Comparison of Large Plot Farm-Scale Strips and Small Plot Performance Trials for Variety Ranking

Kevin Larson[1], Jerry Johnson, Scott Haley, James Quick, James Echols, John Shanahan, Dennis Thompson, and Deborah Harn

Growers' acceptance of research results from replicated small plots has been less than desirable. A common belief among growers is that small replicated plots are inferior to large farm-scale plots because large plots more closely resemble field conditions. Growers' distrust of research results from small plots and greater acceptance from large farm-scale plots was one of the reasons for establishing the Plainsman Agri-Search Foundation. The Plainsman Agri-Search Foundation is a growers association that helps advise and financially supports the Plainsman Research Center, one of the branch stations of Colorado State University Agricultural Experiment Station. The Plainsman Agri-Search Foundation purchased a large farm so that the staff at Plainsman Research Center could perform farm-scale research and not rely solely on information from small research plots. Dryland winter wheat variety trials have been conducted with small replicated plots and large farm-scale strip plots adjacent to one another at the Plainsman Research Center for 10 years. We compared ranking order of dryland winter wheat varieties of large strip plots with two replications to small plots with three or four replications to determine if ranking order was equivalent.

Materials and Methods

We compared grain yields from the past 10 years, 1994 to 2003, (1996 is omitted because winterkill prevented grain harvest) of dryland winter wheat variety performance trials (Johnson, Haley, Quick, Echols, and Shanahan were the principal investigators) and dryland winter wheat variety strips (Larson, Thompson, and Harn were the principal investigators). Small harvest plots (4 ft. by 44 ft.) were used to determine grain yield of varieties for the variety performance trials and large harvest plots (20 ft. by at least 1000 ft.) for wheat variety strips. Both small and large plots were harvested with self-propelled combines. The harvested grain from each plot was weighed with a portable digital scale for the small plots, whereas, a digital scale wagon was used to measure the grain from the large plots. Both small and large variety plots were conducted in the same field at the Plainsman Research Center near Walsh, Colorado. Herbicides and fertilizers were applied field-wide, therefore, all plots received the same weed control and fertilization and are comparative for any particular year. There were more varieties tested in each study; however, we only ranked those varieties that were common to both studies. We compared variety rankings for grain yield between the large wheat variety strip plots and the small wheat variety performance plots with CoStat version 3.03 software using Friedman's method for randomized blocks (CoHort, 1986). The large and small plots were designated as blocks.

Results and Discussion

For the 10 years of comparison, the average yield from the strip plots was 3 bu/acre higher than the small plots. One reason that the large strip plots had higher average yield was that the yields from the wheat strips were adjusted for moistures and

correct plot dimensions were used; whereas, moisture was not measured and plot lengths were incorrectly assigned for the small plots variety performance trials (from conversation with Scott Haley). The discrepancies between yield measurements did not allow us to directly analyze varieties for average grain yields between large and small plots, therefore, we used a nonparametric rankings test, Friedman's method for randomized blocks, to evaluate equivalency of variety ranking order between small and large plots.

In six of nine harvest years, wheat varieties were ranked similarly for small and large plots ($P \leq 0.11$) (Table 1). Three of nine harvest years had non-significant variety ranking probabilities, the lowest variety ranking probability occurred in 2002. The coefficient of variation (CV) for 2002 was 39.9%, and because of the high variance the principal investigators prudently excluded the Walsh site from the dryland wheat variety performance summary for 2002. For all other harvest years, the coefficient of variation, when reported, ranged from 7.3% to 14.0%. Average grain yields of varieties for large and small plots were similarly ranked three-fours of the time (6 out of 8 years) with a ranking probability greater than or equal to 0.11 and excluding the highly variable year (2002). In three-fourths of the harvest years (if the high variance year is excluded), large and small plots provided similar variety yield rankings, indicating that consistent variety evaluations can be performed with either small or large plots. This is similar to a report from researchers in Ontario, Canada who found that non-replicated on-farm strip tests and replicated small-plot trails for dryland winter wheat varieties were both effective methods for variety evaluation (Yan et al., 2002).

Table 1.-Dryland Wheat Variety Ranking Probability Comparison of 10 Years of Large and Small Plots Average Yields.

Year	Ranking Probability	Common Varieties Ranked	Small Plot CV	Large Plot LSD 0.05	Small Plot LSD 0.30	Large Plot Average Yield	Small Plot Average Yield	Large Plot Varieties Tested	Small Plot Varieties Tested
			%			----------bu/acre----------			
2003	0.02	14	---	2.1	2.4	25	19	18	27
2002	0.48	11	39.9	2.9	3.0	13	7	16	29
2001	0.11	9	13.8	3.0	4.3	43	38	15	26
2000	0.34	10	10.2	4.1	3.1	34	35	15	26
1999	0.11	11	7.3	4.2	3.9	60	62	16	22
1998	0.05	10	7.9	3.7	2.8	54	48	16	22
1997	0.37	8	14.0	5.5	5.0	57	47	13	24
1995	0.10	6	---	1.8	1.4	12	12	12	19
1994	0.09	6	13.6	1.2	2.1	29	27	10	18
Average	0.19	9	15.2	3.2	3.1	36	33	15	24

In 1996 there was no grain harvested for both large and small plots due to winterkill.
Large plot variety strips (20 ft.by 1000 ft.) were RCBD with two replications for all years tested.
Small plot variety performance trials (4 ft. x 44 ft.) were RCBD with three replication for 1998 to 2003 and RCBD with four replication for 1994 to 1997.

The 10-year average of least significant differences (LSD) for multiple variety grain yield comparisons for the large plots is only 0.1 bu/acre higher than the LSD for the small plots. The critical LSD values between large and small plots are similar, but the level of significance is higher for the large plots, alpha = 5%, than for the small plots, alpha = 30%. The use of a similar critical LSD value for the small plots is warranted if 1 in 3.33, type I errors are acceptable (the chance of making a type I error for the large plots is 1 in 20). From conversations with growers, most dryland wheat producers are willing to accept critical LSD values with 20% to 30% levels of significance. One grower pointed out that he would not bet on harvesting a wheat crop 3 out of 4 years, let alone having one variety yield more than another variety 3 out of 4 times.

There are advantages and disadvantages of small and large plots for variety evaluations. Small plots allow many varieties to be evaluated simultaneously; whereas, typically only a few select varieties are compared in large plots. Small plots require specialized small plot equipment for planting and harvesting; therefore, the number of locations for small variety plot trials is limited. Large plot variety strip tests can be planted and harvested with typical farm-scale equipment. Numerous on-farm variety strip plots can be tested on growers' fields using their own equipment, and thus provide greater environmental conditions for variety evaluation.

Conclusion

In 6 of 9 years (6 of 8 years, if the high variance year is excluded), small plot variety performance trials with three or four replications provided similar dryland winter wheat variety yield rankings compared to large plot variety strips with two replications. Growers should not be leery of variety evaluations from replicated small plots, if greater type I errors are acceptable. Likewise, researchers should be more accepting of on-farm variety strips, if there are sufficient numbers of on-farm tests to use as replications.

Literature Cited

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[1]Comments and questions can be e-mailed to: Kevin.Larson@colostate.edu.

Kevin Larson, Superintendent/Research Scientist, Plainsman Research Center, Colorado State University

Jerry Johnson, Extension Crop Specialist, Current Leader of the Crop Testing Program, Colorado State University

Scott Haley, Associate Professor, Current Wheat Breeder, Colorado State University

James Quick, (Retired) Professor and Head, Soil and Crop Sciences Department, Former Wheat Breeder, Colorado State University

James Echols, (Retired) Extension Crop Specialist, Former Leader of the Crop Testing Program, Colorado State University

John Shanahan, Associate Professor, University of Nebraska, Former Extension Crop Specialist, Colorado State University

Dennis Thompson, Technician III, Plainsman Research Center, Colorado State University

Deborah Harn, Research Associate, Plainsman Research Center, Colorado State University

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