B, and *AB* comparisons should be considered. In a split-plot design, the *B* and *AB* effects are usually estimated more accurately than the *A* effects. This results from the fact that variation within a block is usually smaller than variation among blocks. The average standard error of a difference is equal for both the randomized block factorial design and the split-plot design. Thus the increased accuracy of the *B* and *AB* effects estimates is obtained by sacrificing accuracy on the *A* effects. If the experimenter is as interested in the *A* effects as he is in the *B* and *AB* effects, the randomized block factorial design should be used. It should also be noted that the *F* ratio denominator degrees of freedom for *A*, *B*, and *AB* in the randomized block factorial design are larger than the corresponding degrees of freedom in a split-plot design.

A numerical index of relative efficiency of the two designs, disregarding differences in degrees of freedom, is given by the following formulas (Federer, 1955, 274). The data used in this example are from Table 8.2-2.

A efficiency

$$= \frac{[(p-1)\text{MS}_{\text{subj w.groups}} + p(n-1)\text{MS}_{B\times\text{subj w.groups}}]/(pq-1)}{\text{MS}_{\text{subj w.groups}}}$$

$$= \frac{[(2-1)1.562 + 2(4-1).507]/[(2)(4)-1]}{1.563} = \frac{.658}{1.563} \times 100$$

$$= 42.1 \text{ percent.}$$

B and *AB* efficiency

$$= \frac{[(p-1)\text{MS}_{\text{subj w.groups}} + p(n-1)\text{MS}_{B\times\text{subj w.groups}}]/(pq-1)}{\text{MS}_{B\times\text{subj w.groups}}}$$

$$= \frac{[(2-1)1.563 + 2(4-1).507]/[(2)(4)-1]}{.507} = \frac{.658}{.507} \times 100$$

$$= 129.8 \text{ percent.}$$

Hence, in this example, a test of the *A* treatment is less than half as efficient in the split-plot design as it is in the randomized block factorial design. On the other hand, the *B* and *AB* tests are more efficient in the split-plot design. The relative efficiency of tests is a basic consideration in the design of experiments.

8.12 INTRODUCTION TO TYPE SPF-*pr.q* DESIGN

The split-plot design described so far in this chapter has had two treatments. The general analysis procedure for a two-treatment split-plot design can be extended to designs having three or more treatments.