ANOVA *F* TEST

ANOVA (Analysis of Variance) is a statistical technique for comparing several means and is used to determine if the differences between means is statistically significant.

To determine which colors best attract insects, experimenters randomly placed 6 sticky boards of each of 4 colors in a field of oats and measured the number of beetles trapped:

BOARD COLOR	INSECTS TRAPPED					
Blue	16	11	20	21	14	7
Green	37	32	20	29	37	32
White	21	12	14	17	13	20
Yellow	45	59	48	46	38	47

1.   PUT DATA INTO SEPARATE LISTS; CHECK/REMOVE ANY OUTLIERS.

Only the number of insects trapped on yellow boards appear to have any outliers (38 and 59)... removed from list

NOTE: This makes the sample size for yellow boards very small (n = 3)

2.   PERFORM 1-VARIABLE STATS:

COLOR	MEAN (x-bar)	STANDARD DEVIATION (s)
Blue (L_1)	14.83	5.345
Green (L_2)	31.17	6.306
White (L_3)	16.17	3.764
Yellow (L_4)	46.5	1.291

3.   CHECK THAT ANOVA CAN BE SAFELY USED (TO COMPARE MEANS):

a)   Independent SRSs from each population... *unknown and may be a concern*

b)   Population has normal distribution **or** $n \geq 40$ (Central Limit Theorem) **or** normal probability plot is relatively linear after removing outliers (n < 40)... *npps appear relatively linear*

c) All standard deviations are the *same* $[s_{largest} \leq 2(s_{smallest})]$

$$\frac{l \arg est}{smallest} = \frac{6.306}{2.291} = 4.88 > 2 \ldots \text{ t}hough \text{ ANOVA is robust, the results may be invalid}$$

4. STATE HYPOTHESES:

μ_1 = mean number of insects trapped by blue boards $\quad\quad \mu_2$ = mean number of insects trapped by green boards
μ_3 = mean number of insects trapped by white boards $\quad\quad \mu_4$ = mean number of insects trapped by yellow boards

$$H_o: \mu_1 = \mu_2 = \mu_3 = \mu_4 \quad\quad H_a : \mu_1, \mu_2, \mu_3, \mu_4 \text{ are not all equal}$$

5. PERFORM TEST (TI-84/89 CAN ONLY BE USED FOR COMPARING ≤ 6 MEANS):

a. **USING CALCULATOR:**

STAT $\longrightarrow$ TESTS $\longrightarrow$ F:ANOVA (L_1, L_2, L_3, L_4) $\longrightarrow$ ENTER:

F Statistic = 45.439, *P*-value = 1.33 x 10^{-8} < .001

b. **USING TABLE D:**

Where degrees of freedom in the numerator = 3 and degrees of freedom in the denominator = 18:

I = # groups = 4 $\quad\quad N$ = # observations = 22 (after removing outliers)

numerator df = $I - 1 = 4 - 1 = 3$ $\quad\quad$ denominator df = $N - I = 22 - 4 = 18$

P-value < .001

6. STATE CONCLUSION

Despite the (very) small samples, the experiment provides strong evidence (p < .001) of differences among the colors. Yellow boards appear to be the best at attracting beetles.