

SPECIAL REPORTA PROGRAM FOR TWO-WAY ANOVA AND DUNCAN'S NEW
MULTIPLE-RANGE TEST ON A SMALL, PROGRAMMABLE CALCULATOR

Eric M. Johnson and Kenneth A. Sorensen
Department of Entomology
North Carolina State University
Raleigh, NC 27650

Nelson (I & A Tests, 1:4-9) explained the importance of the role of statistics in Insecticide and Acaricide Tests. Since then, statistical analysis of data included in the reports has become the rule rather than the exception. C. W. Averre's (I & A Tests, 2:7-10) contribution of a program for a two-way analysis of variance on a Texas Instrument SR52 calculator was instrumental in this increase. Since his publication, the SR52 has been replaced by the T1 programmable 59. The T159 is similar to the SR52 in that programs can be stored on magnetic cards. However, the T159 has the capacity to program up to 960 steps (compared with the SR52's 223) and solid state software library modules are available that can be inserted in the back of the calculator. The T159 lists for \$237.50 but is available from many sources for under \$200. The modules list for \$40. the same printer used with the SR52 may be used with the T159.

The program below uses one magnetic card and the Applied Statistics Module. It is designed to be used with the PC100 printer and includes the following features: transformations, data conversions, actual and transformed data mean printout, printout of degrees of freedom (i.e. error, treatments, and replicates), probability of a greater F value, and Least Significant Range values. one advantage of this program is that it needs to be entered only once into the calculator to run any number of analyses on different data sets. However, the program is limited to an experimental design having a sum total number of treatments and replicates less than 16.

The advantage of this program is its portability, allowing data analysis away from the office. It is inexpensive, and more expedient than using computers in large computer centers. Operation time for a complete analysis of data from an experiment with four replicates and six-eight treatments is approximately ten minutes, including data input.

USERS' DIRECTIONS

(for the T1 Programmable 59 calculator program for two-way
ANOVA and Duncan's New Multiple Range Test)

1. Place Applied Statistics Solid State Software module into calculator. (Personal Programming; 1977)
2. Read magnetic card: check partitioning and data bank to be read. (Personal Programming; 1977)
3. Initialize program. PRESS: E.
4. Enter conversion factor. (if none is needed, go to step 5.) PRESS: E.
5. Enter number of treatments. PRESS: B. (Number of treatments is printed.)
6. Enter number of replicates. PRESS: C. (Number of replicates is printed.)
7. Enter data by treatment. PRESS: A. When all data is entered for each treatment, PRESS: R/S. (See step 14 if data transformation is desired.) (Actual and transformed means are printed.)
8. Calculate data mean and standard deviation. PRESS: D. (Data mean and standard deviation are printed.)
9. Calculate Sum of Squares for treatments, replicates, and total. PRESS: A. (SS trts, SS reps, and SS total are printed.)
10. Calculate F value for treatments, degrees of freedom replicates, degrees of freedom error and probability of significant differences for replicates. PRESS: B. (F reps, df rep, df error, and PR F rep F are printed.)
11. Calculate F value for treatments, degrees of freedom of freedom for treatments, degrees of freedom error, and probability of significant difference for treatments. PRESS: C. (F trts, df trts, df error, and PR F trt F are printed.)
12. Enter t value from table. PRESS: STO 87.
13. Enter Significant Studentized Range values and calculate Least Significant Range values. PRESS: D.
14. TRANSFORMATIONS¹: Locations 040 through 047 have been reserved for entering appropriate keys into program for various transformations. To enter transformations proceed as follows:

¹Modified from Averre (I & A Tests, 2:7-10).

The use of specific names in this publication does not imply endorsement of the products or services named or criticism of similar ones mentioned.

A. PRESS: GTO 040 LRN

B. Select the desired transformation (see below) and key in the sequence: do not exceed eight entries not counting the LRN, INV or 2nd Keys.

I. Linear transformation or coding.

ADDITION: + desired number = LRN
 SUBTRACTION: - desired number = LRN
 MULTIPLICATION: x desired number = LRN
 DIVISION: ÷ desired number = LRN

II. Square root transformation

\sqrt{X} : \sqrt{X} LRN (Used when numbers vary from 10 to 100)
 $\sqrt{X + 0.5}$: + .5 = \sqrt{X} LRN (Used when numbers include many values between 10 and 0)

III. Logarithmic transformation

log X : 2nd log LRN
 log X + 1 : + 1 = 2nd log LRN (Used when same numbers are under 10)

IV. Arcsin or angular transformation

arcsin $\sqrt{\frac{X+100}{100}}$ + 1 0 0 = \sqrt{X} INV 2nd SIN LRN

15. For analysis of another data set go to step 3.

SAMPLE PRINTOUT

Below is a sample printout for the following data using the angular transformation

Treatment	Replicate			
	1	2	3	4
A	36.2	31.7	29.8	33.4
B	29.9	30.9	27.7	28.8
C	22.6	27.1	26.1	23.4
D	15.2	17.2	20.6	19.0
Check	17.3	14.8	16.1	18.5

PRINTOUT	COMMENTS	PRINTOUT	COMMENTS
5	no. treatment	29.34017961	Grand Mean Trans. Data
4	no. replicates	19.31089189	Std. Dev. Trans. Data
36.2	data value trt A	386.2178378	Total Sum of Squares
36.98919175	transformed value	.4800618363	Column Sum of Squares
		356.0452809	Row Sum of Squares
31.7	data value trt A	F REP	
34.26543131	transformed value	.0646711346	F reps
29.8	data value trt A	3	df reps
33.08576142	transformed value	12	df error
33.4	data value trt A	.9775564913	PR (F rep F)
35.30489381	transformed value		
32.775	\bar{X} TRT	35.97325992	F TRT
34.91131957	\bar{X} TSF	4	F trts
	Mean trt A	12	dt trts
	Mean of transf. data		df error
29.9	data value trt B	.0000013601	PR (F trt F)
33.14836609	transformed value	2.167803681	2 Least
		2.276193865	3 Significant
REST		2.341227975	4 Range
OF DATA AND		2.362906012	5 Values
MEAN VALUES	ETC.		

PROGRAM SEQUENCE FOR TI Programmable 59 CALCULATOR FOR
TWO-WAY ANOVA, DUNCAN'S NEW MULTIPLE RANGE TEST, AND OTHER STATISTICS

Loc	Keys	Comments
000	LBL E CMS 1 STO	clear calculator of previous inputs
005	87 PGM 06 E RTN	
010	LBL E' STO 87 RTN	enter conversion
015	LBL B PGM 06 B	enter no. of trts
020	RTN	
021	LBL C PGM 06 C	enter no. of reps
026	9 OP 17 ADV RTN	repartition
031	LBL A X RCL 87	enter data X conversion
036	= PRT SUM 89 NOP	print actual data
041	NOP NOP NOP 88 NOP	transformation
046	NOP NOP SUM 88 PGM	print transformed data
051	06 A ADV RTN	
055	LBL R/S 6 7 3	
060	7 3 7	calculate, label, and
065	OP 04 RCL 89 +	print actual treatment
070	RCL 02 = OP 06	means and transformed
075	0 STO 89 6 7	treatment means.
080	3 7 3 6 2	
085	1 OP 04 RCL 88	
090	+ RCL 02 = OP	
095	06 ADV 0 STO 88	
100	RTN	
101	LBL D PGM 06 B'	calculate and print :2
106	PGM 06 C' RTN	calculate and print S ²
110	LBL A' PGM 16 A	calculate and print SS
115	PGM 16 B PGM 16	total, SS reps, and SS
120	B' RTN	trts.
122	LBL B' 2 1 0	
127	0 3 5 1 7	
132	3 3 OP 04 OP	calculate, label, and print
137	05 PGM 16 C STO	F reps, df reps, df error
142	84 PGM 16 D STO	
147	85 PGM 16 R/S STO	
152	88 RCL 85 PGM 22	calculate Probability of
157	A RCL 88 PGM 22	F calc F, print.
162	B RCL 84 PGM 22	
167	C PRT ADV RTN	
171	LBL C' 2 1 0	
176	0 3 7 3 5	calculate, label, and print
181	3 7 OP 04 OP	F trts, df trts, df error
186	05 PGM 16 C' STO	
191	84 PGM 16 D STO	
196	85 PGM 16 R/S STO	
201	88 GTO 01 53 RTN	
206	LBL D' STO 86 RCL	enter Significant Studentized
211	08 - RCL 09 -	Ranges for desired level
216	RCL 10 = RCL	
221	88 + RCL 02 X	
226	2 = RCL	
231	87 X RCL 86 =	calculate and reprint Least
236	PRT RTN	Significant Range values