

HORT/AGRON 603
ANOVA Review Problems 3

Write out the analysis of variance (source of variation and df) for each of the problems below and show F tests with arrows for the fixed model, unless otherwise instructed.

1. Experiment with 3 varieties of asters to compare 4 levels of growth hormone to induce branching. Installed as a randomized complete block design with 3 replications.
2. Example 1 with 5 samples per plot.
3. An experiment is performed to evaluate the growth and yield of upland taro at 3 ages of harvest, 3 planting densities, and 2 levels of nitrogen. 3 replicates will be installed.
 - a. Sketch one replicate of the experiment installed in a randomized complete block design, and show the treatments clearly. Write out ANOVA and show F tests on fixed and random models.
 - b. Sketch one replicate of the experiment installed in a split plot design with age of harvest as the whole plot and the other treatment combinations as the subplots. Write out ANOVA and do F tests on fixed and random models (all variables either fixed or random).
 - c. Sketch one replicate of the experiment installed in a split-split plot design with age of harvest as the whole plot, planting density as the subplot, and nitrogen as the subsubplot. Write out ANOVA and do F tests on the fixed model.
4. Four different ripening agents (RA) are applied to bunches of bananas in two concentrations; two bunches of bananas are sprayed with concentration C1 of each RA, and 4 bunches of bananas are sprayed with concentration C2 of each RA (days to ripening are the data analyzed). Show F tests for the appropriate model.
5. Example 4 with 5 bananas (fingers) taken from each bunch for brix (sugar) determination. Show F tests for the appropriate model.
6. A split block design is installed with 4 replicates, 3 Zn levels and 4 P levels. The experiment is planted at 3 locations.
7. Four treatments applied to papayas, in RCB with 4 reps. Data were collected from 4 successive harvests.
8. Experiment in a split-split plot design with 4 A treatments, 3 B treatments, 2 C treatments, and 3 reps. (A = MP, B = SP, C = SSP).
9. A balanced lattice with 49 entries

10. Cattle are grown on 3 different pastures; 10 cattle on pasture 1, 7 on pasture 2, 13 on pasture 3. Data are taken on the weight of T-bone steaks, two from each animal.
11. A series of nitrogen experiments with 0, 50, and 100 kg N/ha were installed on flooded rice in 7 locations as a RCB with 3 replicates at each location. Write out ANOVA and show F tests for the fixed and random models (both locations and N fixed or random).
12. Have 4 pens in a barn and want to compare 4 sources of carbohydrate in the feed of cattle. Have 9 animals in each pen and each pen is given one of the sources of carbohydrate. Data are gain in weight of the animals.
13. Have 9 pens and want to compare 3 sources of protein in the diet of hogs (pigs). Have 5 hogs per pen and each set of 3 pens is given one of the sources of protein so have 3 replicates. Data are rate of gain of the animals.
14. Have 25 cows, there are 5 cows each of 5 different ages. Five rations are to be compared so a different ration is fed to each cow in each age group. Cows are kept in 5 pens (one cow of each age group in each pen) and each pen is fed one of the rations. Data are amount of milk produced during the test period.
15. An experiment is conducted to measure the changes in the level of iron (Fe) in blood over a six-week period as affected by feeding 4 rates of an iron supplement to 5 animals in each treatment. Blood samples are collected weekly.
16. An experiment is installed on a hillside on which a gradient of sand exists across the hillside. Therefore, there are gradients in two directions, the slope of the hill and the sand gradient at approximately right angles to it. The experiment compares yield response of soybeans to 2 levels of P and 3 levels of Zn. Use the appropriate number of replicates.
17. Three plants were sampled randomly from each plot of a RCB experiment consisting of 3 reps of 5 treatments at 3 locations.
18. Two plants were sampled randomly every month for 4 months from each plot of a RCB experiment consisting of 2 reps of 5 treatments.
19. Sweetness (brix) was determined on 4 mangos per tree from 3 trees of each of 5 varieties.
20. 6 species of trees were compared in a latin square design.
21. 5 varieties of gardenia are grown at 3 temperatures in growth chambers to evaluate temperature effects on flower initiation. 4 levels of P are also compared with 3 replications in each chamber.

Answers to ANOVA Review Problem 3

1.

Source	df
Blks	2
Trt	(11)
Var	2
L	3
V*L	6
Error	22
Total	35

2.

Source	df
Blks	2
Trt	(11)
Var	2
L	3
V*L	6
Exp. Error	22
Samp. Error	144
Total	179

3.

Source	df	F	R	
Blks	2	←	←	
Trt	(17)	←	←	
Age	2	←		No test- Construct error
Den	2	←		No test- Construct error
A* D	4	←	←	
N	1	←		No test - Construct error
N*A	2	←	←	
N*D	2	←	←	
N*A*D	4	←	←	

Error	34		
Total	53		

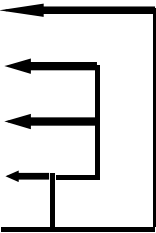
3b.

Source	df	F	R	
Blk	2			
Age	2			
B*A	4			No test- Construct error
Trt	(5)			
Den	2			No test- Construct error
N	1			No test- Construct error
D*N	2			
Trt*A	(10)			
D*A	4			
N*A	2			
D*N*A	4			
Error b	30			
Total	53			

3c.

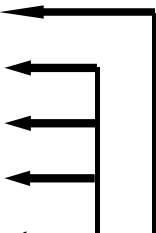
Source	df	F
Blk	2	
Age	2	
B*A (Error a)	4	
Den	2	
D*A	4	
Error b	12	
N	1	
N*A	2	
N*D	2	
N*A*D	4	
Error c	18	
Total	53	

4.






Source	df	R
Bet Trts	(7)	
RA	3	
Con	1	
RA*C	3	
w/ in Trt	16	
Total	23	

(4RA x 1df for C1=4 + 4RA x 3df for C2=12 => 16)

5.

Source	df	R
Bet Trts	(7)	
RA	3	
Con	1	
RA*C	3	
Exp Error	16	
Smpl Error	96	
Total	119	

6.

Source	df	F
Loc	2	
Blk/Loc	9	
Zn	2	
Error b	6	
P	3	
Error c	9	
Zn*P	6	
Error d	18	
Zn*L	4	
P*L	6	

[(r-1) x 3L]

Zn*P*L	12	
Error e	66	$[(b-1) (df \text{ for } Zn*L + P*L + Zn*P*L)]$
Total	143	

7.

Source	df	
Blk	3	
Trt	3	
Error a	9	$(b-1)(t-1)$
Harv	3	
H*T	9	
Error b	36	$(b-1) [(h-1) + (h-1)(t-1)]$
Total	63	

8.

Source	df	
Blk	2	
A	3	
Error a	6	$(r-1)(a-1)$
B	2	
B*A	6	
Error b	16	$(r-1) [(b-1) + (b-1)(a-1)]$
C	1	
C*A	3	
C*B	2	
C*A*B	6	
Error c	24	$(r-1) [(c-1) + (c-1)(a-1) + (c-1)(b-1) + (c-1)(a-1)(b-1)]$
Total	71	

9.

Source	df	
Rep	7	k

Trts (unadj)	48	(k^2-1)
Blks in reps (adj)	48	(k^2-1)
Intra-blk error	288	$(k-1)(k^2-1)$
Total	391	(k^3+k^2-1)

10.

Source	df	
Bet pastures	2	
w/ in pastures	27	$(9 + 6 + 12 \text{ df})$
Sample error	30	$[(s-1) \times 30 \text{ animals}]$
Total	59	

11.

Source	df	
Loc	6	
Reps/Loc	14	$[(r-1) \times 7 \text{ loc}]$
N	2	
N*L	12	
Error b	28	$(r-1)[(n-1) + (n-1)(l-1)]$
Total	62	

12.

Source	df	
Bet sources	3	
w/ in sources	32	$[(a-1) \times 4 \text{ pens}]$
Total	35	

13.

Source	df	
Reps	2	
Protein	2	
Expt error	4	
Smpl error	36	$[(a-1) \times 9 \text{ pens}]$
Total	44	

14.

Source	df
Blks (ages)	4
Ration	4
Error	16
Total	24

15.

Source	df	
Bet rates	3	
w/ in rates	16	$[(a-1) \times 4 \text{ rates}]$
Time	5	
T*R	15	
Error b	80	$(a-1)[(t-1) + (t-1)(r-1)]$
Total	119	

16. Use 6x6 latin square design

Source	df	
Rows (slope)	5	
Col (sand)	5	
Trt	(5)	
P	1	
Zn	2	
P*Zn	2	
Error	20	$(r-1)(c-1) - (t-1)$
Total	35	

17.

Source	df	
Loc	2	
Rep/Loc	6	$[(r-1) \times 3 \text{ loc}]$
Trt	4	
T*L	8	
Expt error	24	$(r-1)[(t-1) + (t-1)(l-1)]$

Smpl error	90	[(s-1) x 3R x 5T x 3L]
Total	134	

18.

Source	df	
Blk	1	
Trt	4	
Error a	4	
Time	3	
T*Trt	12	
Error b	15	
Smpl error	40	[(s-1) x 2B x 5T x 4M]
Total	79	

19.

Source	df	
Bet var	4	
Bet Trees/var	10	[(t-1) x 5V]
Bet Fruit/T/V	45	[(f-1) x 3T x 5V]
Total	59	

20.

Source	df	
Row	5	
Col	5	
Species	5	
Error	20	(r-1)(c-1) - (s-1)
Total	35	

21.

Source	df	
Temp	2	
Rep/Temp	6	[(r-1) x 3T]
Var	4	

P	3	
V*P	12	
T*V	8	
T*P	6	
T*V*P	24	
Error b	114	$[(r-1)(df V+P+V*P+T*V+T*P+T*V*P)]$
Total	179	
