCAL' SEBETA
'CALC' SEBETA=SQRT(PDMS/BETA1)
'LINE' 1
'HEAD' SES=''STANDARD ERROR OF BETA''
'HEAD' SM=''STANDARD ERROR (MEAN)''
'LINE' 3
'VARI' TSTAB,TREG,LMEANS(1...NL) $ NV
'CALC' LMEANS(1...NL)=MEAN(LOC(1...NL))
'VARI' LMEANS $ JJ
'EQUA' LMEANS=LMEANS(1...NL)
'CALC' TREG=(REGCOF-1)/SEBETA
'SCAL' SEM
'CALC' SEM=SQRT(PDMS/(NL-1))
'CALC' TSTAB=(STABPARM/PEMS1)+1
'PRIN/C,LABC=1,LABR=1' SES,SEBETA $ 0,10.4
'PRIN/C,LABC=1,LABR=1' SM,SEM $ 0,10.4
'LINE' 3
'CAPT'
''** TEST FOR REGR. COEFF. AGAINST 1 : COMPARE TREG AGAINST
TVALUE WITH  ITS DEVIATION DEGREES OF FREEDOM AND STABLITY
PARAMETERS AGAINST 0  : COMPARE TSTAT AGAINST P-VALUE WITH
DEVIATION DEGREES OF FREEDOM AND POOLED EDF
** ''
'LINE'1
'PRIN/P' ENTRY,REGCOF,TREG,STABPARM,TSTAB $ 10.0,10(10.3)
'HEAD' T1=''LOCATION MEANS '' : T2=''VARIETY MEANS YIELDS''
'HEAD' T3=''REGRESSION COEFFICIENTS''
'HEAD' T4='' S2 D''
'PAGE' 1
'GRAPH/ATX=T1,ATY=T2' LOCMEAN;LMEANS $ ;ENTRIES
'PAGE' 1
'GRAPH/ATX=T2,ATY=T3' REGCOF;TRTMEAN $ ;GENO
'PAGE' 1
```

```
'GRAPH/ATX-T2,ATY-T4' STABPARM;TRTMEAN $ ;GEND
'LINE' 2
'PRIN' BJ
'REPE'
'RUN'
'CLOSE'
'STOP'
```

Output from Stability Analysis

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
V(i)	15.00	30.74	52.80	150	0

Environment-wise Analysis of Variance

Source of Variation		DF	SS	MS
ENVIRONMENT	1			
REPLICATION		2	26.574	
VARIETIES		9	659.514	73.279
RESIDUAL		18	481.579	26.754
TOTAL		29	1167.667	
ENVIRONMENT	2			
REPLICATION		2	14.456	.
VARIETIES		9	951.635	105.737
RESIDUAL		18	795.097	44.172
TOTAL		29	1761.188	
ENVIRONMENT	3			
REPLICATION		2	4.829	
VARIETIES		9	287.643	31.960
RESIDUAL		18	294.298	16.350
TOTAL		29	586.770	
ENVIRONMENT	4			
REPLICATION		2	3.462	
VARIETIES		9	527.680	58.631
RESIDUAL		18	429.485	23.860
TOTAL		29	960.627	
ENVIRONMENT	5			
REPLICATION		2	214.304	
VARIETIES		9	310.927	34.547
RESIDUAL		18	670.909	37.273
TOTAL		29	1196.140	

*** BARTLETT'S TEST FOR HOMOGENEITY OF VARIANCE ***

DEGREES OF FREEDOM	4
CHI-SQUARE VALUE	5.1627
PROBABILITY	0.2703

Analysis of Variance of Pooled data

Source of Variation	DF	SS	
VARIETIES	9	848.118	94.2[illegible]
ENVIRONMENT	4	2249.017	562.2[illegible]
REPLICATIONS WITHIN ENVIRONMENTS	10	263.625	26.3[illegible]
VARIETIES X ENVIRONMENTS	36	1889.281	52.4[illegible]
RESIDUAL	90	2671.369	29.6[illegible]
TOTAL	149	7921.409	

** Mean data averaged over replications **

ENTRY	LOC(1)	LOC(2)	LOC(3)	LOC(4)	LOC(5)	LOCSD
1	43.13	30.73	23.60	26.77	31.70	7.42
2	38.67	33.43	24.17	24.60	29.50	6.13
3	29.60	43.83	33.67	28.83	27.00	6.74
4	40.33	26.13	26.60	29.90	29.50	5.75
5	41.47	40.43	27.97	32.43	27.40	6.70
6	33.43	38.73	28.27	32.27	36.77	4.07
7	40.70	34.90	26.97	27.00	29.63	5.91
8	32.27	27.60	22.50	23.27	24.50	3.99
9	36.27	27.57	24.47	24.97	31.60	4.96
10	30.23	32.43	28.83	17.87	32.40	6.06
	36.61	33.58	26.70	26.79	30.00	

ENVIRONMENTAL INDEX

5.8733 2.8433 -4.0333 -3.9467 -0.7367

ANALYSIS OF VARIANCE

Source of Variation	DF	SS	MS
VARIETIES	9	282.706	31.412
ENV+(VARIETIES X ENVIROMENTS)	40	1379.433	
ENVIRONMENT (LINEAR)	1	749.668	
VARIETY X ENVIRONMENT (LINEAR)	9	103.957	
POOLED DEVIATION	30	525.806	17.527
VARIETIES			
1	3	39.109	
2	3	0.792	
3	3	170.648	
4	3	77.399	
5	3	52.664	
6	3	46.879	
7	3	3.508	
8	3	3.266	
9	3	31.397	
10	3	100.145	
POOLED ERROR	90	890.456	9.894

*** TEST OF PERFORMANCE (PREDICTED) OF ENTRIES AT EACH LOCATION ***

ENTRY	PR(1)	PR(2)	PR(3)	PR(4)	PR(5)	PROVRAL
1	40.32	35.61	24.92	25.05	30.04	31.19
2	38.37	34.09	24.38	24.50	29.03	30.07
3	34.86	33.69	31.03	31.06	32.30	32.59
4	35.52	32.93	27.04	27.11	29.86	30.49
5	41.58	37.64	28.69	28.81	32.98	33.94
6	36.87	35.34	31.85	31.89	33.52	33.89
7	39.76	35.68	26.40	26.52	30.85	31.84
8	31.30	28.58	22.40	22.48	25.36	26.03
9	34.53	31.66	25.16	25.24	28.28	28.97
10	32.98	30.60	25.17	25.24	27.77	28.35
	36.61	33.58	26.70	26.79	30.00	

*** TABLE OF STABLITY PARAMETERS ***

ENTRY	TRTMEAN	REGCOF	STABPARM
1	31.187	1.555	3.142
2	30.073	1.412	-9.630
3	32.587	0.387	46.989
4	30.493	0.856	15.906
5	33.940	1.301	7.661
6	33.893	0.508	5.732
7	31.840	1.349	-8.725
8	26.027	0.899	-8.805
9	28.973	0.946	0.572
10	28.353	0.789	23.488

GRAND MEAN 30.7367

STANDARD EROR OF BETA 0.4835
STANDARD ERROR (MEAN) 2.0933

** TEST FOR REGR. COEFF. AGAINST 1 AND STABLITY PARAMETERS AGAINST 0

ENTRY	REGCOF	TREG	STABPARM	TSTAB
1	1.555	1.147	3.142	1.318
2	1.412	0.853	-9.630	0.027
3	0.387	-1.268	46.989	5.749
4	0.856	-0.298	15.906	2.608
5	1.301	0.622	7.661	1.774
6	0.508	-1.018	5.732	1.579
7	1.349	0.722	-8.725	0.118
8	0.899	-0.210	-8.805	0.110
9	0.946	-0.112	0.572	1.058
10	0.789	-0.437	23.488	3.374

---------- ---- *** END OF VARIABLE *** ----------

******** END OF STABILIT. MAXIMUM OF 10212 DATA UNITS USED
AT LINE 261 (317468 LEFT)

PROGRAM FOR COMBINED RBD ANALYSIS

```
'REPE' COMBENVS
'UNITS' $60
''
              ------------------------------------------------------
              INPUT
                      FACTORS :
                      YVARS   :
                      NREP    : No of replications used in calc
                                weight variable
                      NENV    : No of ENV EXPERIMENTS
                      PROBLEV : Level of significance
              ------------------------------------------------------
''
'FACT' ENV$4;ENTRY$5 ;REP$3
'SCAL' NREP=3;NENV=4 ;PROBLEV=.05
'GENE' ENV,ENTRY,REP
'CALC'
YLD=23+45.9*RANDU(321;60)*RANDU(32;60)+34*RANDU(41;60)-31*RANDU(21;60)
'VARI' MDF,MS$NENV
'FOR' I=1...NENV
'CAPT' ''                          FOR ENVIRONMENT''
'PRINT' I
'REST' YLD,VET$ENV=I
'BLOCK' REP/ENTRY
'TREAT' ENTRY
'ANOVA' YLD;OUT=YOUT
'SCAL' EDF,ESS,TDF,TSS
'EXTR'YOUT;REP/ENTRY+ENTRY$DF=TDF,EDF;SS=TSS,ESS
'CALC' VET=NREP*EDF/ESS
 : ELEM(MDF;I)=EDF :ELEM(MS;I)=ESS/EDF
'REPE'
''               TEST HOMOGENEITY OF ERROR VARIANCES
                 OVER LINESOURCE ENVIRONMENTS
''
'PRINT/P' MDF,MS
'SCAL' Q,PROB,NENV1
'CALC' NENV1=NENV-1
'CALC' Q=1+(SUM(1/MDF)-1/SUM(MDF))/3/NENV1
    : Q=(SUM(MDF)*LOG(SUM(MDF*MS)/SUM(MDF))-SUM(MDF*LOG(MS)))/Q
    : PROB=1-CPROB(Q;NENV1)
'PRINT/P' NENV1,Q,PROB
'REST' YLD,VET,ENV
'JUMP' LCOMB*(PROB.GT.PROBLEV)
'CAPT'   ''                        ERROR MEAN SQUARES WERE FOUND
         SIGNIFICANTLY HETEROGENEOUS:      WEIGTHED ANALYSIS DONE
''
'BLOCK'REP/ENTRY
'TREAT' ENV*ENTRY
'ANOVA/VT=VET' YLD
'LABE'LCOMB
'CAPT' ''                 EITHER ERROR VARIANCES ARE HOMOGENEOUS OR
                          WEIGHTS IGNORED FOR COMPARISON WITH WEIGHTED

                          ANALYSIS
''
'BLOCK'REP/ENTRY
'TREAT' ENV*ENTRY
'ANOVA' YLD
'RUN'
'CLOS'
'STOP'
```

Output from Combined RBD Analysis

FOR ENVIRONMENT 1

***** ANALYSIS OF VARIANCE *****

VARIATE: YLD

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
REP STRATUM	2	1047.7	15.32	523.9	
REP.ENTRY STRATUM					
ENTRY	4	2098.5	30.69	524.6	1.137
RESIDUAL	8	3692.0	53.99	461.5	
TOTAL	12	5790.5	84.68	482.5	
GRAND TOTAL	14	6838.2	100.00		

GRAND MEAN 37.5
TOTAL NUMBER OF OBSERVATIONS 15

***** TABLES OF MEANS *****

VARIATE: YLD

GRAND MEAN 37.5

ENTRY	1	2	3	4	5
	31.9	48.4	42.0	48.1	17.1

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

TABLE	ENTRY
REP	3
SED	17.54

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

STRATUM	DF	SE	CV%
REP	2	10.24	27.3
REP.ENTRY	8	21.48	57.3

NDF		MS	
8.0000E	0	4.6151E	2
8.0000E	0	8.5893E	1
8.0000E	0	2.8448E	2
8.0000E	0	1.7209E	2

NENV1 3.0000E 0 Q 5.4400E 0 PROB 1.4070E -1
EITHER ERROR VARIANCES ARE HOMOGENEOUS OR
WEIGHTS IGNORED FOR COMPARISON WITH WEIGHTED
ANALYSIS

***** ANALYSIS OF VARIANCE *****
VARIATE: YLD

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
REP STRATUM	2	457.5	3.17	228.7	
REP.ENTRY STRATUM					
ENTRY	4	392.9	2.72	98.2	0.328
RESIDUAL	8	2394.6	16.58	299.3	
TOTAL	12	2787.5	19.30	232.3	
REP.ENTRY.*UNITS* STRATUM					
ENV	3	155.1	1.07	51.7	0.214
ENTRY.ENV	12	3785.5	26.22	315.5	1.305
RESIDUAL	30	7254.5	50.24	241.8	
TOTAL	45	11195.1	77.53	248.8	
GRAND TOTAL	59	14440.1	100.00		

GRAND MEAN 35.6
TOTAL NUMBER OF OBSERVATIONS 60

***** TABLES OF MEANS *****

VARIATE: YLD

GRAND MEAN 35.6

ENV	1	2	3	4
	37.5	33.1	36.2	35.5

ENTRY	1	2	3	4	5
	35.2	37.6	37.5	36.8	30.7

ENV / ENTRY	1	2	3	4
1	31.9	41.5	26.5	41.0
2	48.4	27.1	51.2	23.9
3	42.0	38.0	33.0	36.9
4	48.1	30.7	31.8	36.5
5	17.1	28.2	38.7	38.9

***** STANDARD ERRORS OF DIFFERENCES OF MEANS *****

TABLE	ENV	ENTRY	ENTRY ENV
REP	15	12	3
SED	5.68	7.06	13.07
EXCEPT WHEN COMPARING MEANS WITH SAME LEVEL(S) OF:			
ENTRY			12.70

***** STRATUM STANDARD ERRORS AND COEFFICIENTS OF VARIATION *****

STRATUM	DF	SE	CV%
REP	2	3.38	9.5
REP.ENTRY	8	8.65	24.3
REP.ENTRY.*UNITS*	30	15.55	43.7

PROGRAM FOR COMBINED RBD ANALYSIS WITH UNEQUAL REPLICATIONS

```
'REFE/NUMN=300,NID=300,PRINT=Z' COMBINED
'UNIT' $ 208
'SCAL' NL=4 : NT=13
'NAME'
NN1=AH7223,J11,U4-47-7,UP71513,PI337394F,VAR27,ICGSAF58,ICGSAF78,
          TMV2,P1-5XNCAC17090,GANGAPURI,NCAC17090,EC76446(292)
'FACT' REP $ 4=(1...4)52 : TRT $ NN1=4(1...13)4 : LOCATION $
4=52(1...4)
'VARI' REPLICATES=4,4,4,4
'INPU' 2
'READ/P' AF,OF,YIELD,AFT
'INPU' 1
'RUN'
'SCAL' E(1...NL),D(1...NL),SE(1...NL),CV(1...NL)
'FOR' YSET=AF,OF,YIELD,AFT
'VARI' LOC(1...NL) $ NT
'SCAL' R(1...NL)
'EQUA' R(1...NL)=REPLICATES
'FOR' Z=1...NL;ES1=E(1...NL);DF1=D(1...NL);NREP=R(1...NL);
       M=LOC(1...NL); SE=SE(1...NL); CVS=CV(1...NL)
'REST' YSET $ LOCATION=Z
'BLOCK' REP/TRT
'TREAT' TRT
'ANOVA/PR=0' YSET ; OUT=AOV
'EXTR' AOV; REP.TRT $ SS=SS1;DF=DF1
'EXTR  AOV; TRT $ MEAN=MN
'EQUA  M=MN
'SCAL  ES2,ES1,SE
'CALC  ES1=(SS1/DF1)
'CALC  CVS=SQRT(ES1)/MEAN(M)*100
'CALC  SE=SQRT(ES1/NREP)
'REPE
'REST  YSET
'VARI  DFSUM,DFSET,VARSET $ NL
'EQUA  DFSET=D(1...NL) : VARSET=E(1...NL)
'HEAD  HQ=
''
              *** BARTLETT'S TEST FOR HOMOGENEITY OF VARIANCE ***
''
'HEAD' HQ1=
'' BARTLETT'S TEST FOR HOMOGENEITY OF VARIANCE.
 THIS IS DISTRIBUTED APPROXIMATELY AS CHI-SQUARED WITH D.F. ''
'HEAD' HQ2='' CHI-SQUARE VALUE ''
'SCAL' TABCHI,Q,PROB,NG
'CALC' Q=1+(SUM(1/DFSET)-1/SUM(DFSET))/3/(NL-1)
'CALC' Q=(SUM(DFSET)*LOG(SUM(DFSET*VARSET)/SUM(DFSET))-
              SUM(DFSET*LOG(VARSET)))/Q
'CALC' NG=NL-1
'CALC' TABCHI=CHISQ(0.95;NG)
'PAGE' 1
'PRIN' HQ
'LINE' 3
```

```
'CAPT' ''              VARIANCES     DEGREES OF FREEDOM ''
'PRIN/P,LABR=1,LABC=1' VARSET,DFSET $ 20.3,20.0
'LINE' 3
'PRIN/C,LABR=1,LABC=1' MO1,NG $ 0,5.0
'PRIN/C,LABR=1,LABC=1' MO2,Q $ 0,15.4
'LINE' 4
'BLOCK'
'TREA' LOCATION*TRT
'ANOVA/PR=0' YSET; OUT=AOV1
'EXTR' AOV1; TRT $ SS=SS2; DF=DF2
'    ' AOV1; LOCATION $ SS=SS3; DF=DF3
'EXTR' AOV1; TRT.LOCATION $ SS=SS4; DF=DF4
'SCAL' EMS,NPLOT,EDF,TMS,LMS,TLMS,VR1,VR2,VR3
'CALC' TMS=SS2/DF2: LMS=SS3/DF3: TLMS=SS4/DF4
'CALC' EDF=VSUM(D(1...NL))
'JUMP' L1*(Q.GT.TABCHI)
'CAPT'
''
                  ****************************************
                  Error variances are homogeneous hence
                  pooled error m.s. is the
                  error m.s. at each location weighted
                  by their corresponding degrees
                  of freedom
                  ****************************************
''
'SCAL' EMS
'CALC' DFSUM=VARSET*DFSET
'CALC' EMS=SUM(DFSUM)/SUM(DFSET)
'JUMP' L2
'LABE' L1
'CAPT'
''
                  ****************************************
                  Error variances are heterogeneous hence
                  pooled error m.s. is the
                  error m.s. at each location weighted
                  by their corresponding replications
                  ****************************************
''
'CALC' NPLOT=VSUM(R(1...NL))
'CALC' E(1...NL)=E(1...NL)*R(1...NL)
'CALC' EMS=VSUM(E(1...NL))/NPLOT
'LABE' L2
'CALC' VR1=TMS/EMS: VR2=LMS/EMS: VR3=TLMS/EMS
'PAGE' 1
'CAPT'
''
   ** ANALYSIS OF MULTILOCATIONAL DATA WITH UNEQUAL REPLICATIONS
      ACROSS SITES (COCHRAN AND COX PAGE NO. 555) **
''
'HEAD'   ''SOURCE OF VARIATION      DF            SS            MS
VR''
'HEAD' H(1)='' Genotypes''
'HEAD' H(2)='' Environments
```

```
'HEAD' H(3)='' Gen.Env''
'HEAD' H(4)='' Pooled Error''
'PRINT' S
'PRIN/C,LABR=1,LABC=1' H(1),DF2,SS2,TMS,VR1 $ 0,17.0,2(15.3),10.1
'PRIN/C,LABR=1,LABC=1' H(2),DF3,SS3,LMS,VR2 $ 0,14.0,2(15.3),10.1
'PRIN/C,LABR=1,LABC=1' H(3),DF4,SS4,TLMS,VR3 $ 0,19,2(15.3),10.1
'PRIN/C,LABR=1,LABC=1' H(4),EDF,EMS $ 0,14.0,30.3
'LINE' 3
'CAPT' '' *** TABLE OF MEANS *** ''
'HEAD' F1='SE+/-'' : F2=''MEAN'' : F3=''CV(%)'' : F4=''REPS''
'FACT' TRTS $ NN1,NT=1...NT
'SCAL' MNS(1...NL)
'CALC' MNS(1...NL)=MEAN(LOC(1...NL))
'CALC' LOC(1...NL)=10*INTPT((LOC(1...NL)/10)+0.5)
'CALC' MNS(1...NL)=10*INTPT((MNS(1...NL)/10)+0.5)
'PRIN/P' TRTS,LOC(1...NL) $ 10.0
'LINE' 1
'PRIN/C,LABC=1,LABR=1,LHM=5' F1,SE(1...NL) $ 10,10,20(10)
'PRIN/C,LABC=1,LABR=1,LHM=6' F2,MNS(1...NL) $ 10,10,20(10)
'PRIN/C,LABC=1,LABR=1,LHM=6' F4,R(1...NL) $ 10,20(10)
'PRIN/C,LABC=1,LABR=1,LHM=5' F3,CV(1...NL) $ 10,10,20(10)
'REPE'
'RUN'
'CLOSE'
'STOP'
```

PROGRAM FOR JOINT REGRESSION ANALYSIS

```
      REAL BETA(50),THT(18),TAU(50),SBETA(50),STHT(18),STAU(50),THTD(18)
      REAL D(50,18),Y(50,18),TVALU(50)
C
C     THIS PROGRAM COMPUTES ESTIMATES FROM JOINT REGRESSION(MODIFIED)
C     ANALYSIS
C
C     MISSING VALUES ARE INDICATED BY -9999
  502 FORMAT(20X,F20.10)
  503 FORMAT(10X,I4,5F13.6)
  504 FORMAT(15X,I5,F13.6)
  500 FORMAT(10X,I4,2F13.6)
  501 FORMAT(10X,I4,F13.6)
700   FORMAT(/'    DATA OF MEANS ROWS-TREATMENTS,COLUMNS-ENVIRONMENTS')
701   FORMAT(/' ITERATION NUMBER = ',I4)
702   FORMAT(/' LAGRANGE MULTIPLIERS = ',F22.10)
703   FORMAT(/'            TREATMENT   MEAN   SENSITIVITY ')
704   FORMAT(/'            TREAT  ENVIRONMENT EFFECTS')
705   FORMAT(/' TOTAL NO. OF OBS,  COMMON ERROR VARIANCES',15X,I4,F13.6)
706   FORMAT(/'            TREAT  MEAN  SE(MEAN)  SENSITITY  SE(SNSTVTY)
     +TVALUE(SNSTVTY=1)')
707   FORMAT(/'            TREAT  ENV. EFFECTS    SE(ENV. EFFECTS)')
      NV=25
      NL=8
      ITRNO=2
      NTOT=200
C                    GENERALLY D IS SET TO ZERO FOR ABSENCE OF GEN X ENV
      WRITE(6,700)
      DO 10 I=1,NV
      DO 10 J=1,NL
      D(I,J)=1.
   10 Y(I,J)=0.
C                                  READ HERE Y AND D-----------------
      DO 1 I=1,NV
      READ(5,800) (Y(I,J),J=1,9)
      WRITE(6,801) (Y(I,J),J=1,9)
    1 CONTINUE
  800 FORMAT(X,9F8.2)
  801 FORMAT(X,9F8.2)
C                              READING OF DATA OVER ----------------
C
C                INITIALIZE THE PARAMETERS
C
      H3=0.
      H4=0.
      DO 20 J=1,NL
      H1=0.
      H2=0.
      DO 30 I=1,NV
      H1=H1+D(I,J)
      H2=H2+Y(I,J)*D(I,J)
   30 CONTINUE
      H3=H3+H1
```

```
      H4=H4+H2
      THT(J)=H2/H1
   20 CONTINUE
      H5=H4/H3
      DO 40 J=1,NL
   40 THT(J)=THT(J)-H5
C
C                    START ITERATION
      DO 2 ITR=1,ITRNO
      WRITE(6,701) ITR
C
C
C                    LEAST - SQUARE SOLUTION
      DO 50 I=1,NV
      SD=0.0
      SDY=0.0
      SDTHT=0.0
      SDTHTY=0.0
      SDTHT2=0.0
      DO 60 J=1,NL
      DIJ=D(I,J)
      THTJ=THT(J)
      YIJ=Y(I,J)
      SD=SD+DIJ
      SDY=SDY+DIJ*YIJ
      SDTHT=SDTHT+DIJ*THTJ
      SDTHTY=SDTHTY+DIJ*THTJ*YIJ
      SDTHT2=SDTHT2+DIJ*THTJ*THTJ
   60 CONTINUE
      DET=SD*SDTHT2-SDTHT*SDTHT
      TAU(I)=(SDTHT2*SDY-SDTHT*SDTHTY)/DET
      BETA(I)=(-SDTHT*SDY+SD*SDTHTY)/DET
   50 CONTINUE
C
C
      SNUM=0.
      SDEN=0.
      DO 70 J=1,NL
      SDBYMT=0.
      SDB2=0.
      DO 80 I=1,NV
      SDBYMT=SDBYMT+D(I,J)*BETA(I)*(Y(I,J)-TAU(I))
      SDB2=SDB2+D(I,J)*BETA(I)**2
   80 CONTINUE
      THT(J)=SDBYMT/SDB2
      THTD(J)=1./SDB2
      SNUM=SNUM+THT(J)
      SDEN=SDEN+THTD(J)
   70 CONTINUE
      ALMDA=SNUM/SDEN
      DO 85 J=1,NL
   85 THT(J)=THT(J)-ALMDA*THTD(J)
      WRITE(6,702) ALMDA
C
C                PRINT ESTIMATES
```

```
      WRITE(6,703)
      WRITE(6,500)( I,TAU(I),BETA(I) ,I=1,NV)
      WRITE(6,704)
      WRITE(6,501) (J,THT(J),J=1,NL)
    2 CONTINUE
C                        FIND SIGMA-SQUARE :SIGMA
      SM=0.
      DO 45 I=1,NV
      DO 45 J=1,NL
      SM=SM+D(I,J)*(Y(I,J)-TAU(I)-THT(J)*BETA(I))**2
   45 CONTINUE
      SIGMA2=SM/(NTOT-NL-2*NV+1)
C
C                     VARIANCE COVARIANCE -ASYMPTOTIC
C
      DO 90 I=1,NV
      SD=0.0
      SDY=0.0
      SDTHT=0.0
      SDTHTY=0.0
      SDTHT2=0.0
      DO 100 J=1,NL
      DIJ=D(I,J)
      THTJ=THT(J)
      YIJ=Y(I,J)
      SD=SD+DIJ
      SDY=SDY+DIJ*YIJ
      SDTHT=SDTHT+DIJ*THTJ
      SDTHTY=SDTHTY+DIJ*THTJ*YIJ
      SDTHT2=SDTHT2+DIJ*THTJ*THTJ
  100 CONTINUE
      DET=SD*SDTHT2-SDTHT*SDTHT
      STAU(I)=SQRT(SDTHT2*SIGMA2/DET)
      SBETA(I)=SQRT(SD*SIGMA2/DET)
      TVALU(I)=(BETA(I)-1.)/SBETA(I)
   90 CONTINUE
C
C
      DO  110 J=1,NL
      STHT(J)=SQRT(SIGMA2*THTD(J))
  110 CONTINUE
      WRITE(6,705)
      WRITE(6,504) NTOT,SIGMA2
      WRITE(6,706)
      WRITE(6,503)( I,TAU(I),STAU(I),BETA(I),SBETA(I),TVALU(I) ,I=1,NV)
      WRITE(6,707)
      WRITE(6,500) (J,THT(J),STHT(J),J=1,NL)
      STOP
      END
```

RESULTS FROM JOINT REGRESSION ANALYSIS

DATA OF MEANS ROWS=TREATMENTS, COLUMNS=ENVIRONMENTS

8.70	49.50	27.00	37.90	56.20	75.60	72.50	28.30
7.00	52.40	17.80	50.80	66.50	72.70	77.70	40.70
6.80	26.20	38.50	46.50	63.00	60.80	53.00	19.50
8.80	17.90	30.90	57.80	55.60	66.50	66.00	26.00
5.60	29.00	25.40	58.00	66.10	69.90	71.40	14.90
6.30	31.90	21.30	73.80	54.20	71.40	61.50	38.90
30.90	25.70	34.30	64.40	63.60	89.10	77.10	21.20
6.90	32.20	28.00	68.50	75.30	68.40	62.20	12.20
7.20	27.30	15.10	65.50	60.90	83.30	66.00	16.90
23.60	25.00	10.20	63.90	56.70	88.70	59.00	23.70
11.60	19.90	41.80	68.10	53.60	66.40	62.80	20.40
28.60	42.60	14.80	62.30	51.60	74.10	67.90	2.80
26.10	25.00	25.10	65.30	63.30	74.20	59.50	21.20
6.00	46.20	23.30	47.30	59.60	74.70	72.80	3.70
8.70	25.60	25.30	67.70	59.70	69.90	66.30	6.70
27.40	56.80	48.00	69.60	51.60	92.60	62.50	4.80
7.70	49.30	38.90	69.80	48.30	80.80	89.00	26.10
6.70	14.10	32.20	62.50	51.10	66.10	60.50	6.10
4.40	25.60	20.90	66.80	53.40	58.60	54.10	3.00
2.90	28.20	23.80	59.80	52.00	81.70	59.10	2.80
15.70	48.20	37.80	55.50	65.60	78.80	77.40	23.80
15.10	48.10	36.30	72.90	66.10	80.60	76.30	14.40
18.50	54.20	30.90	74.60	46.50	86.20	80.10	35.10
60.20	97.40	68.90	82.30	74.00	78.30	93.60	52.30
95.20	96.90	95.40	70.50	59.50	83.90	89.50	32.10

ITERATION NUMBER 1

LAGRANGE MULTIPLIERS = -0.0000631218

TREATMENT	MEAN	SENSITIVITY
1	44.462502	0.908156
2	48.200005	0.960454
3	39.287506	0.813196
4	41.187500	0.948357
5	42.537502	1.154732
6	44.912498	0.959397
7	50.787502	1.078941
8	44.212502	1.155494
9	42.775002	1.261824
10	43.850006	1.079240
11	43.075001	0.938164
12	43.087502	1.057553
13	44.962505	0.932323
14	41.700005	1.187460
15	41.237503	1.189973
16	51.662498	1.033039
17	51.237503	1.145955
18	37.412502	1.088364
19	35.850002	1.080776
20	38.787502	1.256269
21	50.350002	1.009293
22	51.225002	1.179292
23	53.262508	1.015093
24	75.875000	0.444197
25	77.875008	0.122457

TREAT	ENVIRONMENT EFFECTS
1	-29.797785
2	-8.568936
3	-15.433350
4	16.581974
5	12.578061
6	28.663300
7	21.750734
8	-25.773996

TOTAL NO. OF OBS,	COMMON ERROR VARIANCES
200	114.767357

TREAT	MEAN	SE(MEAN)	SENSITITY	SE(SNSTVTY)	TVALUE(SNSTVTY=1)
1	44.462502	3.787601	0.904791	0.178755	-0.532624
2	48.200005	3.787601	0.966499	0.178755	-0.187411
3	39.287502	3.787601	0.817193	0.178755	-1.022664
4	41.187500	3.787601	0.956885	0.178755	-0.241193
5	42.537502	3.787601	1.157769	0.178755	0.882598
6	44.912498	3.787601	0.973724	0.178755	-0.146993
7	50.787502	3.787601	1.080828	0.178755	0.452173
8	44.212509	3.787601	1.160562	0.178755	0.898224
9	42.775002	3.787601	1.269110	0.178755	1.505464
10	43.850002	3.787601	1.089403	0.178755	0.500142
11	43.075001	3.787601	0.942605	0.178755	-0.321082
12	43.087494	3.787601	1.048280	0.178755	0.270089
13	44.962505	3.787601	0.939465	0.178755	-0.338648
14	41.700005	3.787601	1.177432	0.178755	0.992598
15	41.237503	3.787601	1.190920	0.178755	1.068053
16	51.662502	3.787601	1.015985	0.178755	0.089426
17	51.237503	3.787601	1.139248	0.178755	0.778984
18	37.412502	3.787601	1.090031	0.178755	0.503656
19	35.850002	3.787601	1.081774	0.178755	0.457461
20	38.787498	3.787601	1.254398	0.178755	1.423160
21	50.350002	3.787601	1.005088	0.178755	0.028464
22	51.225002	3.787601	1.173991	0.178755	0.973349
23	53.262505	3.787601	1.012802	0.178755	0.071619
24	75.875000	3.787601	0.427628	0.178755	-3.201984
25	77.875000	3.787601	0.084139	0.178755	-5.123544

TREAT	ENV. EFFECTS	SE(ENV. EFFECTS)
1	-29.832323	2.081927
2	-8.656723	2.081927
3	-15.477040	2.081927
4	16.611414	2.081927
5	12.634023	2.081927
6	28.658119	2.081927
7	21.723637	2.081927
8	-25.661104	2.081927

```
                PROGRAM FOR WEIGHTED JOINT REGRESSION ANALYSIS

      REAL BETA(10),THT(8),TAU(10),SBETA(10),STHT(8),STAU(10),THTD(8)
      REAL D(10,8),Y(10,8),TVALU(10),REP(8)
C
C     THIS PROGRAM COMPUTES ESTIMATES FROM WEIGHTED JOINT
REGRESSION(MODIFIED)
C     ANALYSIS
C
 701  FORMAT('    'TREAT LOCATION V1INT V2INT V1SOL NREP')
 702  FORMAT('    'ENV EMSV1INT EMSV2INT ERRO EDF EMSSOL')
 703  FORMAT('    'LAGRANGE MULTIPLIER',F15.8)
 704  FORMAT('    'TREAT TAU(MEAN) BETA(STABCOEFF)')
 705  FORMAT('    'ENV    EFFECTS')
 706  FORMAT('    'TRT MEAN(EFF) SE(MEAN) SENST SE(SENST) TVAL(SENST)=1')
 707  FORMAT('    'ENV EFF(ENV) SE(ENV)')
      NV=10
      NL=8
      ITRNO=1
      WRITE(6,701)
      DO 10 I=1,NV
      DO 10 J=1,NL
      D(I,J)=0.
  10  Y(I,J)=0.
C
      NTOT=69
C          READ IN ORDER INTERCROP SORGH,PIGEANPEA,SOL SORGH,REPLICATION
C          ENTER MISSING VALUES AS -9999
      DO 1 II=1,NTOT
      READ(5,800) J,I,SI,PP,SSL,RP
      WRITE(6,801) I,J,SI,PP,SSL,RP
      Y(I,J)=SSL
      IF(SSL.EQ.-9999) D(I,J)=0.
      D(I,J)=1.
      REP(J)=RP
   1  CONTINUE
  800 FORMAT(I1,I2,X,F4.0,X,F4.0,X,F4.0,X,F1.0)
  801 FORMAT(' ',I5,I9,4F7.1)
C          READ IN ORDER MEAN SQUARE ERROR FOR INTERCROP
SORGH,PP,CORR,DF,SOLS
      WRITE(6,702)
      DO 3 JL=1,NL
      READ(5,802) J,SI,PP,CORR,DF,SSL
      WRITE(6,803) J,SI,PP,CORR,DF,SSL
      W=REP(J)/SSL
      DO 3 I=1,NV
   3  D(I,J)=D(I,J)*W
 802  FORMAT(I1,X,F6.0,X,F5.0,X,F7.5,X,F2.0,X,F6.0)
 803  FORMAT(' ',I3,2F9.1,F9.5,2F9.1)
C
C                INITIALIZE THE PARAMETERS
C
      H3=0.
      H4=0.
      DO 20 J=1,NL
```

```
      H1=0.
      H2=0.
      DO 30 I=1,NV
      H1=H1+D(I,J)
      H2=H2+Y(I,J)*D(I,J)
   30 CONTINUE
      H3=H3+H1
      H4=H4+H2
      THT(J)=H2/H1
   20 CONTINUE
      H5=H4/H3
      DO 40 J=1,NL
   40 THT(J)=THT(J)-H5
C
C                  START ITERATION
      DO 2 ITR=1,ITRNO
      WRITE(6,504) ITR
C
C
C                  LEAST - SQUARE SOLUTION
      DO 50 I=1,NV
      SD=0.0
      SDY=0.0
      SDTHT=0.0
      SDTHTY=0.0
      SDTHT2=0.0
      DO 60 J=1,NL
      DIJ=D(I,J)
      THTJ=THT(J)
      YIJ=Y(I,J)
      SD=SD+DIJ
      SDY=SDY+DIJ*YIJ
      SDTHT=SDTHT+DIJ*THTJ
      SDTHTY=SDTHTY+DIJ*THTJ*YIJ
      SDTHT2=SDTHT2+DIJ*THTJ*THTJ
   60 CONTINUE
      DET=SD*SDTHT2-SDTHT*SDTHT
      TAU(I)=(SDTHT2*SDY-SDTHT*SDTHTY)/DET
      BETA(I)=(-SDTHT*SDY+SD*SDTHTY)/DET
      IF(ITR.NE.ITRNO) GO TO 50
      STAU(I)=SQRT(SDTHT2/DET)
      SBETA(I)=SQRT(SD/DET)
      TVALU(I)=(BETA(I)-1.)/SBETA(I)
   50 CONTINUE
C
C
      SNUM=0.
      SDEN=0.
      DO 70 J=1,NL
      SDBYMT=0.
      SDB2=0.
      DO 80 I=1,NV
      SDBYMT=SDBYMT+D(I,J)*BETA(I)*(Y(I,J)-TAU(I))
      SDB2=SDB2+D(I,J)*BETA(I)**2
   80 CONTINUE
```

```
      THT(J)=SDBYMT/SDB2
      THTD(J)=1./SDB2
      SNUM=SNUM+THT(J)
      SDEN=SDEN+THTD(J)
      IF(ITR.NE.ITRNO) GO TO 70
      STHT(J)=SQRT(THTD(J))
   70 CONTINUE
      ALMDA=SNUM/SDEN
      DO 85 J=1,NL
   85 THT(J)=THT(J)-ALMDA*THTD(J)
      WRITE(6,703) ALMDA
C
C             PRINT ESTIMATES
      WRITE(6,704)
      WRITE(6,500)( I,TAU(I),BETA(I) ,I=1,NV)
      WRITE(6,705)
      WRITE(6,501) (J,THT(J),J=1,NL)
  500 FORMAT(1X,I6,F16.6,F16.6)
  501 FORMAT(1X,I5,F15.6)
    2 CONTINUE
      WRITE(6,706)
      WRITE(6,503)( I,TAU(I),STAU(I),BETA(I),SBETA(I),TVALU(I) ,I=1,NV)
      WRITE(6,707)
      WRITE(6,500) (J,THT(J),STHT(J),J=1,NL)
  503 FORMAT(1X,I4,5F13.6)
  504 FORMAT(15X,'ITERATION NO IS  :',I5)
      STOP
      END
```

RESULTS FROM WEIGHTED REGRESSION ANALYSIS

TREAT	LOCATION	V1INT	V2INT	V1SOL	NREP
1	1	3804.0	850.0	1699.0	4.0
2	1	3632.0	815.0	1406.0	4.0
3	1	3642.0	742.0	1429.0	4.0
4	1	3387.0	759.0	1389.0	4.0
10	1	3933.0	843.0	1525.0	4.0
			.....		
			.....		
			.....		
			.....		
1	8	3630.0	826.0	945.0	3.0
3	8	3410.0	1077.0	1224.0	3.0
4	8	4110.0	946.0	1110.0	3.0
5	8	3868.0	754.0	927.0	3.0
6	8	3856.0	1089.0	1536.0	3.0
7	8	3490.0	1070.0	1188.0	3.0
8	8	3756.0	1146.0	1365.0	3.0
9	8	3850.0	886.0	1119.0	3.0

ENV	EMSV1INT	EMSV2INT	ERHO	EDF	EMSSOL
1	288105.0	83432.0	0.30918	12.0	76563.0
2	175595.0	36037.0	0.37773	21.0	40926.0
3	409756.0	39556.0	0.12341	27.0	69317.0
4	751131.0	31301.0	-0.17176	14.0	182783.0
5	224484.0	22618.0	-0.08867	18.0	21381.0
6	417459.0	26929.0	0.21511	18.0	82029.0
7	138626.0	70525.0	0.15931	18.0	97622.0
8	517584.0	34232.0	0.35979	14.0	129531.0

ITERATION NO IS : 1

LAGRANGE MULTIPLIER 0.03507650

TREAT	TAU(MEAN)	BETA(STABCOEFF)
1	1144.251099	0.870893
2	1072.728760	1.046836
3	1074.920898	1.025175
4	1119.281494	0.775466
5	1047.810669	1.060502
6	1214.682373	0.751370
7	918.978699	1.159698
8	1147.288818	1.152844
9	1067.875122	0.943473
10	1057.234497	1.276768

ENV	EFFECTS
1	258.915802
2	638.716553
3	120.273941
4	121.053467
5	-517.591187
6	-401.076447
7	-113.577065
8	-106.715195

TRT	MEAN(EFF)	SE(MEAN)	SENST	SE(SENST)	TVAL(SENST)=1
1	1144.251099	47.239426	0.870893	0.103085	-1.252439
2	1072.728760	48.448536	1.046836	0.103102	0.454265
3	1074.920898	47.958717	1.025175	0.104360	0.241235
4	1119.281494	47.239426	0.775466	0.103085	-2.178157
5	1047.810669	49.849316	1.060502	0.107259	0.564074
6	1214.682373	49.849316	0.751370	0.107259	-2.318038
7	918.978699	50.889828	1.159698	0.109094	1.463850
8	1147.288818	67.446358	1.152844	0.178446	0.856527
9	1067.875122	67.446358	0.943473	0.178446	-0.316774
10	1057.234497	48.448536	1.276768	0.103102	2.684414

ENV	EFF(ENV)	SE(ENV)
1	258.915802	61.042690
2	638.716553	35.386246
3	120.273941	40.839466
4	121.053467	87.301033
5	-517.591187	26.190487
6	-401.076447	51.299515
7	-113.577065	55.963306
8	-106.715195	75.057785

PROGRAM FOR BIVARIATE JOINT REGRESSION ANALYSIS

```
      REAL D(10,8),Y(10,8),Z(10,8)
      REAL TH1(8),TH2(8),BT1(10),TU1(10),BT2(10),TU2(10)
      REAL AA(16),BB(4)
      DIMENSION LSPAC(4),MSPAC(4)
      REAL HH1(8),HH2(8),HH3(8),GG1(8),GG3(8),DTHG(8),VRT1(8)
      REAL VRT2(8),COVT(8)
C
C     THIS PROGRAM COMPUTES ESTIMATES FROM BIVARIATE JOINT
REGRESSION(MODIFIED)
C     ANALYSIS
C
700   FORMAT(     'TREAT   ENV   SYLD-INT   PYLD-INT ')
701   FORMAT(     'ITERATION ')
702   FORMAT(     'TRT  MEAN(1)  SENSTV(1)  MEAN(2)   SENSTV(2)')
703   FORMAT(     'ENV    EFFECT(1)     EFFECT(2)')
704   FORMAT(     'EDF    RMS(1)    RMS(2)    ERHO   LAMDA1    LAMDA2 ')
705   FORMAT(     '1. TREAT    MEAN(1)   SENST(1)   MEAN(2)   SENST(2)
     +2. 4X4 VARIANCE COVARIANCE MATRIX OF EFFECT AND SENSITIVITY')
706   FORMAT(' ','ON TWO VARIABLES IN ORDER OF EFFECT(1), SENSI
     +TIVITY(1),EFFECT(2),SENSITIVITY(2) AND ')
707   FORMAT(' ','3. VALUE OF CHIQUES D.F=2 AND F-TEST STATISTIC
     +D.F.=2,ERROR DF FOR TESTING TWO SENSITIVITES
     +EQUAL TO UNITIES')
714   FORMAT(' ','EDF    RMS(1)    RMS(2)    ERHO   LAMDA1    LAMDA2 ')
715   FORMAT(' ','ENV  EFF(1)  COFF(2)  VAR(EFF1)  VAR(EFF2)  COVAR')
      WRITE(6,700)
      NV=10
      NL=8
      ITRNO=3
      NTOT=69
      DEGFR=NTOT-NL-2*NV+1
      DO 10 I=1,NV
      DO 10 J=1,NL
      D(I,J)=0.
      Z(I,J)=0.
  10  Y(I,J)=0.
C
      DO 1 II=1,NTOT
      READ(5,800) J,I,A,B
      WRITE(6,801) I,J,A,B
 801  FORMAT(2I5,2F10.1)
      Y(I,J)=A
      Z(I,J)=B
      D(I,J)=1.
   1  CONTINUE
 800  FORMAT(I1,I2,X,F4.0,X,F4.0)
C
C                INITIALIZE THE PARAMETERS
C
C                                THETA1 AND THETA2
      SD=0.
      SDY=0.
```

```
      SDZ=0.
      SDYY=0.
      SDZZ=0.
      DO 20 J=1,NL
      H1=0.
      H2=0.
      H3=0.
      DO 30 I=1,NV
      DIJ=D(I,J)
      YIJ=Y(I,J)
      ZIJ=Z(I,J)
      H1=H1+DIJ
      H2=H2+DIJ*YIJ
      H3=H3+DIJ*ZIJ
      SDYY=SDYY+DIJ*YIJ*YIJ
      SDZZ=SDZZ+DIJ*ZIJ*ZIJ
      SDYZ=SDYZ+DIJ*YIJ*ZIJ
30    CONTINUE
      SD=SD+H1
      SDY=SDY+H2
      SDZ=SDZ+H3
      TH1(J)=H2/H1
      TH2(J)=H3/H1
20    CONTINUE
      DO 40 J=1,NL
      TH1(J)=TH1(J)-SDY/SD
40    TH2(J)=TH2(J)-SDZ/SD
                                          SIG1 SIG2 RHO
      SIG11=(SDYY-SDY*SDY/SD)/SD
      SIG22=(SDZZ-SDZ*SDZ/SD)/SD
      SIG1=SQRT(SIG11)
      SIG2=SQRT(SIG22)
      SIG12=SIG1*SIG2
      RHO=(SDYZ-SDY*SDZ/SD)/SD/SIG1/SIG2
C
C                  START ITERATION
      WRITE(6,701)
      DO 2 ITR=1,ITRNO
      R1HO2=1-RHO*RHO
      WRITE(6,500) ITR
C
C
C                  LEAST - SQUARE SOLUTION
      WRITE(6,702)
      DO 50 I=1,NV
      SD=0.
      SDY=0.
      SDZ=0.
      SDT1=0.
      SDT2=0.
      SDT11=0.
      SDT12=0.
      SDT22=0.
      SDT1Y=0.
      SDT1Z=0.
```

```
      SDT2Y=0.
      SDT2Z=0.
C
      DO 60 J=1,ML
      DIJ=D(I,J)
      TH1J=TH1(J)
      TH2J=TH2(J)
      YIJ=Y(I,J)
      ZIJ=Z(I,J)
      SD=SD+DIJ
      SDY=SDY+DIJ*YIJ
      SDZ=SDZ+DIJ*ZIJ
      SDT1=SDT1+DIJ*TH1J
      SDT2=SDT2+DIJ*TH2J
      SDT11=SDT11+DIJ*TH1J*TH1J
      SDT12=SDT12+DIJ*TH1J*TH2J
      SDT22=SDT22+DIJ*TH2J*TH2J
      SDT1Y=SDT1Y+DIJ*TH1J*YIJ
      SDT1Z=SDT1Z+DIJ*TH1J*ZIJ
      SDT2Y=SDT2Y+DIJ*TH2J*YIJ
      SDT2Z=SDT2Z+DIJ*TH2J*ZIJ
   60 CONTINUE
C
C              COMPUTE  COEFFIENT MATRIX AA(4,4) ,VECTOR BB(4)
C
C
C                   AA X = BB : X( TU1,BT1,TU2,BT2 ) FOR ITH VARIETY
C
      AA(1)=SD/SIG11
      AA(2)=SDT1/SIG11
      AA(3)=-RHO*SD/SIG12
      AA(4)=-RHO*SDT2/SIG12
      AA(5)=AA(2)
      AA(6)=SDT11/SIG11
      AA(7)=-RHO*SDT1/SIG12
      AA(8)=-RHO*SDT12/SIG12
      AA(9)=AA(3)
      AA(10)=AA(7)
      AA(11)=SD/SIG22
      AA(12)=SDT2/SIG22
      AA(13)=AA(4)
      AA(14)=AA(8)
      AA(15)=AA(12)
      AA(16)=SDT22/SIG22
C
      BB(1)=(SDY/SIG1-RHO*SDZ/SIG2)/SIG1
      BB(2)=(SDT1Y/SIG1-RHO*SDT1Z/SIG2)/SIG1
      BB(3)=(SDZ/SIG2-RHO*SDY/SIG1)/SIG2
      BB(4)=(SDT2Z/SIG2-RHO*SDT2Y/SIG1)/SIG2
C
      IF(ITR.NE.ITRNO) GO TO 51
C             COMPUTE VAR COV MATRIX OF TAU1,BETA1,TAU2,BETA2
      CALL MINV(AA,4,DDET,LSPAC,MSPAC)
      TU1(I)=AA(1)*BB(1)+AA(5)*BB(2)+AA(9)*BB(3)+AA(13)*BB(4)
      BT1(I)=AA(2)*BB(1)+AA(6)*BB(2)+AA(10)*BB(3)+AA(14)*BB(4)
```

```
      TU2(I)=AA(3)*BB(1)+AA(7)*BB(2)+AA(11)*BB(3)+AA(15)*BB(4)
      BT2(I)=AA(4)*BB(1)+AA(8)*BB(2)+AA(12)*BB(3)+AA(16)*BB(4)
      WRITE(6,705)
      WRITE(6,706)
      WRITE(6,707)
      WRITE(6,500) I,TU1(I),BT1(I),TU2(I),BT2(I)
      DO 52 IL=1,16
   52 AA(IL)=R1HO2*AA(IL)
      WRITE(6,503) (AA(IL),IL=1,16)
C
C            COMPUTE TEST STATISTIC TO TEST HYP : BETA1=BETA2=1
      H11=(BT1(I)-1)**2
      H22=(BT1(I)-1)**2
      H12=(BT1(I)-1)*(BT2(I)-1)
      CHISTAT=(H11*AA(16)-2.*H12*AA(8)+H22*AA(6))
      CHISTAT=CHISTAT/(AA(6)*AA(16)-AA(8)**2)
      FSTAT=CHISTAT*(DEGFR-2)/2./DEGFR
      WRITE(6,503) CHISTAT,FSTAT
      GOTO 50
   51 CALL SIMQ(AA,BB,N,KS)
      TU1(I)=BB(1)
      BT1(I)=BB(2)
      TU2(I)=BB(3)
      BT2(I)=BB(4)
      WRITE(6,500) I,TU1(I),BT1(I),TU2(I),BT2(I)
   50 CONTINUE
C
C              COMPUTE THETA1,THETA2 ALMBDA1 ALMBDA2
      SGL1=0.
      SGL2=0.
      SGL4=0.
      SGH1=0.
      SGH2=0.
      DO 70 J=1,NL
      H1=0.
      H2=0.
      H3=0.
      H4=0.
      H5=0.
      DO 80 I=1,NV
      DIJ=D(I,J)
      YIJT=(Y(I,J)-TU1(I))/SIG1
      ZIJT=(Z(I,J) TU2(I))/SIG2
      H1=H1+DIJ*BT1(I)*(YIJT-RHO*ZIJT)
      H2=H2+DIJ*BT1(I)**2
      H3=H3+DIJ*BT1(I)*BT2(I)
      H4=H4+DIJ*BT2(I)*(ZIJT-RHO*YIJT)
      H5=H5+DIJ*BT2(I)**2
   80 CONTINUE
      HH1(J)=H1/SIG1
      HH2(J)=H2/SIG11
      HH3(J)=-RHO*H3/SIG12
      GG1(J)=H4/SIG2
      GG3(J)=H5/SIG22
      DTHGJ=HH2(J)*GG3(J)-HH3(J)**2
```

```
      DTRG(J)=DTRGJ
      SGL1=SGL1+GG3(J)/DTRGJ
      SGL2=SGL2+HH3(J)/DTRGJ
      SGLA=SGLA+HH2(J)/DTRGJ
      SGH1=SGH1+(GG3(J)*HH1(J)-HH3(J)*GG1(J))/DTRGJ
      SGH2=SGH2+(-HH3(J)*HH1(J)+HH2(J)*GG1(J))/DTRGJ
      IF(ITR.NE.ITRG) GO TO 70
C
      VRT1(J)=R1SQ2*GG3(J)/DTRGJ
      VRT2(J)=R1SQ2*HH2(J)/DTRGJ
      COVT(J)=-R1SQ2*HH3(J)/DTRGJ
   70 CONTINUE
C
C         COMPUTE LAMBDA1  LAMBDA2
      DETSG=SGL1*SGLA-SGL2*SGL2
      ALM1=(SGLA*SGH1-SGL2*SGH2)/DETSG
      ALM2=(SGL2*SGH1-SGL1*SGH2)/DETSG
C         COMPUTE THETA1  THETA2
      DO 90 J=1,NL
      DETJ=DTRG(J)
      AB1=HH1(J)-ALM1
      AB2=GG1(J)-ALM2
      TH1(J)=(GG3(J)*AB1-HH3(J)*AB2)/DETJ
      TH2(J)=(-HH3(J)*AB1+HH2(J)*AB2)/DETJ
   90 CONTINUE
C         COMPUTE  SIGMA1 SIGMA2 RHO
      H1=0.
      H2=0.
      H12=0.
      DO 100 I=1,NV
      DO 100 J=1,NL
      DIJ=D(I,J)
      H4=Y(I,J)-TU1(I)-BT1(I)*TH1(J)
      H5=Z(I,J)-TU2(I)-BT2(I)*TH2(J)
      H1=H1+DIJ*H4*H4
      H2=H2+DIJ*H5*H5
      H12=H12+DIJ*H4*H5
  100 CONTINUE
      SIG11=H1/DBGFR
      SIG22=H2/DBGFR
      SIG1=SQRT(SIG11)
      SIG2=SQRT(SIG22)
      SIG12=SIG1*SIG2
      RHO=H12/SQRT(H1*H2)
C
C              PRINT ESTIMATES
      WRITE(6,703)
      WRITE(6,501) (J,TH1(J),TH2(J),J=1,NL)
      WRITE(6,704)
      WRITE(6,502) DBGFR,SIG1,SIG2,RHO,ALM1,ALM2
  500 FORMAT(3X,I4,4F13.6,/)
  501 FORMAT(3X,I4,2F13.6,/)
  502 FORMAT(3X,F6.1,5F13.6,/)
  503 FORMAT(3X,4F20.6,/)
    2 CONTINUE

      WRITE(6,715)
      WRITE(6,504) (J,TH1(J),TH2(J),VRT1(J),VRT2(J),COVT(J),J=1,NL)
  504 FORMAT(' ',I3,5F16.4,/)
C
      STOP
      END
```

RESULTS FROM BIVARIATE JOINT REGRESSION ANALYSIS

TREAT	ENV	SYLD-INT	PYLD-INT
1	1	3804.0	850.0
2	1	3632.0	815.0
3	1	3642.0	742.0
4	1	3387.0	759.0
10	1	3933.0	843.0
		..	
		..	
1	8	3630.0	826.0
3	8	3410.0	1077.0
4	8	4110.0	946.0
5	8	3868.0	754.0
6	8	3856.0	1089.0
7	8	3490.0	1070.0
8	8	3756.0	1146.0
9	8	3850.0	886.0

ITERATION 1

.S1

TRT	MEAN(1)	SENSTV(1)	MEAN(2)	SENSTV(2)
1	0.083509	1.458016	0.054952	6.116528
2	0.075943	10.442776	0.044557	7.624817
3	0.071023	8.044513	0.049939	6.216131
4	0.084898	4.610260	0.055864	5.188794
5	0.073373	9.729654	0.054450	6.524384
6	0.076127	13.134376	0.051534	6.016765
7	0.061798	0.750457	0.036175	7.505774
8	0.063166	9.078160	0.031206	0.041671.
9	0.065417	10.079757	0.032848	0.105297
10	0.073607	8.416056	0.055037	6.471583

ENV	EFFECT(1)	EFFECT(2)
1	-476.235382	-55.427218
2	-46.929966	103.785881
3	165.288208	11.064734
4	254.753143	-3.697899
5	53.055092	48.954983
6	73.004601	16.735373
7	44.970741	9.077755
8	-67.906723	0.882253

EDF	RMS(1)	RMS(2)	ERHO	LAMDA1	LAMDA2
42.0	5356.638184	1047.782227	0.934605	0.464470	0.314934

TRT MEAN(1) SENSTV(1) MEAN(2) SENSTV(2)

1. TREAT MEAN(1) SENST(1) MEAN(2) SENST(2)2. 4X4 VARIANCE COVARIANCE MATRIX OF EFFECT AND SENSITIVITY ON TWO VARIABLES IN ORDER OF EFFECT(1), SENSITIVITY(1),EFFECT(2),SENSITIVITY(2) AND 3. VALUE OF CHIQUES D.F=2 AND F-TEST STATISTICD.F.=2,ERROR DF FOR TESTING TWO SENSITIVITESEQUAL TO UNITIES

1	4314.158203	0.019814	813.131409	0.053144
	3704971.000000	-0.000001	704627.687500	0.000000
	-0.000001	0.000088	0.000000	0.000040
	704627.687500	0.000000	138773.953125	0.000000
	0.000000	0.000040	0.000000	0.000432
	11673.588867	5558.852051		
2	4245.956055	0.037713	765.475952	0.099269
	4238243.000000	-0.656576	805284.062500	-0.300109
	-0.656576	0.000108	0.000234	0.000049
	805284.062500	0.000234	158598.187500	0.002076
	-0.300109	0.000049	0.002076	0.000436
	9399.317383	4475.865234		
3	4333.304199	0.028750	845.644653	0.069024
	4236385.000000	0.459823	805302.812500	0.181290
	0.459823	0.000098	0.004415	0.000038
	805302.812500	0.004415	158603.218750	0.049650
	0.181290	0.000038	0.049650	0.000432
	10578.157227	5037.217773		
4	4385.912109	0.026704	826.632324	0.041362
	3704971.000000	-0.000001	704627.687500	0.000000
	-0.000001	0.000088	0.000000	0.000040
	704627.687500	0.000000	138773.953125	0.000000
	0.000000	0.000040	0.000000	0.000432
	11470.688477	5462.232422		

5	4225.834473	0.010732	863.580933	0.068675
	4256281.500000	-2.061656	804683.125000	0.937967
	-2.061648	0.000193	0.056380	-0.000088
	804683.125000	0.056379	158842.968750	-0.380732
	0.937967	-0.000088	-0.380732	0.000592
	8730.912109	4157.577148		
6	4061.154053	0.040724	843.862732	0.038229
	4256281.500000	-2.061656	804683.125000	0.937967
	-2.061648	0.000193	0.056380	-0.000088
	804683.125000	0.056379	158842.968750	-0.380732
	0.937967	-0.000088	-0.380732	0.000592
	8302.250977	3953.452637		
7	3853.708008	0.056742	681.206177	0.070851
	4950513.000000	-1.517187	939062.437500	0.708143
	-1.517191	0.000218	0.062539	-0.000102
	939062.375000	0.062540	185258.531250	-0.369565
	0.708148	-0.000102	-0.369564	0.000600
	7529.534180	3585.492676		
8	3663.057617	0.047089	664.598206	0.047350
	4980249.000000	-2.828425	939424.437500	-0.155561
	-2.828425	0.000199	0.005364	0.000011
	939424.437500	0.005364	185645.343750	1.249683
	-0.155571	0.000011	1.249682	0.002544
	4893.307129	2330.146240		
9	3940.963135	0.038488	705.348328	0.065157
	4980249.000000	-2.828425	939424.437500	-0.155561
	-2.828425	0.000199	0.005364	0.000011
	939424.437500	0.005364	185645.343750	1.249683
	-0.155571	0.000011	1.249682	0.002544
	4983.141602	2372.924561		
10	4219.336914	0.022228	917.140991	0.088944
	4238243.000000	-0.656576	805284.062500	-0.300109
	-0.656576	0.000108	0.000234	0.000049
	805284.062500	0.000234	158598.187500	0.002076
	-0.300109	0.000049	0.002076	0.000436
	9713.272461	4625.368164		

ENV	EFFECT(1)	EFFECT(2)
1	-54898.308594	-2664.604248
2	-12810.079102	7388.790039
3	46723.957031	772.448120
4	46823.808594	2033.733765
5	19125.273438	-4006.521729
6	4786.783691	-2887.911865
7	-5083.293457	-304.017914
8	-44668.136719	-331.910706

EDF	RMS(1)	RMS(2)	ERRO	LAMDA1	LAMDA2
42.0	929.980164	228.796997	0.724956	0.000000	-0.000002

ENV	EFF(1)	COFF(2)	VAR(EFE1)	VAR(EFF2)	COVAR
1	-54898.3086	-2664.6042	2692891648.0000	14343063.0000	186632416.00
2	-12810.0791	7388.7900	454860608.0000	3937053.7500	36574120.00
3	46723.9570	772.4481	328102080.0000	3443949.7500	29163134.00
4	46823.8086	2033.7338	432111360.0000	3931962.2500	35042480.00
5	19125.2734	-4006.5217	328102080.0000	3443949.7500	29163134.00
6	4786.7837	-2887.9119	328102080.0000	3443949.7500	29163134.00
7	-5083.2935	-304.0179	328102080.0000	3443949.7500	29163134.00
8	-44668.1367	-331.9107	430610208.0000	6350227.0000	46110668.00

PROGRAM FOR WEIGHTED BIVARIATE JOINT REGRESSION ANALYSIS

```
      REAL D(10,8),Y(10,8),Z(10,8)
      REAL TH1(8),TH2(8),BT1(10),TU1(10),BT2(10),TU2(10)
      REAL AA(16),BB(4),RHO(8),SIG1(8),SIG2(8),SIG12(8),REP(8)
      DIMENSION LSPAC(4),MSPAC(4)
      REAL HH1(8),HH2(8),HH3(8),GG1(8),GG3(8),DTHG(8),VRT1(8)
      REAL VRT2(8),COVT(8)
C
C     THIS PROGRAM COMPUTES ESTIMATES FROM BIVARIATE JOINT
REGRESSION(MODIFIED)
C     ANALYSIS
C
  701 FORMAT(' ','TRT    ENV    VAR1     VAR2     REPS')
  702 FORMAT(' ','ENV    EMS(VAR1)    EMS(VAR2)   ERHO     EDF')
  703 FORMAT(' ','TRT MEAN(VAR1)  SENST(VAR1) MEAN(VAR2) SENST(VAR2)')
  704 FORMAT(' ','ENV   EFF(VAR1)   EFF(VAR2)')
  705 FORMAT(' ','EDF    LAMDA1    LAMDA2')
706   FORMAT(' ','1. TREAT    MEAN(1)   SENST(1)   MEAN(2)   SENST(2)
     +2. 4X4 VARIANCE COVARIANCE MATRIX OF EFFECT AND SENSITIVITY')
707   FORMAT(' ','ON TWO VARIABLES IN ORDER OF EFFECT(1), SENSI
     +TIVITY(1),EFFECT(2),SENSITIVITY(2) AND ')
708   FORMAT(' ','3. VALUE OF CHIQUES D.F=2 AND F-TEST STATISTIC
     +D.F.=2,ERROR DF FOR TESTING TWO SENSITIVITES
     +EQUAL TO UNITIES')
715   FORMAT(' ','ENV  COEF(1)  COFF(2)  VAR(EFF1)  VAR(EFF2)  COVAR')
      NV=10
      NL=8
      ITRNO=4
      NTOT=69
      DEGFR=NTOT-NL-2*NV+1
      DO 10 I=1,NV
      DO 10 J=1,NL
      D(I,J)=0.
      Z(I,J)=0.
   10 Y(I,J)=0.
C
      WRITE(6,701)
      DO 1 II=1,NTOT
      READ(5,800) J,I,A,B,C
      WRITE(6,801) I,J,A,B,C
  801 FORMAT(2I5,3F7.1)
      Y(I,J)=A
      Z(I,J)=B
      D(I,J)=1.
      REP(J)=C
    1 CONTINUE
  800 FORMAT(I1,I2,X,F4.0,X,F4.0,6X,F1.0)
C               READ VARIABLE VARIANCES AND CORRELATIONS
      WRITE(6,702)
      DO 2 JL=1,NL
      READ(5,802)J, H1,H2,H3,H4
      WRITE(6,803) J,H1,H2,H3,H4
      H33=(1-H3**H3)/REP(J)
```

```
      SIG1(J)=H33*H1
      SIG2(J)=H33*H2
      RHO(J)=H3
      SIG12(J)=H33*SQRT(H1*H2)
    2 CONTINUE
  802 FORMAT(I1,X,F6.0,X,F5.0,X,F7.5,X,F2.0)
  803 FORMAT(4X,I5,F10.1,F10.1,F12.6,F8.1)
C
C                 INITIALIZE THE PARAMETERS THETA1 THETA2
      SD=0.
      SDY=0.
      SDZ=0.
      DO 20 J=1,NL
      H1=0.
      H2=0.
      H3=0.
      DO 30 I=1,NV
      DIJ=D(I,J)
      YIJ=Y(I,J)
      ZIJ=Z(I,J)
      H1=H1+DIJ
      H2=H2+DIJ*YIJ
      H3=H3+DIJ*ZIJ
   30 CONTINUE
      SD=SD+H1
      SDY=SDY+H2
      SDZ=SDZ+H3
      TH1(J)=H2/H1
      TH2(J)=H3/H1
   20 CONTINUE
      DO 40 J=1,NL
      TH1(J)=TH1(J)-SDY/SD
   40 TH2(J)=TH2(J)-SDZ/SD
C
C                   START ITERATION
      DO 2222 ITR=1,ITRNO
      WRITE(6,499) ITR
C
C
C                   LEAST - SQUARE SOLUTION
      WRITE(6,703)
      DO 50 I=1,NV
C
      SDYZT1=0.
      SDYZB1=0.
      SDYZT2=0.
      SDYZB2=0.
C
      A1=0.
      A2=0.
      A3=0.
      A4=0.
      A6=0.
      A7=0.
      A8=0.
```

```
      A11=0.
      A12=0.
      A16=0.
C
      DO 60 J=1,NL
      RHOJ=RHO(J)
      SIG1J=SIG1(J)
      SIG2J=SIG2(J)
      SIG12J=SIG12(J)
      DIJ=D(I,J)
      TH1J=TH1(J)
      TH2J=TH2(J)
      YIJ=Y(I,J)
      ZIJ=Z(I,J)
C
      SDYZT1=SDYZT1+DIJ*(YIJ/SIG1J-RHOJ*ZIJ/SIG12J)
      SDYZB1=SDYZB1+DIJ*TH1J*(YIJ/SIG1J-RHOJ*ZIJ/SIG12J)
      SDYZT2=SDYZT2+DIJ*(ZIJ/SIG2J-RHOJ*YIJ/SIG12J)
      SDYZB2=SDYZB2+DIJ*TH2J*(ZIJ/SIG2J-RHOJ*YIJ/SIG12J)
C
      A1=A1+DIJ/SIG1J
      A2=A2+DIJ*TH1J/SIG1J
      A3=A3-DIJ*RHOJ/SIG12J
      A4=A4-DIJ*RHOJ*TH2J/SIG12J
      A6=A6+DIJ*TH1J*TH1J/SIG1J
      A7=A7-DIJ*TH1J*RHOJ/SIG12J
      A8=A8-DIJ*RHOJ*TH1J*TH2J/SIG12J
      A11=A11+DIJ/SIG2J
      A12=A12+DIJ*TH2J/SIG2J
      A16=A16+DIJ*TH2J*TH2J/SIG2J
   60 CONTINUE
C
C              COMPUTE  COEFFIENT MATRIX AA(4,4) ,VECTOR BB(4)
C
C
C                    AA X = BB : X( TU1,BT1,TU2,BT2 ) FOR ITH VARIETY
C
      AA(1)=A1
      AA(2)=A2
      AA(3)=A3
      AA(4)=A4
      AA(5)=A2
      AA(6)=A6
      AA(7)=A7
      AA(8)=A8
      AA(9)=A3
      AA(10)=A7
      AA(11)=A11
      AA(12)=A12
      AA(13)=A4
      AA(14)=A8
      AA(15)=A12
      AA(16)=A16
C
      BB(1)=SDYZT1
```

```
      BB(2)=SDYZB1
      BB(3)=SDYZT2
      BB(4)=SDYZB2
C
      IF(ITR.NE.ITRNO) GO TO 51
C             COMPUTE VAR COV MATRIX OF TAU1,BETA1,TAU2,BETA2
      CALL MINV(AA,4,DDET,LSPAC,MSPAC)
      TU1(I)=AA(1)*BB(1)+AA(5)*BB(2)+AA(9)*BB(3)+AA(13)*BB(4)
      BT1(I)=AA(2)*BB(1)+AA(6)*BB(2)+AA(10)*BB(3)+AA(14)*BB(4)
      TU2(I)=AA(3)*BB(1)+AA(7)*BB(2)+AA(11)*BB(3)+AA(15)*BB(4)
      BT2(I)=AA(4)*BB(1)+AA(8)*BB(2)+AA(12)*BB(3)+AA(16)*BB(4)
      WRITE(6,703)
      WRITE(6,500) I,TU1(I),BT1(I),TU2(I),BT2(I)
      WRITE(6,706)
      WRITE(6,707)
      WRITE(6,708)
      WRITE(6,503) (AA(IL),IL=1,16)
C
C             COMPUTE TEST STATISTIC TO TEST HYP : BETA1=BETA2=1
      H11=(BT1(I)-1)**2
      H22=(BT1(I)-1)**2
      H12=(BT1(I)-1)*(BT2(I)-1)
      CHISTAT=(H11*AA(16)-2.*H12*AA(8)+H22*AA(6))
      CHISTAT=CHISTAT/(AA(6)*AA(16)-AA(8)**2)
      FSTAT=CHISTAT*(DEGFR-2)/2./DEGFR
      WRITE(6,503) CHISTAT,FSTAT
      GOTO 50
   51 CALL SIMQ(AA,BB,4,KS)
      TU1(I)=BB(1)
      BT1(I)=BB(2)
      TU2(I)=BB(3)
      BT2(I)=BB(4)
      WRITE(6,500) I,TU1(I),BT1(I),TU2(I),BT2(I)
   50 CONTINUE
C
C               COMPUTE THETA1,THETA2 ALMBDA1 ALMBDA2
      SGL1=0.
      SGL2=0.
      SGL4=0.
      SGH1=0.
      SGH2=0.
      DO 70 J=1,NL
      SIG1J=SIG1(J)
      SIG2J=SIG2(J)
      SIG12J=SIG12(J)
      RHOJ=RHO(J)
      H1=0.
      H2=0.
      H3=0.
      H4=0.
      H5=0.
      DO 80 I=1,NV
      DIJ=D(I,J)
      YIJT=Y(I,J) TU1(I)
      ZIJT=Z(I,J) TU2(I)
```

```
      H1=H1+DIJ*BT1(I)*(YIJT/SIG1J-RHOJ*ZIJT/SIG12J)
      H2=H2+DIJ*BT1(I)**2
      H3=H3+DIJ*BT1(I)*BT2(I)
      H4=H4+DIJ*BT2(I)*(ZIJT/SIG2J-RHOJ*YIJT/SIG12J)
      H5=H5+DIJ*BT2(I)**2
   80 CONTINUE
      HH1(J)=H1
      HH2(J)=H2/SIG1J
      HH3(J)=-RHOJ*H3/SIG12J
      GG1(J)=H4
      GG3(J)=H5/SIG2J
      DTHGJ=HH2(J)*GG3(J)-HH3(J)**2
      DTHG(J)=DTHGJ
      SGL1=SGL1+GG3(J)/DTHGJ
      SGL2=SGL2+HH3(J)/DTHGJ
      SGL4=SGL4+HH2(J)/DTHGJ
      SGH1=SGH1+(GG3(J)*HH1(J)-HH3(J)*GG1(J))/DTHGJ
      SGH2=SGH2+(-HH3(J)*HH1(J)+HH2(J)*GG1(J))/DTHGJ
      IF(ITR.NE.ITRNO) GO TO 70
C
      VRT1(J)=GG3(J)/DTHGJ
      VRT2(J)=HH2(J)/DTHGJ
      COVT(J)=-HH3(J)/DTHGJ
   70 CONTINUE
C
C         COMPUTE LAMBDA1  LAMBDA2
      DETSG=SGL1*SGL4-SGL2*SGL2
      ALM1=(SGL4*SGH1+SGL2*SGH2)/DETSG
      ALM2=(SGL2*SGH1+SGL1*SGH2)/DETSG
C         COMPUTE THETA1  THETA2
      DO 90 J=1,NL
      DETJ=DTHG(J)
      AB1=HH1(J)-ALM1
      AB2=GG1(J)-ALM2
      TH1(J)=(GG3(J)*AB1-HH3(J)*AB2)/DETJ
      TH2(J)=(-HH3(J)*AB1+HH2(J)*AB2)/DETJ
   90 CONTINUE
C
C             PRINT ESTIMATES
      WRITE(6,704)
      WRITE(6,501) (J,TH1(J),TH2(J),J=1,NL)
      WRITE(6,705)
      WRITE(6,502) DEGFR,ALM1,ALM2
 2222 CONTINUE
  499 FORMAT(10X,'ITERATION NO IS   :',I4)
  500 FORMAT(10X,I4,4F13.6)
  501 FORMAT(10X,I4,2F13.6,/)
  502 FORMAT(10X,F6.1,5F13.6,/)
  503 FORMAT(15X,4F13.6,/)
      WRITE(6,715)
      WRITE(6,504) (J,TH1(J),TH2(J),VRT1(J),VRT2(J),COVT(J),J=1,NL)
  504 FORMAT(10X,I4,5F13.6,/)
C
      STOP
      END
```

RESULTS FROM WEIGHTED BIVARIATE REGRESSION ANALYSIS

TRT	ENV	VAR1	VAR2	REPS
1	1	3804.0	850.0	4.0
2	1	3632.0	815.0	4.0
3	1	3642.0	742.0	4.0
4	1	3387.0	759.0	4.0
10	1	3933.0	843.0	4.0
		...		
		...		
		...		
1	8	3630.0	826.0	3.0
3	8	3410.0	1077.0	3.0
4	8	4110.0	946.0	3.0
5	8	3868.0	754.0	3.0
6	8	3856.0	1089.0	3.0
7	8	3490.0	1070.0	3.0
8	8	3756.0	1146.0	3.0
9	8	3850.0	886.0	3.0

ENV	EMS(VAR1)	EMS(VAR2)	ERHO	EDF
1	288105.0	83432.0	-0.309180	12.0
2	175595.0	36037.0	0.377730	21.0
3	409756.0	39556.0	0.123410	27.0
4	751131.0	31301.0	-0.171760	14.0
5	274484.0	22618.0	-0.088670	18.0
6	417459.0	26929.0	0.215110	18.0
7	138626.0	70525.0	0.159310	18.0
8	517584.0	34232.0	0.359790	14.0

ITERATION NO IS : 1

TRT	MEAN(VAR1)	SENST(VAR1)	MEAN(VAR2)	SENST(VAR2)
1	4410.149414	0.633202	804.555481	0.812163
2	4370.578613	1.121467	777.204529	1.340350
3	4418.928711	1.021170	795.386780	0.936854
4	4421.537598	1.148939	809.216797	0.654562
5	4276.890137	0.981668	887.717102	0.886410
6	4298.751953	1.465754	879.365540	0.786262
7	4375.071289	1.371924	664.105713	1.200050
8	4289.876465	0.781387	727.087402	1.096903
9	4478.263184	1.005689	745.597778	1.184621
10	4262.130371	0.765908	940.474304	1.147738

ENV	EFF(VAR1)	EFF(VAR2)
1	-680.271606	-77.531906
2	-48.514023	589.296326
3	935.904175	-53.037010
4	1065.739258	29.910137
5	-337.764038	-429.506134
6	-98.690483	-203.827301
7	-309.886658	-51.605736
8	-526.516663	196.301590

EDF	LAMDA1	LAMDA2
42.0	-0.002652	0.014029

1. TREAT MEAN(1) SENST(1) MEAN(2) SENST(2)
2. 4X4 VARIANCE COVARIANCE MATRIX OF EFFECT AND SENSITIVITY ON TWO VARIABLES IN ORDER OF EFFECT(1), SENSITIVITY(1), EFFECT(2),SENSITIVITY(2) AND
3. VALUE OF CHIQUES D.F=2 AND F-TEST STATISTICD.F.=2,ERROR DF FOR TESTING TWO SENSITIVITESEQUAL TO UNITIES

1	4393.178223	0.603704	822.096619	0.799379
	10449.613281	5.010652	409.492859	1.795509
	5.010652	0.039584	0.236263	-0.000196
	409.492859	0.236263	1300.429810	0.017952
	1.795509	-0.000196	0.017952	0.012955
	16.152014	7.691435		
2	4349.997070	1.068208	815.920471	1.361463
	10851.132813	4.264052	424.467621	1.891686
	4.264052	0.041304	0.466766	0.000124
	424.467621	0.466766	1502.354492	0.410645
	1.891686	0.000124	0.410645	0.013730
	0.440681	0.209848		
3	4394.662598	0.973250	813.546570	0.953790
	11924.964844	9.175306	655.445435	1.989921
	9.175306	0.051464	0.786708	0.000319
	655.445435	0.786708	1508.465698	0.089977
	1.989921	0.000319	0.089977	0.012990
	0.067821	0.032296		

4	4395.751953	1.142130	824.313843	0.650741
	10449.613281	5.010652	409.492859	1.795509
	5.010652	0.039584	0.236263	-0.000196
	409.492859	0.236263	1300.429810	0.017952
	1.795509	-0.000196	0.017952	0.012955
	2.031814	0.967530		
5	4234.846191	1.003077	903.900208	0.848544
	11665.522461	0.751354	613.259338	2.062043
	0.751354	0.054603	-0.388710	-0.001177
	613.259338	-0.388710	1414.292358	0.020587
	2.062043	-0.001177	0.020587	0.013036
	-0.000642	-0.000306		
6	4242.588867	1.495584	893.408447	0.778268
	11665.522461	0.751354	613.259338	2.062043
	0.751354	0.054603	-0.388710	-0.001177
	613.259338	-0.388710	1414.292358	0.020587
	2.062043	-0.001177	0.020587	0.013036
	23.020069	10.961938		
7	4329.231934	1.390356	682.625000	1.217370
	12722.694336	5.065219	843.162903	2.181178
	5.065219	0.073352	0.085593	-0.000793
	843.162903	0.085593	1652.039795	0.087918
	2.181178	-0.000793	0.087918	0.013058
	13.895811	6.617053		
8	4259.741699	0.764733	747.960083	1.116490
	15900.554688	0.616525	691.765076	2.017512
	0.616525	0.055024	-0.965725	-0.004298
	691.765076	-0.965725	2207.198975	4.322198
	2.017512	-0.004298	4.322198	0.036425
	2.430356	1.157312		

9	4432.650879	1.022369	755.802856	1.103348
	15900.554688	0.616525	691.765076	2.017512
	0.616525	0.055024	-0.965725	-0.004298
	691.765076	-0.965725	2207.198975	4.322198
	2.017512	-0.004298	4.322198	0.036425
	0.033051	0.015738		
10	4248.677734	0.727827	973.614807	1.165373
	10851.132813	4.264052	424.467621	1.891686
	4.264052	0.041304	0.466766	0.000124
	424.467621	0.466766	1502.354492	0.410645
	1.891686	0.000124	0.410645	0.013730
	7.208717	3.432722		

ENV	EFF(VAR1)	EFF(VAR2)
1	-754.551208	-43.577530
2	-21.961470	576.533020
3	958.229492	-60.778042
4	1021.054321	26.092342
5	-326.958008	-440.023529
6	-96.319923	-219.002457
7	-282.481964	-42.747337
8	-497.011139	203.503693

EDF	LAMDA1	LAMDA2
42.0	-0.000294	0.000669

ENV	COEF(1)	COFF(2)	VAR(EFF1)	VAR(EFF2)	COVAR
1	-754.551208	-43.577530	16614.724609	3978.950195	-2376.548340
2	-21.961470	576.533020	4549.224609	1105.524170	795.287048
3	958.229492	-60.778042	9218.521484	944.176025	343.013824
4	1021.054321	26.092342	30352.837891	1288.215454	-993.176819
5	-326.958008	440.023529	6739.500977	720.445557	-184.075211
6	-96.319923	-219.002457	12476.149414	853.869690	661.455750
7	-282.481964	-42.747337	4153.405273	2241.853760	457.986725
8	-497.011139	203.503693	18046.164063	1552.462524	1808.043823

PROGRAMS FOR INCOMPLETE BLOCK DESIGNS

PROGRAM FOR INCOMPLETE BLOCK DESIGN ANALYSIS

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'REFE/NID=800,NUNN=800,PRINT=2' KUIPERSE
'UNITS' S 60
'FACT' BLOK $ 5 : TREAT $ 16
'SCAL' NV=4
'SET' PPSET=1,1,12 : QQSET=2,12,13
'SCAL' NUNITS=60
'SCAL' NBLOK=5 : NTREAT=16
'VARI' TREATNUM=1...16
'READ/P' BLOK,TREAT,VARIABLE(1...NV)
'FOR' ZZ=VARIABLE(1)
'SET' YSET=ZZ
''PROGRAMME FOR KUIPER-CORSTEEN INTERACTION
  GENERATE INCIDENCE MATRIX FROM BLOCK AND TREATMENT STRUCTURE''
'MATR' NMAT $ NTREAT,NBLOK
:JR,RVEC $ NTREAT,1
:JK,KVEC $ NBLOK,1
'SCAL' H1,H2,H3
'CALC' NMAT=0
'CALC' FLBLOK=FLOAT(BLOK):FLTREAT=FLOAT(TREAT)
'FOR' I=1...NUNITS
'COPY' H1 FLBLOK$I:H2 FLTREAT$I
'CALC'  H3=H1+(H2-1)*NBLOK
: ELEM(NMAT;H3)=ELEM(NMAT;H3)+1
'REPE'
''CALCULATE REPLICATION AND BLOCK SIZE VECTORS''
'CALC'JR=1:JK=1
: RVEC=PDT(NMAT;JK)
: KVEC=TPDT(NMAT;JP)
'SCAL' NOBS
'CALC' NOBS=SUM(RVEC)
'CALC' RVEC=1/RVEC
:      KVEC=1/KVEC
'VARI' POINT1$NTREAT:POINT2$NBLOK
''
                              COMPUTE Q VECTOR OF ADJUSTED TOTALS
''
'SCAL' GRMN,CV%
'CALC' GRMN=MEAN(YSET)
'MATR' QVEC,TRTOT$NTREAT,1:BLTOT$NBLOK,1
'FOR' I=1...NTREAT
'REST'YSET$TREAT=I
'CALC' H1=SUM(YSET)
:ELEM(TRTOT;I)=H1
'CALC' H1=I+(I-1)*NTREAT
:      ELEM(POINT1;I)=H1
'REPE'
'FOR' J=1...NBLOK
'REST' YSET$BLOK=J
'CALC' H1=SUM(YSET)
:ELEM(BLTOT;J)=H1
'CALC' H1=J+(J-1)*NBLOK
:      ELEM(POINT2;J)=H1
```

```
'REPE'
'REST' YSET
'SET' NITER=5
'MATR' U(1) $ NBLOK,NTREAT
:V(1),CINV $ NTREAT,NTREAT
'MATR' TRNMAT$NBLOK,NTREAT
'CALC  TRNMAT=TRANS(NMAT)
'MATR  RMAT$NTREAT,NTREAT:KMAT$NBLOK,NBLOK
'CALC  RMAT=0 :KMAT=0
'COPY  RMAT$POINT1=RVEC:KMAT$POINT2=KVEC
'CALC  QVEC=TRTOT-PDT(PDT(NMAT;KMAT);BLTOT)
: V(1)=RMAT 1/NOBS:CINV=0
'FOR'  II=1...NITER
'CALC' U(1)=PDT(PDT(KMAT;TRNMAT);V(1))
:CINV=V(1)+CINV
'JUMP' LB1*(II.EQ.NITER)
'CALC' V(1)=PDT(PDT(RMAT;NMAT);U(1))
'LABE' LB1 'REPE'
''
                PSUEDO-ESTIMATES OF TREATMENTS EFFECT
''
'MATR' TRTMN,TREFF$NTREAT,1
'CALC' TREFF=PDT(CINV;QVEC)+GRMN
:      TRTMN=RVEC*TRTOT
'SCAL' SS(1,2,3,4,5),MS(1,2,3,4),DF(1,2,3,4) ,VRAS
'CALC' SS(1)=TPDT(QVEC;TREFF):SS(2)=TPDT(BLTOT;PDT(KMAT;BLTOT))
: SS(5)=NOBS*GRMN**2:SS(2)=SS(2)-SS(5):SS(4)=SUM(YSET*YSET)-SS(5)
: SS(3)=SS(4)-SS(1)-SS(2):DF(1)=NTREAT-1:DF(2)=NBLOK-1 :DF(4)=NOBS-1
: DF(3)=DF(4)-DF(1)-DF(2)
: MS(1)=SS(1)/DF(1):MS(2)=SS(2)/DF(2):MS(3)=SS(3)/DF(3): VRAS=MS(1)/MS(3)
'HEAD' HHX='                              ANALYSIS OF VARIANCE              '
'HEAD'
HX=''-------------------------------------------------------------''
'HEAD' HY='' SOURCE OF VARIATION              DF        SS         MS
VRATIO''
'HEAD  X(1)='' BLOCKS (IGNORING TRTS) ''
'HEAD  X(2)='' ENTRIES (ELIMINATING BLOCKS) ''
'HEAD  X(3) '' WITHIN ENTRIES (ERROR) ''
'HEAD  X(4)='' TOTAL ''
'HEAD  X(5)='' TOTAL OBSERVATIONS ''
'HEAD  X(6)='' TREAT NUM   UNADJMN    ADJMN     SE(ADJMN) ''
'PRIN  HHX
'PRIN  HX
'PRIN  HY
'PRIN  HX
'PRINT/C,LABR=1' X(1),DF(2),SS(2),MS(2)  $ 0,12.0,10.3,9.3
'PRINT/C,LABR=1' X(2),DF(1),SS(1),MS(1),VRAS $  0,6.0,10.3,2(9.3)
:         X(3),DF(3),SS(3),MS(3)  $ 0,12.0,10.3,9.3
'PRINT/C,LABR=1' X(4),DF(4),SS(4) $ 0,29.0,10.3
'PRIN' HX
'SCAL' IPOS,PPOS,QPOS,PQPOS,SED
'VARI' SE $ NTREAT
'FOR' I=1...NTREAT
'CALC' IPOS=1+(I-1)*NTREAT
'CALC' IPOS=ELEM(CINV;IPOS)
```

```
'CALC' IPOS=SQRT(IPOS*MS(3))
'COPY' SESI=IPOS
'REPE'
'FOR' PP=PPSET ; QQ=QQSET
'CALC' PPOS=PP+(PP-1)*NTREAT
'CALC' QPOS=QQ+(QQ-1)*NTREAT
'CALC' PQPOS=PP+(QQ-1)*NTREAT
'CALC' SED=ELEM(CINV;PPOS)+ELEM(CINV;QPOS)-2*ELEM(CINV;PQPOS)
'CALC' SED=SQRT(MS(3)*SED)
'PRIN/P' PP,QQ,SED $ 10.0,10.0,10.4
'REPE'
'CALC' CV%=100*SQRT(MS(3))/GRMN
'HEAD' H(3)='' GRAND MEAN ''
'HEAD' H(4)='' COEFFICIENT OF VARIATION ''
'PRIN/C,LABR=1' X(5), NOBS $ 0,16.0
'PRIN/C,LABR=1' H(3),GRMN $ 0,26.1
'PRIN/C,LABR=1' H(4),CV% $ 0,12.1
'PRIN' X(6)
'PRINT/P,LABR=1,LABC=1' TREATNUM,TRTMN,TREFF,SE $ 10.0,3(10.3)
'REPE'
'RUN'
     1     1 2461 2847  848    9
     1     2 1782 2599  627   27
     1     3 2344 3088  847   80
     1     4 2452 3213  642   34
     1     5 2230 3539  795   63
     1     6 2459 3227  840   77
     1     7 2350 3228  935   68
     1     8 2419 3023  696   65
     1     9 2502 3194  629   14.3
     1    10 2367 3466  817   71
     1    11 2066 2721  630   30
     2     1 1284 2289  487    0
     2     2 2191 2490 1081   47
     2     3 3380 3236  913   83.9
     2     4 2222 3167  961   85
     2     5 1667 3320 1347   65
     2     6 1856 2622  918   59
     2     7 2849 3293  884   36
     2     8 2162 3081 1223   77
     2     9 2267 2886  758   3.13
     2    10 1907 2779  734   65
     2    11 1487 2477  526   10
     3     1 1462 2374  479    4
     3     2 1444 2160  534   66
     3     3 2924 3016  922   89.2
     3     4 3010 3259  892   83
     3     5 1467 2532  873   78
     3     6 3138 3566  857   81
     3     7 2868 3059  674   70
     3     8 2325 2961 1212   66
     3     9 2223 2531  696   32.3
     3    10 2506 2900  844   62
     3    11 2790 2989  802   39
     4     1 1736 2742  607    0
```

```
     4     2 2224 2706  708   80
     4     3 2452 2813  704   62.2
     4     4 2952 3571  958   68
     4     5 2060 3290  952   76
     4     6 2000 2687  746   73
     4     7 2111 2676  712   25
     4     8 2366 3156 1190   62
     4     9 1853 2706  661   21.2
     4    10 2583 3125  783   68
     4    11 2326 2975  815   47
     5     1 1348 2096  576    0
     5     2 2989 2818  737   79
     5     3 2082 2405  886   85.3
     5     4 2370 3001 1374   84
     5     5 2082 3005  699   82
     5     6 2951 3379  841   77
     5     7 1344 2122  477    0
     5     8 2827 2978 1250   89
     5     9 2926 3099  829   29
     5    10 2078 2914  837   71
     5    11 2446 3371  874   58
     1    12 2105 3127  692   58
     2    13 3085 3538  821   68
     3    14 1767 3226  624   40
     4    15 2477 3554  699   65
     5    16 3020 3759  913  100
'BOD'
'CLOS'
'STOP'
```

OUTPUT FROM INCOMPLETE BLOCK DESIGN ANALYSIS

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
VARIABLE(1)	1284	2302	3380	60	0
VARIABLE(2)	2096	2966	3759	60	0
VARIABLE(3)	477.0	816.1	1374.0	60	0
VARIABLE(4)	0.00	55.11	100.00	60	0

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SS	MS	VRATIO
BLOCKS (IGNORING TRTS)	4	136992.000	34248.000	
ENTRIES (ELIMINATING BLOCKS)	15	6326060.500	421737.375	1.917
WITHIN ENTRIES (ERROR)	40	8801748.000	220043.703	
TOTAL	59	15264800.000		

.	2	SED 296.6774
.	12	SED 529.2021
12	13	SED 692.8878

TOTAL OBSERVATIONS	60
GRAND MEAN	2302.0
COEFFICIENT OF VARIATION	20.4

TREAT-NUM	UNADJMN	ADJMN	SE(ADJMN)
	1658.200	1658.200	200.852
2	2127.400	2127.400	200.852
3	2636.400	2636.400	200.852
4	2701.200	2701.200	200.852
5	1901.200	1901.200	200.852
	2480.400	2480.400	200.852
	2302.400	2302.400	200.852
8	2420.000	2420.000	200.852
9	2354.200	2354.200	200.852
10	2328.200	2328.200	200.852
11	2223.000	2223.000	200.852
12	2105.000	2059.147	482.057
13	3085.000	3209.506	482.057
14	1767.000	1673.876	482.057
15	2477.000	2519.691	482.057
16	3020.000	2991.780	482.057

189 'CLOS'
******** END OF KUIPERSE. MAXIMUM OF 12494 DATA UNITS USED
AT LINE 70 (315186 LEFT)

```
'refe/nunn=300,nid=300' SQLAT
'units' $ 243
'fact' SREP $ 1-243(1):UREP $ 3-81(1...3)
 :     PLOT $ 9-(1...9)27:TREAT $ 81: BVR $ 9-(9(1...9))3
'input'2
'read/P' TREAT,YLD
'FOR' YSET=YLD
'scal' SR : ZERO=0 : ONE=1 : TWO=2 : THREE=3 : TEN=10
'scal' SS1,DF1,DF2,BU,F2,R,K,VR,SEDO,SED1,SEDA,MM,CV,EMS,SSS,EFFR
'scal' LB1,LB2
'assi' KK=YSET $ ONE
'vari' ADJMNS,RS,F $ KK
'vari' OATM,RNK,TREATNO $ TREAT
'head' HX=''FITTED VALUES''
   :   HY=''RESIDUALS''
   :   P0=''TREATMENTS CONCURRING ZERO TIMES''
   :   P1=''TREATMENTS CONCURRING ONCE''
   :   P2=''TREATMENTS CONCURRING''
   :   P3='' TIMES''
   :   P4=''AVERAGE''
   :   P5='' EFFECTIVE ERROR MEAN SQUARE ''
   :   P6='' STANDARD ERROR ''
   :   P7='' COEFFICIENT OF VARIATION ''
   :   P8='' EFFECIENCY OF THIS DESIGN OVER RBD ''
'table'X $ SREP,UREP,BVR,PLOT  :  BZ $ SREP,UREP,BVR
'calc' OATM=ONE $ RNK=CUM(OATM)
  $    F=FLOAT(SREP) $ SR=MAX(F)
  $    F=(FLOAT(UREP) ONE)*SR+F
'grou' REP=INTPT(F)
'calc' F=FLOAT(TREAT)
'tabu' F ; X
'equa' F=X
'grou' TRT=INTPT(F)
'set'  YS = YSET
'calc' ADJMNS=YS
'bloc' TREAT/REP
'treat'  REP + REP.BVR//(SREP*UREP*BVR)
'anova/acon=z1,pr=TEN' YS ; OUT=AOV ; FVAL=F ; RES=RS
'extr/stra=TWO' AOV ; REP+BVR+(SREP*UREP).BVR $ EFF=BD(3,1,2,4,5) ;
    SS=SQ(3,1,2,4,5) ; DF=DQ(3,1,2,4,5)
'extr' AOV ; TREAT.REP $ SS=SS2 ; DF=DF2
'calc' BZ=BD(1)+BD(2)+BD(4)+BD(5)
  $    SS1=SQ(1)+SQ(2)+SQ(4)+SQ(5)
  $    DF1=DQ(1)+DQ(2)+DQ(4)+DQ(5)
  $    ADJMNS=REPMV(F)
  $    SSS=(SS1+SS2)/(DF1+DF2)
'bloc'
'trea' UREP+UREP.BVR
'anov/acon=z3,pr=TEN' ADJMNS ; OUT=AOV2
'extr' AOV2 ; UREP.BVR $ SS=BU
'tabu' ADJMNS ; X
```

```
'equa' UNADJMNS=X
'bloc'
'treat' TRT
'anova/pr=ONE,acon=z4,SE=N' UNADJMNS; OUT=AOV3
'extr' AOV3; TRT $ MEAN=UATM
'calc' SS1=SS1/DF1 $ SS2=SS2/DF2
  $    R=DQ(3)+ONE $ K=ONE+DF1/R
  $    FZ=(SS1-SS2)/((R-SR)*SS1+(SR-ONE)*SS2)
  $    FZ=FZ*(SS1.GT.SS2) + ZERO*(SS1.LE.SS2)
'calc' X=X-FZ*BZ*(R SR)
'equa' ADJMNS=X
'bloc'
'treat' TRT
'anova/pr=ONE,se=n,acon=z2' ADJMNS ; OUT=AOV1
'extr' AOV1 ; TRT $ MEAN=ATM
'EQUA' OATM=ATM
'CALC' OATM=-OATM
'CALC' TREATNO=RNK
'CALC' TREATNO=ORDER(TREATNO;OATM)
'CALC' OATM=ORDER(OATM)
'CALC' OATM=-OATM
'CAPT'
''        ORDERED ADJUSTED TREATMENT MEANS
            ORDER      TREATNO          ADJUSTED MEAN
''
'PRIN/P,LABC=1,LABR=1' RNK,TREATNO,OATM $ 13.0,13.0,13.3
'CALC' FZ=FZ/K
  $    SED0=TWO*SS2*(ONE+R*FZ)/R
  $    SED1=TWO*SS2*(ONE+(R-SR)*FZ)/R
  $    EEMS=SS2*(ONE+R*K*FZ/(K+ONE))
  $    SEDA=TWO*SS2*(ONE+R*K*FZ/(K+ONE))/R
  $    SED0,SED1,SEDA=SQRT(SED0,SED1,SEDA)
  $    SS1=SQ(1) + SQ(4)
  $    EFFE (SS1/EEMS)*100
'line' ONE
'HEAD' XYX='' ***STANDARD ERRORS OF THE DIFFERENCE BETWEEN TREATMENTS ***
''
'PRIN' XYX
'line' ONE
'prin/c,labr 1' P0,SED0 $ 16.4
'line' ONE
'jump' LB1*(SR.GT.ONE)
'prin/c,labr 1' P1,SED1 $ 16.4
'jump' LB2
'labe' LB1
'prin/c,labr 1' P2,SR,P3,SED1 $ 0,5.0,0,16.4
'labe' LB2
'line' ONE
'prin/c,labr 1' P4,SEDA $ 16.4
'line' ONE
'HEAD' YXY='' APPROXIMATE F TEST WITH DEGREES OF FREEDOM DF1 AND DF2 ''
'PRIN' YXY
'extr/stra=1' AOV ; TREAT + BWR + (SREP*UREP).BWR $
              SS SQ(3,1,2,4,5) ; DF=DQ(3,1,2,4,5)
'calc'  VR=SQ(3) + SQ(1) + SQ(2) + SQ(4) + SQ(5)
```

```
  $ DF1 = DQ(3) + DQ(1) + DQ(2) + DQ(4) + DQ(5)
  $ BU=BU*R/((R-SR)*(ONE+K*PZ))-SS1
  $ BU=K*(R-SR)*PZ*BU/SR
  $ VR=VR-BU
  $ VR=VR/(DF1*SS2)
'prin/p' VR,DF1,DF2 $ 13.2,10.0,10.0
'line' ONE
'prin/c,labr=1' P5,EEMS $ 13.4
'LINE' ONE
'CALC' MM=MEAN(ATM)
'calc' CV=SQRT(EEMS)*100.0/MM
'PRIN/C,LABR=1' P7,CV $ 10.1
'LINE' ONE
'SCAL' SE
'CALC' SE=SEDA/SQRT(2)
'PRIN/C,LABR=1' P6,SE $ 10.3
'LINE' 1
'PRINT/C,LABR=1' P8,EFFE $ 10.1
'REPE'
'INPU' 1
'RUN'
'CLOSE'
'STOP'
```

OUTPUT FROM SIMPLE LATTICE DESIGN

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
V1	4.00	13.62	30.00	50	0

***** ANALYSIS OF VARIANCE *****

VARIATE: V1

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
TREAT STRATUM					
REP.BWR	8	270.16	18.11	33.77	1.869
RESIDUAL	16	289.12	19.38	18.07	
TOTAL	24	559.28	37.49	23.30	
TREAT.REP STRATUM					
REP	1	212.18	14.22	212.18	15.539
REP.BWR	8	501.84	33.64	62.73	4.594
RESIDUAL	16	218.48	14.65	13.66	
TOTAL	25	932.50	62.51	37.30	
GRAND TOTAL	49	1491.78	100.00		

GRAND MEAN 13.62
TOTAL NUMBER OF OBSERVATIONS 50

***** INFORMATION SUMMARY *****

MODEL TERM	EF	NON-ORTHOGONAL TERMS
TREAT STRATUM		
BWR	0.500	
BWR.UREP	0.500	
TREAT.REP STRATUM		
BWR	0.500	TREAT
BWR.UREP	0.500	TREAT

ALIASED MODEL TERMS
SREP
UREP
BWR.SREP
SREP.UREP
BWR.SREP.UREP
REP.BWR

*** SINGLE D.F. TERMS MAY VERY OCCASIONALLY
FAIL TO BE DETECTED DUE TO NUMERICAL
COINCIDENCES IN THE DUMMY WORKING VARIATE.
IF IN DOUBT ABOUT THE ABOVE ANALYSIS, RUN
AGAIN RESETTING OPTION SEED OF ANOVA.

***** TABLES OF MEANS *****

VARIATE: UNADJMN

GRAND MEAN 13.62

TRT	1	2	3	4	5	6
	15.00	14.00	10.50	12.50	10.50	14.50
	8	9	10	11	12	13
	8.00	11.50	11.50	20.50	10.50	9.50

TRT	14	15	16	17	18	19
	19.50	18.00	14.50	13.50	12.50	11.00
	21	22	23	24	25	
	11.00	19.00	11.50	18.50	16.50	

***** TABLES OF MEANS *****

VARIATE: ADJMNS

GRAND MEAN 13.62

TRT	1	2	3	4	5	6
	19.07	16.97	14.65	14.77	12.85	13.17
	8	9	10	11	12	13
	6.75	8.37	8.45	23.55	12.46	12.63

TRT	14	15	16	17	18	19
	20.75	19.33	12.62	10.53	10.70	7.32
	21	22	23	24	25	
	11.63	18.53	12.20	17.33	15.40	

ORDERED ADJUSTED TREATMENT MEANS

ORDER	TREATNO	ADJUSTED MEAN
1	11	23.551
2	14	20.752
3	15	19.330
4	1	19.068
5	22	18.531
6	24	17.327
7	2	16.973
8	25	15.405
9	4	14.769
10	7	14.646
11	6	13.170
12	5	12.847
13	13	12.629
14	16	12.622
15	12	12.456
16	23	12.204
17	21	11.626
18	20	11.401
19	18	10.701
20	17	10.527
21	3	9.075
22	10	8.449
23	9	8.371
24	19	7.323
25	8	6.748

***STANDARD ERRORS OF THE DIFFERENCE BETWEEN TREATMENTS ***

TREATMENTS CONCURRING ZERO TIMES 4.2342

TREATMENTS CONCURRING ONCE 3.9739

AVERAGE 4.1492

APPROXIMATE F TEST WITH DEGREES OF FREEDOM DF1 AND DF2

VR 1.97 DF1 24 DF2 16

EFFECTIVE ERROR MEAN SQUARE 17.2159

COEFFICIENT OF VARIATION 30.5

STANDARD ERROR 2.934

EFFECIENCY OF THIS DESIGN OVER RBD 174.

179 CLOSE

******** END OF SQLAT. MAXIMUM OF 66687 DATA UNITS USED AT LINE 66
66808 LEFT)

OUTPUT FROM BALANCED LATTICE DESIGN

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
V1	0.730	1.595	2.260	36	0

***** ANALYSIS OF VARIANCE *****

VARIATE: V1

SOURCE OF VARIATION	DF	SS	SS%	MS	
TREAT STRATUM					
REP.BWR	8	3.22610	54.12	0.40326	
TOTAL	8	3.22610	54.12	0.40326	
TREAT.REP STRATUM					
REP	3	0.07739	1.30	0.02580	0.3
REP.BWR	8	1.42060	23.83	0.17758	2.3
RESIDUAL	16	1.23681	20.75	0.07730	
TOTAL	27	2.73480	45.88	0.10129	
GRAND TOTAL	35	5.96090	100.00		

GRAND MEAN	1.595
TOTAL NUMBER OF OBSERVATIONS	36

***** INFORMATION SUMMARY *****

MODEL TERM	EF	NON-ORTHOGONAL TERMS
TREAT STRATUM		
BWR	0.250	
BWR.UREP	0.250	
TREAT.REP STRATUM		
BWR	0.750	TREAT
BWR.UREP	0.750	TREAT

ALIASED MODEL TERMS
SREP
UREP
BWR.SREP
SREP.UREP
BWR.SREP.UREP
REP.BWR

***** TABLES OF MEANS *****

VARIATE: UNADJMN

GRAND MEAN 1.595

TRT	1	2	3	4	5	6	7
	1.743	1.848	2.013	1.605	1.003	1.905	1.365
	8	9					
	1.403	1.480					

***** TABLES OF MEANS *****

VARIATE: ADJMNS

GRAND MEAN 1.595

TRT	1	2	3	4	5	6	7
	1.804	1.754	1.964	1.727	0.939	1.845	1.387
	8	9					
	1.435	1.500					

ORDERED ADJUSTED TREATMENT MEANS

ORDER	TREATNO	ADJUSTED MEAN
1	3	1.964
2	6	1.845
3	1	1.804
4	2	1.754
5	4	1.727
6	9	1.500
7	8	1.435
8	7	1.387
9	5	0.939

***STANDARD ERRORS OF THE DIFFERENCE BETWEEN TREATMENTS ***

TREATMENTS CONCURRING ZERO TIMES 0.2199

TREATMENTS CONCURRING ONCE 0.2143

AVERAGE 0.2143

APPROXIMATE F TEST WITH DEGREES OF FREEDOM DF1 AND DF2

VR 4.32 DF1 8 DF2 16

EFFECTIVE ERROR MEAN SQUARE 0.0919

COEFFICIENT OF VARIATION 19.0

STANDARD ERROR 0.152

EFFECIENCY OF THIS DESIGN OVER RBD 120.5

PROGRAM FOR LATTICE SQUARE DESIGN ANALSYS

```
'REPE/NUNN=600,NID=600,PRINT=2' LATTICESQUARE
'UNITS' $ 80
'SCAL' NT=16: NREP=5: NSITES=1: NVAR=1: NROWCOL=4
'INTE' NLOC=1...NSITES
'INTE' NUMVAR=1...NVAR
'FACT' SREP $ 1-80(1)
  :  UREP $ NREP =16(1...5): TREAT $ NT
  :  RWR  $ NROWCOL=4(1...4)5
  :  CWR $ NROWCOL=(1...4)20
'INPU' 2
'READ/P,NUN=Q' TREAT,YLD
'FOR' YSET=YLD
'SCALAR' SR : ZERO = 0 : ONE = 1 : TWO = 2 : THREE = 3
   :  TEN=10  :  LARGE=1.0E30
'SCAL'SS1R,SS1C,SED1R,SED1C,DF1R,DF1C,FZR,FZC,R,K,SEDO,SEDA,LB1,LB2,VR
 'SCAL' L1,PS1C,PS1R,UR,MM,CV
 'ASSI' KK=YSET $ ONE
 'VARI' ADJMNS,RS,F $ KK
 'VARI' OATM,RNK,TREATNO $ TREAT
 'HEAD' HX=''FITTED VALUES''
   :     HY=''RESIDUALS''
   :     P0 = ''TREATMENTS CONCURRING ZERO TIMES''
   :     P1 = ''TREATMENTS CONCURRING ONCE''
   :     P2 = ''TREATMENTS CONCURRING''
   :     P3='' TIMES''
   :     P4='' IN ROWS ''
   :     P5='' IN COLUMNS ''
   :     P6 = ''AVERAGE''
   :     P7='' EFFECTIVE ERROR VARIANCE ''
   :     P8='' EFFICIENCY COMPARED TO RBD ''
   :     P9='' PERCENT ''
   :     P11='' COEFFICIENT OF VARIATION''
   :     P12=''STANDARD ERROR''
 'CALC' OATM=ONE $ RNK=CUM(OATM)
  $ F=FLOAT(SREP)
   $     SR = MAX(F)
   $     F=(FLOAT(UREP)-ONE)*SR+F
 'GROU' REP=INTPT(F)
 'CALC' F=FLOAT(TREAT)
 'TABU' F ; X
 'EQUA' F=X
 'GROU' TRT=INTPT(F)
 'SET' YS = YSET
 'CALC' ADJMNS=YS
 'BLOCK' UREP
 'TREAT' TREAT+TREAT.UREP
 'ANOVA/PR=ZERO' ADJMNS; OUT=AOV7
 'EXTR' AOV7; TREAT.UREP $ SS=SST ; DF=DFT
 'BLOCKS' TREAT/REP
 'TREAT'REP+REP.RWR/ (SREP*UREP*RWR)+REP.CWR//(SREP*UREP*CWR)
 'ANOVA/PR=TEN,ACON=Z2'YS;OUT=AOV
 'EXTR/STRA=TWO'AOV : REP + RWR+(SREP*UREP).RWR + CWR+(SREP*UREP).CWR $
```

```
 EFF=BD(3,1,2,4,5,6,7,8,9); SS=BQ(3,1,2,4,5,6,7,8,9) ;
 DF=DQ(3,1,2,4,5,6,7,8,9)
'EXTRACT' AOV ; TREAT.REP $ SS=SS2 ; DF=DF2
'TREAT'REP+REP.CVR//(SREP*UREP*CVR)+REP.RVR//(SREP*UREP*RVR)
'ANOVA/PR=TEN,ACON=Z1' YS ; OUT=AOV ; FVAL=F ; RES=RS
'EXTRACT/STRA=TWO'AOV;RVR+(SREP*UREP).RVR$SS=SQ(1,2,4,5)
'EXTRACT/STRA=TWO'AOV;CVR+(SREP*UREP).CVR$EFF=BD(6,7,8,9)
'TABLE'  X $ SREP,UREP,RVR,CVR  :  BZR $ SREP,UREP,RVR
;BZC$SREP,UREP,CVR
'CALC'BZR=BD(1)+BD(2)+BD(4)+BD(5) $ BZC=BD(6)+BD(7)+BD(8)+BD(9)
 $  SS1R=SQ(1)+SQ(2)+SQ(4)+SQ(5) $ SS1C=SQ(6)+SQ(7)+SQ(8)+SQ(9)
 $  DF1R=DQ(1)+DQ(2)+DQ(4)+DQ(5) $ DF1C=DQ(6)+DQ(7)+DQ(8)+DQ(9)
 $  ADJMNS=REPMV(F)
'TABULATE' ADJMNS ; X
'CALC' SS1R=SS1R/DF1R $ SS1C=SS1C/DF1C $ SS2=SS2/DF2
 $ R=DQ(3)+ONE $ K=ONE+DF1R/R
 $  FZR=(SS1R-SS2)/((R-SR)*SS1R+(SR-ONE)*SS2)
     $ FZC=(SS1C-SS2)/((R-SR)*SS1C+(SR-ONE)*SS2)
 $  UR=R/SR
 $  UR=UR-(K+ONE)*INTPT(UR/(K+ONE))
'JUMP' L1*(UR.GT.ZERO)
'CALC' PSIC=SS2/(SS1C-SS2) $ PSIR=SS2/(SS1R-SS2)
 $ PSIC,PSIR=PSIC,PSIR*(SR*K-1)/(SR*K)
 $ PSIC,PSIR=PSIC,PSIR + ONE
 $ PSIC=PSIC*(SS1C.GT.SS2) + LARGE*(SS1C.LE.SS2)
 $ PSIR=PSIR*(SS1R.GT.SS2) + LARGE*(SS1R.LE.SS2)
 $ FZC=(K+ONE)*PSIR*PSIC-PSIR-PSIC
 $ FZR=PSIC/FZC $ FZC=PSIR/FZC
'LABEL' L1
'CALC' FZR=ZERO*(SS1R.LE.SS2)+FZR*(SS1R.GT.SS2)
 $ FZC=ZERO*(SS1C.LE.SS2)+FZC*(SS1C.GT.SS2)
'EQUA' UNADJMNS-X
'BLOCKS'
'TREATS' TRT
'ANOVA/PR=ONE,ACON=Z3' UNADJMNS; OUT=AOV3
'EXTR' AOV3; TRT $ MEAN=UATM
 'CALC' X=X-(FZR*BZR+FZC*BZC)*(R-SR)
'EQUATE' ADJMNS=X
'BLOCKS'
'TREATS' TRT
'ANOVA/PR=ONE,ACON=Z3' ADJMNS ; OUT=AOV2
'EXTR' AOV2 ; TRT $ SS=SS1 ; DF=DF1 ; MEAN=ATM
'CALC'FZR,FZC=FZR,FZC/K
 $ SED0=TWO*SS2*(ONE+(FZR+FZC)*R)/R
 $ SED1R=TWO*SS2*(ONE+FZR*(R-SR)+FZC*R)/R
 $ SED1C=TWO*SS2*(ONE+FZC*(R-SR)+FZR*R)/R
 $ SEDA=TWO*SS2*(ONE+R*K*(FZR+FZC)/(K+ONE))/R
 $ SS1=SS1/DF1
'PRIN' FZR,FZC $ 10.4
'SCAL' EE
'CALC' EE=R*SEDA
'PRIN' EE $ 10.4
'CALC'  VR=TWO*SS1/EE
 $ SED0,SED1R,SED1C,SEDA=SQRT(SED0,SED1R,SED1C,SEDA)
'LINE' TWO
```

```
 'CAPT' ''
 *** STANDARD ERRORS OF THE DIFFERENCE BETWEEN TREATMENTS ***
 ''
 'JUMP' LB2*(UR.EQ.ZERO)
 'LINE' TWO
 'PRIN/C,LABR=ONE' PO,SEDO $ 0,16.3
 'LINE' TWO
 'JUMP' LB1*(SR.GT.ONE)
 'PRIN/C,LABR=ONE' P1,P4,SED1R $ 0,16.3
 'LINE' TWO
 'PRIN/C,LABR=ONE' P1,P5,SED1C $ 0,16.3
 'JUMP' LB2
 'LABEL' LB1
 'PRIN/C,LABR=ONE' P2,SR,P3,P4,SED1R $ 0,5.0,0,0,16.3
 'LINE' TWO
 'PRIN/C,LABR=ONE'P2,SR,P3,P5,SED1C $ 0,5.0,0,0,16.3
 'LABEL' LB2
 'LINE' TWO
 'PRIN/C,LABR=ONE' P6,SEDA $ 0,16.3
 'LINE' TWO
 'CAPT' ''
 APPROXIMATE F TEST WITH DEGREES OF FREEDOM DF1 AND DF2''
 'PRIN/P' VR,DF1,DF2 $ 13.3,10.0,10.0
'GRAPH' RS;F
'FOR' I=1...4
'REST' RS $ UREP=I
'TABLE' TABLES $ RWR,CWR
'TABU' RS; TABLES
'PRINT' TABLES$ 8.1
'REPE'
'REST' RS
'LINE' TWO
'CALC' VR=SS1/VR
'PRIN/C,LABR=ONE' P7,VR $ 16.3
'SCAL' EFER,SST,SE,CV,MM
'CALC' MM=MEAN(ATM)
'CALC' EFER=VR
'CALC' CV=(SQRT(EFER)/MM)*100
'PRIN/C,LABR=ONE' P11,CV $ 0,16.1
'CALC' SE=SEDA/SQRT(2)
'PRIN/C,LABR=ONE' P12,SE $ 16.2
'CALC' SST=SST/DFT
'CALC' VR=(SST/VR)*100
'LINE' 2
'PRIN/C,LABR=ONE' P8,VR,P9 $ 12.0
'REPE'
'LABEL' L5
'LINE' 1
'INPU' 1
'RUN'
'CLOSE'
'STOP'
```

OUTPUT FROM LATTICE SQUARE DESIGN ANALYSIS

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
V(1)	16.90	29.19	43.00	75	0

***** ANALYSIS OF VARIANCE *****

VARIATE: V(1)

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
TREAT STRATUM					
REP.RWR	12	337.764	15.27	28.147	
REP.CWR	12	273.318	12.36	22.776	
TOTAL	24	611.082	27.63	25.462	
TREAT.REP STRATUM					
REP	2	546.877	24.73	273.438	28.558
REP.RWR	12	585.630	26.48	48.803	5.097
REP.CWR	12	238.211	10.77	19.851	2.073
RESIDUAL	24	229.796	10.39	9.575	
TOTAL	50	1600.513	72.37	32.010	
GRAND TOTAL	74	2211.595	100.00		

GRAND MEAN 29.19
TOTAL NUMBER OF OBSERVATIONS 75

***** INFORMATION SUMMARY *****

MODEL TERM	EF	NON-ORTHOGONAL TERMS
TREAT STRATUM		
RWR	0.333	
RWR.UREP	0.333	
CWR	0.333	
UREP.CWR	0.333	
TREAT.REP STRATUM		
RWR	0.667	TREAT
RWR.UREP	0.667	TREAT
CWR	0.667	TREAT
UREP.CWR	0.667	TREAT

ALIASED MODEL TERMS
SREP
UREP
RWR.SREP
SREP.UREP
RWR.SREP.UREP
REP.RWR
SREP.CWR
SREP.UREP.CWR
REP.CWR

***** ANALYSIS OF VARIANCE *****

VARIATE: V(1)

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
TREAT STRATUM					
REP.CWR	12	273.318	12.36	22.776	
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REP.RWR	12	585.630	26.48	48.803	5.097
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TOTAL NUMBER OF OBSERVATIONS 75

***** INFORMATION SUMMARY *****

MODEL TERM	EF	NON-ORTHOGONAL TERMS
TREAT STRATUM		
CWR	0.333	
CWR.UREP	0.333	
RWR	0.333	
UREP.RWR	0.333	
TREAT.REP STRATUM		
CWR	0.667	TREAT
CWR.UREP	0.667	TREAT
RWR	0.667	TREAT
UREP.RWR	0.667	TREAT

ALIASED MODEL TERMS
SREP
UREP
CWR.SREP
SREP.UREP
CWR.SREP.UREP
REP.CWR
SREP.RWR
SREP.UREP.RWR
REP.RWR

***** TABLES OF MEANS *****
VARIATE: UNADJMS

GRAND MEAN 29.19

TRT	1	2	3	4	5	6	7
	26.23	29.63	26.30	30.07	34.10	27.53	29.37
	8	9	10	11	12	13	
	34.50	31.10	31.70	27.37	30.53	26.20	
TRT	14	15	16	17	18	19	20
	27.73	31.43	31.33	30.07	29.93	34.20	24.27
	21	22	23	24	25		
	25.73	29.50	24.83	25.77	30.37		

***** TABLES OF MEANS *****

VARIATE: ADJMNS

GRAND MEAN 29.19

TRT	1	2	3	4	5	6	7
	27.90	28.55	29.31	29.64	31.78	28.14	27.22
	8	9	10	11	12	13	
	33.35	29.12	32.47	30.02	30.04	26.18	
TRT	14	15	16	17	18	19	20
	28.74	32.90	28.50	27.92	31.28	35.68	25.66
	21	22	23	24	25		
	26.02	31.47	24.19	26.56	27.16		

*** STANDARD ERRORS OF THE DIFFERENCE BETWEEN TREATMENTS ***

TREATMENTS CONCURRING ZERO TIMES 2.986
TREATMENTS CONCURRING ONCE IN ROWS 2.8984E 0
TREATMENTS CONCURRING ONCE IN COLUMNS 2.9297E 0
AVERAGE 2.914
APPROXIMATE F TEST WITH DEGREES OF FREEDOM DF1 AND DF2

VR 1.755 DF1 24 DF2 24
EFFECTIVE ERROR VARIANCE 12.738
COEFFICIENT OF VARIATION 12.2
STANDARD ERROR OF MEAN 2.06
EFFICIENCY COMPARED TO RBD 172 PERCENT

150 'CLOSE'
********* END OF LATTICES. MAXIMUM OF 168888 DATA UNITS USED AT
LINE 93 (158792 LEFT)

PROGRAM FOR RECTANGULAR LATTICE DESIGN ANALYSIS

```
'REFE/NUNN=1000,NID=1000' RECTANGULARLATTICE
'UNITS' $ 36
'FACT' SREP $ 1=36(1) : UREP $ 3
  :    BWR $ 5= 3(4,1,3,2,4,2,3,1,1,2,3,4)
  :    TREAT $ 12
'READ/P' UREP,TREAT,V1
'FOR' YSET=V1
'HEAD'  HX = ''FITTED VALUES''
   :    HY = ''RESIDUALS''
   :    HRB=''   RANDOMISED BLOCK ANALYSIS''
   :    P0 = ''TREATMENTS CONCURRING ZERO TIMES''
   :    P1 = ''TREATMENTS CONCURRING ONCE''
   :    P2 = ''TREATMENTS CONCURRING''
   :    P3 = '' TIMES''
   :    P4 = ''AVERAGE''
   :    H1=''  EFFECTIVE ERROR VARIANCE ''
   :    H2=''  EFFICIENCY OF THIS DESIGN OVER RBD ''
'SCAL'  BU,SR,LB1,LB2,LB3
  :  ZERO=0 : ONE=1 : TWO=2 : THREE=3 : TEN=10
'SCAL'
R,S,K,SS1,DF1,PM,FA,FB,ID,SED0,SED1,SEDA,VR,T,EEMS,SSS1,SSS2,SSS,DFF,
EFFE
'ASSI' KK=YSET $ ONE
'VARI' DATA,F,FF,RM,RS,WM,ZM $ KK
'VARI' OATM,RNK,TREATNO $ TREAT
'CALC' OATM=ONE $ RNK=CUM(OATM)
 $ F=FLOAT(SREP) $ SR=MAX(F)
 $ F=(FLOAT(UREP) ONE)*SR+F
'GROU' REP=INTPT(F)
'FOR'  Y = YSET
'CALC'  DATA=Y
'BLOC' TREAT/REP
'TREAT' REP+REP.BWR//(SREP*UREP*BWR)
'ANOVA/PR=TEN,ACON=Z1'Y; OUT AOV ; FVAL=F ; RES=RS
'EXTR/STRA=TWO' AOV ; REP+BWR+(SREP*UREP).BWR $ SS=SQ(3,1,2,4,5) ;
   DF=DQ(3,1,2,4,5)
'EXTRACT' AOV; TREAT.REP $ SS=SS2 ; DF=DF2
'CALC' SSS2=SS2
'CALC' DF1=DQ(1)+DQ(2)+DQ(4)+DQ(5)
   $ SSS1=(SQ(1)+SQ(2)+SQ(4)+SQ(5))
   $ SS1=(SQ(1)+SQ(2)+SQ(4)+SQ(5))/DF1
   $ SS2=SS2/DF2
   $ SSS=SSS1+SSS2
   $ DFF=DF1+DF2
   $ SSS=SSS/DFF
   $    R=DQ(3)+ONE  $  S=DQ(1)+ONE
'JUMP' LB3*(SS1.LE.SS2)
'CALC' T=NMV(DATA)
 $ K=(DF2+T+R*S-ONE)/(S*(R-ONE)) $ ID=S-K $ PM=(R-ONE)/R*SS2/(SS1-SS2)
 $  DATA=REPMV(F)
'BLOCKS'
'TREAT' TREAT
```

```
'LINE' TWO
PRIN/C,LABR=ONE' PO,SEDO $ 16.2
'LINE' TWO
PRIN/C,LABR=ONE,LABC=ONE' H1,EEMS $ 20.0,10.2
'LINE' TWO
PRIN/C,LABR=ONE,LABC=ONE' H2,EFFE $ 20.0,10.2
PRIN/C,LABR=ONE' P1,SED1 $ 16.2
'JUMP'  LB1*(SR.GT.ONE)
'PRIN/C,LABR=ONE' P1,SED1 $ 16.2
'JUMP'  LB2
'LABEL'  LB1
'PRIN/C,LABR=ONE'  P2,SR,P3,SED1  $  0,4.0,0,16.2
'LINE' TWO
'PRIN/C,LABR=ONE,LABC=ONE' H1,EEMS $ 20.0,10.2
'LINE' TWO
'PRIN/C,LABR=ONE,LABC=ONE' H2,EFFE $ 20.0,10.2
'JUMP' LB2
'LABE' LB3
'LINE' TEN
'CAPT' ''
      BLOCK MEAN SQUARE LESS THAN OR EQUAL TO ERROR MEAN SQUARE.
      RECOVERY OF INTERBLOCK INFORMATION WILL NOT BE PERFORMED.
      DATA WILL BE ANALYSED AS A RANDOMISED BLOCK.
'BLOC' SREP/UREP/TREAT
'TREAT' TREAT
'DESC' Y $ ; HRB
'ANOVA/ACON=25' Y ; FVAL=F ; RES=RS
'LABEL'  LB2
'GRAP/ATX=HX,ATY=HY'  RS ; F
'REPE'
'REPE'
'R'
1 10 7
1 12 12
1 11 11
1 2 9
1 3 4
1 1 16
1 7 16
1 9 15
1 8 23
1 4 0
1 5 3
1 6 11
2 3 11
2 6 20
2 9 17
2 1 17
2 11 8
2 8 19
2 12 9
2 2 10
2 5 6
2 10 6
2 4 5
```

```
'ANOVA/PR=ZERO,ACON=Z2'DATA;RES=RM
'TREAT' BWR.REP
'ANOVA/PR=ZERO,ACON=Z3'RM;FVAL=FF
'TREAT' BWR
'ANOVA/PR=ZERO,ACON=Z4'FF;FVAL=WM
'TREAT' REP + REP.BWR
'ANOV/PR=ZERO,ACON=Z6' DATA ; OUT=AOV2
'EXTR' AOV2 ; REP.BWR $ SS=BU
'CALC'FA=R*K*(PM+ONE)-S*SR$FB=ID/(FA*(FA+R))
 $ ZM=R*K*(FF/FA-R*WM*FB) $ DATA=DATA-ZM
'TREAT' TREAT
'ANOVA/PR=ONE,SE=N,ACON=Z2' DATA ; OUT=AOV1
'EXTR' AOV1 ; TREAT $ MEAN=ATM
'EQUA' OATM=ATM
'CALC' OATM=-OATM
 $  TREATNO=RNK
 $  TREATNO=ORDER(TREATNO ; OATM)
 $  OATM=ORDER(OATM)
 $  OATM=-OATM
'LINE' TWO
'CAPT' ''
   **** ORDERED ADJUSTED TREATMENT MEANS ****

         ORDER     TREATMENT     ADJUSTED
                      NUMBER     MEAN     ''
'PRIN/P,LABC=ONE' RNK,TREATNO,OATM $ 13.0,13.0,13.1
'JUMP' LB2*(SS2.LE.ZERO)
'CALC' SED0 = R*FB*(SR*S-R)*(SR*S-R)
 $ SED0=SED0/(SR*(S*K-ONE)-R*(S-TWO))
 $ SED0 = TWO*SS2*(ONE+R/FA-SED0)/R
 $ SED1=FB*(R-SR)*(S*SR-R)/(S-TWO)
 $ SED1=TWO*SS2*(ONE+(R-SR)/FA-SED1)/R
 $ SEDA=R*(S-ONE)*K/((S*K-ONE)*FA)
 $ SEDA = SEDA   FB*R*(SR*S-R)*(S-ONE)/(S*K-ONE)
 $ EEMS=SS2*(ONE+SEDA)
 $ SEDA=TWO*SS2*(ONE+SEDA)/R
 $ SED0,SED1,SEDA SQRT(SED0,SED1,SEDA)
 $ EFFE=(SSS/EEMS)*100
'CAPT' ''
APPROXIMATE (INTRABLOCK) F TEST WITH DEGREES OF FREEDOM DF1 AND DF2 ''
'EXTR/STRA=ONE' AOV ; TREAT + BWR + (SREP*UREP).BWR $
              SS=SQ(3,1,2,4,5) ; DF=DQ(3,1,2,4,5)
'CALC' SS1=SS1*DF1
 $ VR = SQ(3) + SQ(1) + SQ(2) + SQ(4) + SQ(5)
 $ DF1 = DQ(3) + DQ(1) + DQ(2) + DQ(4) + DQ(5)
 $ VR = VR + SS1   BU
 $ VR = VR/(DF1*SS2)
'LINE' THREE
'PRIN/P' VR,DF1,DF2 $ 13.5,10.0,10.0
'LINE' TWO
'CAPT' ''
*** STANDARD ERRORS OF THE DIFFERENCE BETWEEN TREATMENTS ***
''
'LINE' TWO
'PRIN/C,LABR=ONE' P4,SEDA $ 16.2
```

```
2 7 14
3 8 20
3 6 15
3 12 10
3 9 16
3 10 9
3 2 15
3 11 6
3 3 3
3 4 1
3 5 11
3 1 22
3 7 17
'EOD'
'CLOS'
'STOP'
```

OUTPUT FROM RECTANGULAR LATTICE DESIGN

IDENTIFIER	MINIMUM	MEAN	MAXIMUM	VALUES	MISSING
V1	0.00	11.50	23.00	36	0

***** ANALYSIS OF VARIANCE *****

VARIATE: V1

SOURCE OF VARIATION	DF	SS	SS%	MS	VR
TREAT STRATUM					
REP.BWR	9	1.029E 3	80.96	1.143E 2	6.018
RESIDUAL	2	3.800E 1	2.99	1.900E 1	
TOTAL	11	1.067E 3	83.95	9.700E 1	
TREAT.REP STRATUM					
REP	2	1.550E 1	1.22	7.750E 0	
REP.BWR	9	1.885E 2	14.83	2.094E 1	
RESIDUAL	13	0.000E 0	0.00	0.000E 0	
TOTAL	24	2.040E 2	16.05	8.500E 0	
GRAND TOTAL	35	1.271E 3	100.00		

GRAND MEAN 11.50
TOTAL NUMBER OF OBSERVATIONS 36

***** INFORMATION SUMMARY *****

MODEL TERM	EF	NON-ORTHOGONAL TERMS
TREAT STRATUM		
BWR	0.111	
BWR.UREP	0.444	
TREAT.REP STRATUM		
BWR	0.889	TREAT
BWR.UREP	0.556	TREAT

ALIASED MODEL TERMS
SREP
UREP
BWR.SREP
SREP.UREP
BWR.SREP.UREP
REP.BWR

***** TABLES OF MEANS *****

VARIATE: DATA

GRAND MEAN 11.50

TREAT	1	2	3	4	5	6
	18.67	11.67	6.67	4.67	7.67	15.67
	7	8	9	10	11	12
	13.67	20.67	12.67	5.67	9.67	10.67

**** ORDERED ADJUSTED TREATMENT MEANS ****

ORDER	TREATMENT NUMBER	ADJUSTED MEAN
1	8	20.7
2	1	18.7
3	6	15.7
4	7	13.7
5	9	12.7
6	2	11.7
7	12	10.7
8	11	9.7
9	5	7.7
10	3	6.7
11	10	5.7
12	4	4.7

PROGRAM FOR CUBIC LATTICE DESIGN ANALYSIS

```
      DIMENSION LINE(80),REP(3),VAR(512),BLU(192),VAUW(8,8,8),D(64),
      1E(64),G(8),F(64),H(8),ZJ(64),ZK(64),B1(8),A1(8),YJ1(8),B(8),
      2YK(8),C(8),C1(8),ZL(64),YL(64),YK1(8),YL1(8),A(8),YJ(8),
      3AB1(8),CA1(8),BC1(8),YJ1L(8),YKL1(8),YJK1(8),SOS(7),TOS(4),
      4NDF(7),SM(7),ALPH(8),BETA(8),GAM(8),SOV(7)
      DATA NREP,LOL/3,'*'/
      REAL*8 SOV/' REPS. ','COMP. A','COMP. B','COMP. C','VARIETY',
      1' ERROR ',' TOTAL '/
100   FORMAT(2X,I2,1X,I3,2F3.0)
101   FORMAT(80A1)
102   FORMAT(1H ,79A1)
103   FORMAT(2I2)
104   FORMAT(13H OUT OF RANGE)
105   FORMAT(7X,A7,8X,I4,2X,F12.2,2X,F12.2)
106   FORMAT(//5X,34H UNADJUSTED/ADJUSTED VARIETY MEANS//)
107   FORMAT(2I5,8F10.0)
108   FORMAT(10X,8F10.0)
1000  READ(9,101) LINE
C     HEADLINE
      IF(LINE(1).NE.LOL) GOTO 1000
1010  IF(LINE(2).EQ.LOL) STOP
1020  WRITE(3,102)(LINE(J),J=2,80)
      WRITE(3,102)
      READ(9,103)NU
C     SIZE OF LATTICE
      IF(NU.LE.8)GOTO 1030
      WRITE(3,104)
      STOP
1030  NU2=NU*NU
      NU3=NU2*NU
      NVAR=NU3*3
      TV=NVAR
      UN=NU
      UN1=NU-1
      UN2=NU2
      UN3=NU3
      N2U2=NU2+NU2
      N3U2=N2U2+NU2
      NU1=NU-1
      N3U1=3*NU1
      NDF(1)=NREP-1
      NDF(2)=N3U1
      NDF(3)=N3U1
      NDF(4)=N3U1*NU1
      NDF(5)=NU3-1
      NDF(7)=NVAR-1
      NDF(6)=NDF(7)-NDF(1)-NDF(2)-NDF(3)-NDF(4)-NDF(5)
      DO 250 J=1,NREP
250   REP(J)=0.0
      DO 251 J=1,NU3
251   VAR(J)=0.0
      DO 252 J=1,N3U2
```

```
252     BLU(J)=0.0
        DO 253 J=1,NU
        DO 253 K=1,NU
        DO 253 L=1,NU
253     VAUV(J,K,L)=0.0
        DO 254 J=1,NU2
        D(J)=0.0
        E(J)=0.0
        F(J)=0.0
254     YL(J)=0.0
        DO 255 J=1,NU
        G(J)=0.0
        B1(J)=0.0
        H(J)=0.0
        A1(J)=0.0
        YJ1(J)=0.0
        B(J)=0.0
        YK(J)=0.0
        C(J)=0.0
        C1(J)=0.0
        YK1(J)=0.0
        YL1(J) 0.0
        A(J)=0.0
255     YJ(J)=0.0
        DO 256 J=1,7
256     SOS(J)=0.0
        AM=0.0
        SA=0.0
        SB=0.0
        SC=0.0
        SJ=0.0
        SJ1=0.0
        SK=0.0
        SK1=0.0
        SL=0.0
        SL1=0.0
        CF=0.0
        DO 5 IR=1,NREP
        DO 5 IWUV=1,NU3
        READ(9,*)IB,IJK,D1,D1,DATA,D1,D1,D1,D1,D1,D1
        I10=IJK/10
        IW=I10/10
        IU=I10-IW*10
        IV=IJK-I10*10
        IF(IR-2) 30,31,32
30      IB=NU*(IW-1)+IV
        GO TO 33
31      IB=NU*(IW-1)+IU+NU2
        GO TO 33
32      IB=2*NU2+NU*(IU-1)+IV
33      CONTINUE
        IVAR=NU2*(IW-1)+NU*(IV-1)+IU
        REP(IR)=REP(IR)+DATA
C       REP TOTALS
        VAR(IVAR)=VAR(IVAR)+DATA
```

```
C       VARIETY TOTALS
        BLU(IB)=BLU(IB)+DATA
C       UNADJUSTED BLOCK TOTALS
        VAUW(IW,IU,IV)=VAUW(IW,IU,IV)+DATA
C       VARIETY TOTALS IN TWO WAY TABLE '+' VALUES
        ID=NU*(IW-1)+IV
        D(ID)=D(ID)+DATA
C       D VALUES FORMED
        IE=NU*(IW-1)+IU
        E(IE)=E(IE)+DATA
        G(IU)=G(IU)+DATA
C       E VALUES FORMED
        JF=NU*(IU-1)+IV
        F(JF)=F(JF)+DATA
        H(IV)=H(IV)+DATA
C       F VALUES FORMED
        CF=CF+DATA
        T=T+DATA*DATA
5       CONTINUE
        CF=CF*CF/TV
        SOS(7)=T-CF
C       CORRECTED SUM OF SQUARES FOR TOTALS
        DO 6 K=1,NU2
        ZJ(K)=D(K)-3.0*BLU(K)
C       J VALUES CALCULATED FROM J=D-3A
        ZK(K)=E(K)-3.0*BLU(NU2+K)
C       K VALUES CALCULATED FROM K=E-3B
        ZL(K)=F(K)-3.0*BLU(N2U2+K)
C       L VALUES CALCULATED FROM L=F-3C
6       CONTINUE
        JB=NU2
        DO 7 I=1,NU
        DO 7 J=1,NU
        JB=JB+1
        B1(I)=B1(I)+BLU(JB)
C       B1 CALCULATED
7       C1(I)=C1(I)+BLU(NU2+JB)
C       C VALUES CALCULATED
        JB=0
        DO 8 I=1,NU
        DO 8 J=1,NU
        JB=JB+1
        A1(J)=A1(J)+BLU(JB)
        YJ1(J)=YJ1(J)+ZJ(JB)
        B(J)=B(J)+BLU(NU2+JB)
        YK(J)=YK(J)+ZK(JB)
        C(J)=C(J)+BLU(N2U2+JB)
        YL(J)=YL(J)+ZL(JB)
        YK1(I)=YK1(I)+ZK(JB)
        YL1(I)=YL1(I)+ZL(JB)
        A(I)  =A(I)  +BLU(JB)
        YJ(I)=YJ(I)+ZJ(JB)
8       CONTINUE
C       A1,J1,B,C,AND K VALUES CALCULATED
C       L,K1,L1 AND A VALUES CALCULATED
```

```
      DO 9 J=1,NU
      AB1(J)=A(J)-B1(J)
      CA1(J)=C(J)-A1(J)
      BC1(J)=B(J)-C1(J)
      YJ1L(J)=YJ1(J)+YL(J)
      YKL1(J)=YK(J)+YL1(J)
      YJK1(J)=YJ(J)+YK1(J)
      SA=SA+A(J)
      SB=SB+B(J)
      SC=SC+C(J)
      SJ=SJ+YJ(J)
      SJ1=SJ1+YJ1(J)
      SK=SK+YK(J)
      SK1=SK1+YK1(J)
      SL=SL+YL(J)
9     SL1=SL1+YL1(J)
      DO 10 J=1,NU2
10    SOS(4)=SOS(4)+ZK(J)**2+SJ(J)**2+SL(J)**2
      SOS(4)=SOS(4)/(6.0*UN)
      DO 11 J=1,NU
11    TOS(4)=TOS(4)+YL(J)**2+YL1(J)**2+YJ(J)**2+YJ1(J)**2
     1+YK(J)**2+YK1(J)**2
      TOS(4)=TOS(4)/(6.0*UN2)
      SOS(4)=SOS(4)-TOS(4)+(SL**2+SK**2+SJ**2)/(2.0*TV)
      DO 12 IR=1,NREP
12    SOS(1)=SOS(1)+REP(IR)*REP(IR)
      SOS(1)=SOS(1)*3.0/TV-CF
      DO 13 K=1,NU
      SOS(2)=SOS(2)+AB1(K)**2+BC1(K)**2+CA1(K)**2
13    SOS(3)=SOS(3)+YJK1(K)**2+YKL1(K)**2+YJ1L(K)**2
      SOS(2)=SOS(2)/(2.0*UN2)
      SOS(2)=SOS(2)-((SA-SB)**2+(SB-SC)**2+(SC-SA)**2)
     1/(2.0*UN3)
      SOS(3)=SOS(3)/(6.0*UN2)
      SOS(3)=SOS(3)-((SJ+SK)**2+(SL+SK)**2+(SL+SJ)**2)
     1/(6.0*UN3)
      DO 14 J=1,NU3
14    SOS(5)=SOS(5)+VAR(J)**2/3.0
      SOS(5)=SOS(5)-CF
      SOS(6)=SOS(7)-SOS(1)-SOS(2)-SOS(3)-SOS(4)-SOS(5)
      DO 15J=1,7
15    SM(J)=SOS(J)/NDF(J)
C     SUM OF SQUARES, DEGREES OF FREEDOM AND MEAN SQUARES FORMED.
      W=1./SM(6)
      W2=2.*(SOS(1)+SOS(2)+SOS(3)+SOS(4)-SM(6)*(3.*UN2-1))/UN3
      W1=1./(SM(6)+W2)
      W3=W+W+W
      XK1=W3/(W +W1+W1)
      XK2=W3/(W +W +W1)
      CONK=2.0/(W3*UN2)
      VAR1=SQRT(CONK*(XK1+XK2*(UN1+UN1)+UN1*UN1))
      VAR2=SQRT(CONK*(2.*XK1+XK2*(3.*UN-4.)+UN1*(UN-2.)))
      VAR3=SQRT(CONK*(3.*XK1+XK2*3.*(UN-2.)+UN2-3.*UN1))
      VAR4=SQRT(CONK*UN2*(3.*XK1+3.*XK2*UN1+UN1*UN1)/(UN2+UN+1))
      EFF=100.0*(UN2+W*(UN+1.)/W1)/(3.*XK1+3.*UN1*XK2+UN1*UN1)
```

```
110   FORMAT(/9X,'S.E. OF DIFFERENCE BETWEEN TWO VARIETIES'/)
111   FORMAT(9X,'SAME INDEX FOR TWO FACTORS (V211-V111)=',F15.2)
112   FORMAT(9X,'SAME INDEX FOR ONE FACTOR  (V221-V111)=',F15.2)
113   FORMAT(9X,'NO INDEX THE SAME          (V222-V111)=',F15.2)
114   FORMAT(//9X,'AVERAGE STANDARD ERROR OF ALL COMPARISONS ='
      1,F11.2)
115   FORMAT(//9X,'EFFICIENCY COMPARED TO RANDOMISED BLOCK
      1,F11.1)
C     WEIGHTS CALCULATED
C     SOURCE OF VARIATION
121   FORMAT(/38X,2HIV/1OH   IW   IU.8I10/)
      WRITE(3,1105)
1105  FORMAT(//,2X,'SOURCE OF VARIATION D.F.  S. OF S.',
      15X, 'MEAN SQUARE',/)
      DO 19 J=1,7
19    WRITE(3,105) SOV(J),NDF(J),SOS(J),SM(J)
C     ANOVA TABLE
      AMDA=(W-W1)/(W+2*W1)
      EUW=(W-W1)/(2*W+W1)
      CONS=(AMDA-EUW)/(UN2)
      DO 16 J=1,NU
      ALPH(J)=CONS*(YK(J)+YL1(J))
      BETA(J)=CONS*(YL(J)+YJ1(J))
16    GAM(J)=CONS*(YJ(J)+ YK1(J))
      WRITE(3,106)
      WRITE(3,121)(I,I=1,NU)
      IN=-NU
      DO 18 IW 1,NU
      IN=IN+NU
      DO 18 IU 1,NU
      JL=IN+IU
      NI=(IU-1)*NU
      DO 17 I 1,NU
      KL=IN+I
      JK=NI+I
      H(I)=VAUW(IW,IU,I)/3.
      HI=ALPH(IU)+BETA(I)+GAM(IW)+EUW*(ZK(JL)+ZJ(KL)+ZL(JK))/UN
17    G(I)=H(I)+HI/3.
      WRITE(3,107)IW,IU,(H(I),I=1,NU)
      WRITE(3,108)(G(I),I=1,NU)
18    WRITE(3,102)
C     ADJUSTED VARIETY MEAN CALCULATED
      DO 300 J=1,3
      AM=AM+REP(J)
300   REP(J)=REP(J)/NU3
      AM=AM/TV
      CV=100*SQRT(SM(6))/AM
      WRITE(3,301)(REP(J),J=1,3),AM,CV
301   FORMAT(//,2X, 'REPLICATE MEANS', 3F12.2//2X,'OVERALL MEAN'
      1F10.2,2X,'C.V.%' F6.2//)
      WRITE(3,110)
      WRITE(3,111)VAR1
      WRITE(3,112)VAR2
      WRITE(3,113)VAR3
      WRITE(3.114) VAR4
      WRITE(3,115) EFF
      END
```

PROGRAMS FOR GENERATING RANDOMIZATIONS FOR INCOMPLETE BLOCK DESIGNS

PROGRAM FOR GENERATING RANDOMIZATIONS FOR
SIMPLE, TRIPLE LATTICE DESIGNS

```
      DIMENSION N(3,25,25),IA(625),NT(625),IB(25),ID(25),IG(25)
     +,NPLAN(3,25,25),NPLNO(3,25,25),IPLOT(3,625),ITRT(3,625),IT(625),
     +IP(3,625)
      INTEGER X
      CHARACTER*12 ALOC,AFILE1,AFILE2,AFILE3
      TYPE *,'THIS PROGRAM WRITTEN BY G.SWAMINATHAN GENERATES
     + RANDOMISED FIELD PLAN FOR K X K TRIPLE OR SIMPLE LATTICE
     + DESIGN IN BLOCKS OF K UNITS WHERE K <= 25 AND K >= 3'
  791 TYPE *,'ENTER THE SEED VALUES (THE VALUES SHOULD BE ODD NUMBERS
     + AND CONSISTS OF ODD NUMBER OF DIGITS Ex 931 10785)'
      ACCEPT *,MA,MB
      TYPE *,'ENTER THE NUMBER OF REPLICATIONS'
      ACCEPT *,NREP
      IF(NREP.GT.3) GOTO 901
      TYPE *,'ENTER THE SIZE OF THE DESIGN (Ex. FOR A K X K
     +TRIPLAT IT IS K)'
      ACCEPT *,NSIZ
      IF(NSIZ.GT.25) GOTO 901
      TYPE *,'ENTER THE NUMBER REPEATS OF THE DESIGN (FOR NO REPITITION
     + TYPE 1)'
      ACCEPT *,NREPE
      TYPE *,'TYPE THE LOCATION NAME (MAX 12 CHARACTERS) '
      ACCEPT 221,ALOC
  221 FORMAT(A12)
      TYPE *,'TYPE A FILE NAME FOR FIELD PLAN'
      ACCEPT 223,AFILE1
  223 FORMAT(A12)
      TYPE *,'TYPE A FILE NAME FOR CREATING FIELD LABELS'
      ACCEPT 224,AFILE2
  224 FORMAT(A12)
      TYPE *,'TYPE A FILE NAME FOR CREATING FIELD BOOKS'
      ACCEPT 225,AFILE3
  225 FORMAT(A12)
      OPEN(UNIT=6,FILE=AFILE1,STATUS='NEW')
      OPEN(UNIT=8,FILE=AFILE2,STATUS='NEW')
      OPEN(UNIT=11,FILE=AFILE3,STATUS='NEW')
      WRITE(6,1) MA,MB
    1 FORMAT(//,2X,'THE SEED VALUES ARE=' ,I10,',',I10,//)
      WRITE(6,227) ALOC
  227 FORMAT(//,2X,'LOCATION:          ',A12,//)
      NBL=NSIZ
      NTRT=NBL*NSIZ
      IF(NTRT.GT.99) KK=1000
      IF(NTRT.LE.99) KK=100
      DO 2 I=1,NSIZ
      DO 3 J=1,NSIZ
      N(1,I,J)=J+NSIZ*(I-1)
      N(2,I,J)=I+NSIZ*(J-1)
    3 CONTINUE
    2 CONTINUE
      DO 77 J=1,NBL
```

```
   77 N(3,J,J)=J
      DO 200 J=1,NBL
      K1=J
      K2=J-1
      X=0
      DO 110 K=K1,NSIZ
      IF(K.EQ.J) GOTO 110
      N(3,J,K)=X+N(3,J,K-1)+(NSIZ+1)
  110 CONTINUE
      DO 111 K=1,K2
      IF(K.EQ.J) GOTO 111
      N(3,J,K)=N(3,J-1,NSIZ)-NSIZ+1+(K-1)*(NSIZ+1)
111   CONTINUE
200   CONTINUE
C     ---------- ------   RANDOMISE TREATMENTS -----------------------
      DO 15 II=1,NTRT
   15 IA(II)=0
      DO 20 JJ=1,NTRT
   25 JA=RAN(MA,MB)*NTRT+1
      IF(IA(JA).EQ.1) GOTO 25
      IA(JA)=1
      NT(JJ)=JA
   20 CONTINUE
C     --                                     -------------------
      DO 999 II=1,NREPE
      WRITE(6,7) II
    7 FORMAT(//,2X,'REPEAT OF THE DESIGN',I4,//)
      WRITE(6,830) NBL,NSIZ
  830 FORMAT(' ',5X,' RANDOMIZED PLAN FOR',1X,I3,1X,'X',1X,I3,1X,'T
     +RIPLE LATTICE DESIGN',//)
      DO 30 I=1,NREP
   30 IB(I)=0
      DO 35 I=1,NREP
   40 IC=RAN(MA,MB)*NREP+1
      IF(IB(IC).EQ.1) GOTO 40
      IB(IC)=1
C
----------- --      ------  ----- - -   ---- -----------------------
      DO 45 J=1,NBL
   45 ID(J)=0
      DO 50 J=1,NBL
   55 IE=RAN(MA,MB)*NBL+1
      IF(ID(IE).EQ.1) GOTO 55
      ID(IE)=1
C
-----------  ---- -- --  -  - -     --        ----------------------
      DO 70 K=1,NSIZ
   70 IG(K)=0
      DO 75 K=1,NSIZ
   76 IH=RAN(MA,MB)*NSIZ+1
      IF(IG(IH).EQ.1) GOTO 76
      IG(IH)=1
      MJ=NT(N(IC,IE,IH))
      NPLAN(I,J,K)=MJ
      NPLNO(I,J,K)=KK*(I+NREP*(II-1))
```

```
      NPLNO(I,J,K)=NPLNO(I,J,K)+(K+NSIZ*(J-1))
      MI=NPLNO(I,J,K)
      JK=K+NSIZ*(J-1)
      IPLOT(I,JK)=MI
      ITRT(I,JK)=MJ
   75 CONTINUE
   50 CONTINUE
   35 CONTINUE
      DO 116 I=1,NREP
      DO 117 J=1,NTRT
      IT(ITRT(I,J))=J
  117 CONTINUE
      DO 118 J=1,NTRT
      IP(I,J)=IPLOT(I,IT(J))
  118 CONTINUE
  116 CONTINUE
      DO 100 I=1,NREP
      WRITE(6,102) I
  102 FORMAT(//,2X,'REP',I5,8X,'PLOTNOS AND TREATMENTS',//)
      DO 101 J=1,NBL
      WRITE(6,103) J,(NPLNO(I,J,K),K=1,NSIZ)
      WRITE(6,104) (NPLAN(I,J,K),K=1,NSIZ)
  101 CONTINUE
      WRITE(6,337)
  100 CONTINUE
      WRITE(8,227) ALOC
      WRITE(8,7) II
      WRITE(8,833)
  833 FORMAT(' ','TREAT NO.                PLOT NO.',/)
      DO 119 J=1,NTRT
  119 WRITE(8,832) J,(IP(I,J),I=1,NREP)
      DO 798 I=1,NREP
      DO 798 J=1,NBL
      DO 798 K=1,NSIZ
  798 WRITE(11,769) NPLAN(I,J,K)
  999 CONTINUE
  832 FORMAT(' ',I9,6X,3I8)
  769 FORMAT(' ',I6)
  103 FORMAT(/,1X,'BLOC',I3,25I5)
  104 FORMAT(' ',7X,25I5)
  337 FORMAT(' ','----------------------------------------------
     +---------- ----------------------------------------')
        WRITE(6,78)
   78 FORMAT(' ',//)
      TYPE *,'HAVE YOU FINISHED USING THIS PROGRAM? (YES OR NO)'
      ACCEPT 79,AS
   79 FORMAT(A3)
      IF(AS.EQ.'YES') STOP
      WRITE(6,881)
  881 FORMAT('+')
      GOTO 791
  901 TYPE *,'PLEASE ASK FOR ASSISTANCE'
      END
```

RANDOMIZED PLAN FOR 5 X 5 SIMPLE LATTICE DESIGN

THE SEED VALUES ARE- 761, 345

LOCATION: ICRISAT, PAT

REPEAT OF THE DESIGN 1

REP 1 PLOTNOS AND TREATMENTS

BLOC	1	101	102	103	104	105
		14	1	16	18	22
BLOC	2	106	107	108	109	110
		4	24	21	23	2
BLOC	3	111	112	113	114	115
		3	13	12	10	11
BLOC	4	116	117	118	119	120
		19	15	17	[illegible]	7
BLOC	5	121	122	123	124	125
		6	8	20	25	9

REP PLOTNOS AND TREATMENTS

BLOC	1	201	202	203	204	205
		20	18	13	21	15
BL[illegible]						
BLOC	3	211	212	213	214	215
		5	[illegible]	25	[illegible]	11
BLOC	4	216	[illegible]	218	219	220
		3	[illegible]	8	[illegible]	23
BLOC	5	221	222	223	224	225
		19	16	2	10	9

RANDOMIZED PLAN FOR 5 X 5 TRIPLE LATTICE DESIGN

THE SEED VALUES ARE- 111, 333

LOCATION: ICRISAT, PAT

REPEAT OF THE DESIGN 1

REP 1 PLOTNOS AND TREATMENTS

BLOC	1	101	102	103	104	105
		3	8	10	24	1
BLOC	2	106	107	108	109	110
		6	12	17	5	23
BLOC	3	111	112	113	114	115
		11	14	16	4	21
BLOC	4	116	117	118	119	120
		13	25	15	9	18
BLOC	5	121	122	123	124	125
		19	20	22	7	2

REP 2 PLOTNOS AND TREATMENTS

BLOC	1	201	202	203	204	205
		15	8	7	16	5
BLOC	2	206	207	208	209	210
		22	9	14	10	17
BLOC	3	211	212	213	214	215
		1	4	19	6	18
BLOC	4	216	217	218	219	220
		25	21	20	24	12
BLOC	5	221	222	223	224	225
		3	2	13	11	23

REP 3	PLOTNOS AND TREATMENTS				
BLOC 1	301	302	303	304	305
	21	10	5	2	18
BLOC 2	306	307	308	309	310
	17	7	11	25	1
BLOC 3	311	312	313	314	315
	19	3	15	12	14
BLOC 4	316	317	318	319	320
	8	20	4	9	23
BLOC 5	321	322	323	324	325
	22	24	13	6	16

PROGRAM FOR GENERATING RANDOMIZATIONS FOR RECTANGULAR LATTICE DESIGNS

```
      SUBROUTINE G12(MA,MB,NREP,NSIZ,NREPE,NTRT,NBL,NSI)
      CHARACTER*12 ALOC,AFILE1,AFILE2
      COMMON N(10,25,25)
      INTEGER B(20,20),NN(322)
      TYPE *,'THIS PROGRAM WRITTEN BY G. SWAMINATHAN GENERATES
     +RANDOMISED FIELD PLANS FOR K X (K+1) LATTICE DESIGN IN BLOCKS OF
     +SIZE K WHERE K<=9 AND K>=3.)'
      TYPE *,'-------------------------------------------------------

      TYPE *,'ENTER THE SEED VALUES [THESE VALUES SHOULD
     + ODD NUMBERS AND CONSISTS OF ODD NUMBER OF DIGITS
     + Ex. 381 90187]'
      ACCEPT *,MA,MB
      TYPE *,'ENTER THE NUMBER OF REPLICATIONS'
      ACCEPT *,NREP
      TYPE *,'ENTER THE NUMBER OF PLOTS PER BLOCK Ex.( FOR KX(K+1)
     +RECLAT IT IS K).'
      ACCEPT *,NSIZ
      TYPE *,'ENTER THE NUMBER REPEATS OF THE DESIGN [FOR NO REPITITION
     + TYPE 1]'
      ACCEPT *,NREPE
      TYPE *,'ENTER THE LOCATION NAME (MAX 12 CHARACTERS)'
      ACCEPT 298,ALOC
  298 FORMAT(A12)
      TYPE *,'TYPE THE FILE NAME FOR FIELD PLAN 1 '
      ACCEPT 278,AFILE1
  278 FORMAT(A12)
      TYPE *,'TYPE THE FILE NAME FOR FIELD PLAN 2 '
      ACCEPT 279,AFILE2
  279 FORMAT(A12)
      OPEN(UNIT=6,FILE=AFILE1,STATUS 'NEW')
      OPEN(UNIT=8,FILE=AFILE2,STATUS 'NEW')
      WRITE(6,1) MA,MB
    1 FORMAT(//,2X,'THE SEED VALUES ARE=' ,I10,',',I10,//)
      WRITE(6,299) ALOC
  299 FORMAT(//,2X,'LOCATION:              ',A12)
      WRITE(8,302) ALOC
  302 FORMAT(//,2X,'LOCATION:              ',A12)
      NBL=NSIZ+1
      NTRT=NBL*NSIZ
      DO 2 I=1,NBL
      DO 3 J=1,NBL
      IF(J.GT.I) B(I,J)=(J+NBL*(I-1))-I
      IF(J.LT.I) B(I,J)=(J+NBL*(I-1))-(I-1)
    3 CONTINUE
    2 CONTINUE
      DO 19 I=1,NBL
      J1=I
      DO 21 J=J1,NBL
      IF(J.LE.I) GOTO 21
      N(1,I,J-1)=B(I,J)
```

```
      N(2,I,J-1)=B(J,I)
21    CONTINUE
      J2=I
      DO 26 J=1,J2
      IF(J.GE.I) GOTO 26
      N(1,I,J)=B(I,J)
      N(2,I,J)=B(J,I)
26    CONTINUE
19    CONTINUE
      IF(NTRT.EQ.12) GOTO 50
      IF(NTRT.EQ.20) GOTO 51
      IF(NTRT.EQ.30) GOTO 52
      IF(NTRT.EQ.42) GOTO 53
      IF(NTRT.EQ.56) GOTO 54
      IF(NTRT.EQ.72) GOTO 55
      IF(NTRT.EQ.90) GOTO 56
      TYPE *,'PLEASE ASK FOR ASSISTANCE'
      STOP
50    II=0
      GOTO 60
51    II=12
      GOTO 60
52    II=32
      GOTO 60
53    II=62
      GOTO 60
54    II=104
      GOTO 60
55    II=160
      GOTO 60
56    II=232
60    DO 14 I=1,NBI
      DO 14 K=1,NSIZ
      I=II+K+NSIZ*(I-1)
      N(3,I,K)=NN(I)
14    CONTINUE
      DATA (NN(I),I=1,322)
     +6,8,12,2,9,10,3,4,11,1,5,7,
     +8,11,15,18,2,9,16,20,4,7,14,17,1,5,12,19,3,6,10,13,
     +7,13,19,25,27,5,14,16,23,29,1,8,20,21,30,2,9,15,22,26,3,10,11,17,
     +28,4,6,12,18,24,
     +12,17,22,28,33,38,2,13,24,29,35,40,4,9,20,25,36,42,6,11,16,27,32,
     +37,1,7,18,23,34,39,3,8,14,19,30,41,5,10,15,21,26,31,
     +9,17,25,33,41,49,51,7,18,26,34,38,43,53,1,10,27,35,36,47,55,
     +2,11,19,29,42,44,56,3,12,20,28,37,45,50,4,13,21,22,30,46,52,
     +5,14,15,23,31,39,54,6,8,16,24,32,40,48,
     +16,23,30,37,45,52,59,66,2,17,32,39,46,54,61,68,4,11,26,33,48,55,
     +63,70,6,13,20,35,42,49,64,72,8,15,22,29,44,51,58,65,1,9,24,
     +31,38,53,60,67,3,10,18,25,40,47,62,69,5,12,19,27,34,41,56,71,7,
     +14,21,28,36,43,50,57,
     +11,21,31,41,51,61,71,81,83,9,22,32,42,52,62,64,76,84,1,12,33,
     +43,53,63,68,73,87,2,13,23,44,54,55,65,79,89,3,14,24,34,46,56,
     +72,75,90,4,15,25,35,45,57,67,74,82,1,16,26,36,37,47,66,77,85,
     +6,17,27,28,38,48,58,78,86,7,18,19,29,39,49,59,69,88,8,10,20,
     +30,40,50,60,70,80,
```

```
      RETURN
      END
      DIMENSION NT(625),IA(625),IB(10),ID(25),IG(25)
     +,NPLAN(10,25,25),NPLNO(10,25,25),ITRT(3,625),IPLOT(3,625)
     +,IT(625),IP(3,625)
      CHARACTER AS*3
      COMMON N(10,25,25)
  790 CALL G12(MA,MB,NREP,NSIZ,NREPE,NTRT,NBL,NSI)
      IF(NTRT.GT.99) KK=1000
      IF(NTRT.LE.99) KK=100
C     ----------------    RANDOMISE TREATMENTS ----------------------
      DO 15 II=1,NTRT
   15 IA(II)=0
      DO 20 JJ=1,NTRT
   25 JA=RAN(MA,MB)*NTRT+1
      IF(IA(JA).EQ.1) GOTO 25
      IA(JA)=1
      NT(JJ)=JA
   20 CONTINUE
C     ---------  --- --- ------------------------------------------
      DO 999 II=1,NREPE
      WRITE(6,7) II
    7 FORMAT(//,2X,'REPEAT OF THE DESIGN',I4,//)
      WRITE(6,830) NSIZ,NBL
  830 FORMAT(' ',5X,' RANDOMIZED PLAN FOR',1X,I3,1X,'X',1X,I3,1X,'R
     +ECTANGULAR LATTICE DESIGN',//)
      DO 30 I 1,NREP
   30 IB(I)=0
      DO 35 I=1,NREP
   40 IC=RAN(MA,MB)*NREP+1
      IF(IB(IC).EQ.1) GOTO 40
      IB(IC)=1
C
---------  -  ---  --        -  - ------------------------------------
      DO 45 J=1,NBL
   45 ID(J)=0
      DO 50 J=1,NBL
   55 IE=RAN(MA,MB)*NBL+1
      IF(ID(IE).EQ.1) GOTO 55
      ID(IE)=1
C
---------    -   --  --------  --  -- -------------------------------
      DO 70 K 1,NSIZ
   70 IG(K)=0
      DO 75 K 1,NSIZ
   76 IH=RAN(MA,MB)*NSIZ+1
      IF(IG(IH).EQ.1) GOTO 76
      IG(IH)=1
      MJ=NT(N(IC,IF,IH))
      NPLAN(I,J,K)=MJ
      NPLNO(I,J,K)=KK*(I+NREP*(II 1))
      NPLNO(I,J,K)=NPLNO(I,J,K)+(K+NSIZ*(J-1))
      MI=NPLNO(I,J,K)
      JK=K+NSIZ*(I 1)
      ITRT(I,JK)=MJ
```

```
      IPLOT(I,JK)=MI
   75 CONTINUE
   50 CONTINUE
   35 CONTINUE
      DO 116 I=1,NREP
      DO 117 J=1,NTRT
  117 IT(ITRT(I,J))=J
      DO 118 J=1,NTRT
  118 IP(I,J)=IPLOT(I,IT(J))
  116 CONTINUE
      DO 100 I=1,NREP
      WRITE(6,102) I
  102 FORMAT(//,2X,'REP',I5,8X,'PLOTNOS AND TREATMENTS',//)
      DO 101 J=1,NBL
      WRITE(6,103) J,(NPLNO(I,J,K),K=1,NSIZ)
      WRITE(6,104) (NPLAN(I,J,K),K=1,NSIZ)
  101 CONTINUE
      WRITE(6,778)
  778 FORMAT(//,'---- - ---------------------------      ------
     +------')
  100 CONTINUE
      WRITE(8,7) II
      WRITE(8,123)
  123 FORMAT(' ','TREAT NO.          PLOT NO.')
      DO 121 J=1,NTRT
  121 WRITE(8,122) J,(IP(I,J),I=1,NREP)
  122 FORMAT(' ',I9,6X,3I8)
  999 CONTINUE
  103 FORMAT(/,2X,'BLOCK',I3,2(I5))
  104 FORMAT(' ',9X,2315,//)
      WRITE(6,791)
  791 FORMAT(' ',//)
      TYPE *,'HAVE YOU FINISHED USING THIS PROGRAM? (YES OR NO)
      ACCEPT 799,AS
  799 FORMAT(A3)
      IF(AS.EQ.'YES') STOP
      GOTO 790
      END
```

RANDOMIZED PLAN FOR 4 X 5 RECTANGULAR LATTICE DESIGN

THE SEED VALUES ARE- 777, 333

LOCATION: ICRISAT

REPEAT OF THE DESIGN 1

REP 1 PLOTNOS AND TREATMENTS

BLOCK	1	101	102	103	104
		14	6	7	3
BLOCK	2	105	106	107	108
		19	11	15	10
BLOCK	3	109	110	111	112
		17	18	5	12
BLOCK	4	113	114	115	116
		20	8	1	16
BLOCK	5	117	118	119	120
		4	13	2	9

REP 2 PLOTNOS AND TREATMENTS

BLOCK	1	201	202	203	204
		14	4	16	12
BLOCK	2	205	206	207	208
		5	7	13	11
BLOCK	3	209	210	211	212
		1	6	2	19
BLOCK	4	213	214	215	216
		17	20	10	9
BLOCK	5	217	218	219	220
		8	18	3	15

PROGRAM FOR GENERATING RANDOMIZATIONS FOR CUBLIC LATTICE DESIGNS

```
C       PROGRAM TO GENERATE RANDOM NUMBERS
        DIMENSION IE(10)
        DIMENSION IA(1000),IB(1000),LL(1000),IC(1000),ID(1000)
        CHARACTER *12 AFILE1
        JU(I,J,K)=ID(I*NS+J*NP+K-NS-NP)
110     TYPE *,'ENTER TWO SEED VALUES'
        ACCEPT *,NA,NB
        TYPE *,'NO. OF TRIALS,  NO. OF REPS,  SIZE OF LATTICE'
        ACCEPT *,NTRIAL,NREP,NP
        TYPE *,'ENTER OUTPUT FILE NAME'
        ACCEPT 278, AFILE1
278     FORMAT(A12)
        OPEN(UNIT=6,FILE=AFILE1,STATUS='NEW')
        IF(NTRIAL.EQ.0) GOTO 999
        MA=NA
        MB=NB
        NS=NP*NP
        CN=NS
        DP=NP
        NQ=NS*NP
        DO 200 I=1,NTRIAL
        DO 14 II=1,NQ
14      IC(II)=1
        DO 16 II=1,NQ
15      K=RAN(NA,NB)*NQ+1
        IF(IC(K).EQ.0) GOTO 15
        IC(K)=0
16      ID(II)=K
        DO 100 J=1,NREP
        WRITE(6,101)I
101     FORMAT(15X,6HTRIAL=,I4,5X,6HREPL.=,I4/10X,2(5X,5(2H--)))
102     FORMAT(9(6X,3I2,I4))
        DO 10 K=1,NS
10      IA(K)=1
        DO 100 K=1,NS
11      KK=RAN(MA,MB)*CN+1.0
        IF(IA(KK).EQ.0) GO TO 11
        IA(KK)=0
        DO 20 L=1,NP
20      IB(L)=1
        DO 90 L=1,NP
12      LLL=RAN(MA,MB)*DP+1.0
        IF(IB(LLL).EQ.0) GO TO 12
        IB(LLL)=0
        LL(L)=LLL
90      CONTINUE
        K1=(KK-1)/NP
        K2=KK-K1*NP
        K1=K1+1
        IF(J-2)1,2,3
1       DO 201 L=1,NP
```