End-Border Effects in Irrigated Barley Yield Trials


COMPEITION and border effects are recognized as sources of error in agronomic experiments (1, 5, 10, 11). Most research experiments regarding border effects have been designed to study side-border effects in non-irrigated areas. Additional research is needed to determine the magnitude of end-border effects under irrigated conditions.

REVIEW OF LITERATURE

Border effects have been studied in a number of different crops. Green (6), Drapala and Johnson (5), and Hartwig et al. (7) reported significant border effects in cotton, millet and sudangrass, and soybeans, respectively. In grain sorghum Ross (12) found no difference in yield or behavior between guarded and unguarded plots. Draper8 concluded that 12 inches should be removed from each end of safflower yield test plots.

Arny (2), McClelland (11), and Hulbert et al. (8) obtained significant border effects that extended to at least 12 inches within small grain plots. Arny and Hayes (3) found that all small grain varieties did not respond the same to the bordering alley. Brown and Weibel (4) obtained a significant variety \( \times \) border interaction indicating that the border effects were not the same for every selection.

Critical moisture conditions and seasonal changes have been suggested as factors influencing border effects. Klages (9) observed that border effects in small grains were intensified under drought conditions. Hulbert et al. (8) studied border effects in 3 spring wheat varieties for a 2-year period and concluded that seasonal changes and the growth habit of a variety influence border effects.

It is of interest to study the response of different yield components to the border effects. Brown and Weibel (4) suggested that the increased yield in the border rows of wheat and oats was due to excessive tillering.

The authors were unable to find any report in the literature on the end-border effects in small grains grown in the irrigated areas of the West.

MATERIALS AND METHODS

Experiments were conducted at 2 locations in Arizona (Mesa and Yuma) in 1959 and 1960 to study the end-border effects in fall-sown irrigated barley. The experiments consisted of barley variety yield tests with 12 varieties: Arivat, Harlan, California Mariout, Vaughn, Atlas 57, Atlas 54, California 1096, Rojo, Winter Tennessee, Glacier, Naked Barley Bulk, and White Barley from Composite Cross II. The experimental design was a randomized complete block with four replications. Plots were laid out in an irrigation border that was 30 \( \times \) 300 feet in size and each plot consisted of 4 rows 12 feet long with a 1-foot bare alley on each end. A five-foot bare alley on border was adjacent to each plot.

At maturity, the 2 middle rows in each 4-row set were harvested with a hand-sickle in 12 one-foot sections. The sections were referred to as sections 1 through 12. Sections 1 and 12 were adjacent to the bare-alleys. Sections 6 and 7 were farthest from the alleys. Following data were obtained for each section: yield of grain, number of tillers that produced seed, number of seeds per head, and weight of 400 seeds.

Three analyses of variance, with different sources of variation, were calculated to evaluate the data. They are: Analysis Without Subsampling, Analysis with Subsampling, and Replication Analysis.

In the analysis without subsampling, the coefficients of variability were calculated for 6 row lengths: 2 feet, 4 feet, 6 feet, 10 feet, and 12 feet. Each row length was obtained by combining successive pairs of one-foot sections that were an equal distance from the alley. For example, the 2-foot row included sections 6 and 7 feet from the alley and the 4-foot row included sections 2 and 8, etc. The object of the analysis without subsampling was to determine the influence of end-border effects on the variability.

In the analysis with subsampling, 6 analyses of variance were calculated for 2-, 4-, 6-, 8-, 10-, and 12-foot sections, double rows. Each row length was obtained by combining successive pairs of one-foot sections that were an equal distance from the alley. For example, the 2-foot row included sections 6 and 7 feet from the alley and the 4-foot row included sections 2 and 8, etc. The object of the analysis with subsampling was to determine the influence of end-border effects on the sampling errors of the six analyses. The variance to the experimental errors also was calculated.

In the replication analysis, the variation within a plot for each variety was estimated for different row lengths as described previously. The coefficient of variability calculated the within replication variation which should be at a minimum to provide precise detection of differences. Replication variation was estimated separately for each variety to determine the influence of end-borders on individual varieties.

RESULTS AND DISCUSSION

The average grain yields for 12 barley varieties at Mesa were over-estimated by 23% when the rows were not removed (Figures 1 and 2). For example, Glacier ranked fifth when based on all 12 sections, but rose to second place when exclusion of 1-foot end-borders from each section was not apparent from these results that the end-borders reduced bias in the estimate of the variety means. The detection of differences end-borders should be more precise when estimating yields.

Table 1 gives the sampling error variance component due to experimental error in grain yield and the three yield components. Sampling error variances were obtained when estimating.