EVALUATION OF POST-HARVEST RESIDUE REMOVAL EQUIPMENT ON KENTUCKY BLUEGRASS GROWN FOR SEED IN CENTRAL OREGON

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Abstract

In 1991 a study was initiated to evaluate post-harvest residue removal equipment on Kentucky bluegrass *(Poa pratensis L.)*. This study started with two grower's fields, planted either with aggressive or non-aggressive variety types. Each year two more fields were added for a total of six fields at the climax of the trial. Data presented is for the 1992 harvest of two fields (aggressive and non-aggressive), and 1993 harvest of four fields (two aggressive and two non-aggressive). The trial will run until harvest of 1997.

Baling after combining is the common practice in central Oregon, therefore all treatments were in addition to baling. Averaged over all testing sites, seed yield and fertile tiller number were highest with open-field burning. Seed yield and fertile tiller number were intermediate when residue was removed with a vacuum-sweep plus propane treatment, vacuum-sweep treatment alone or with the wheel rake. Flail-only and bale-only treatments resulted in the lowest seed yields and fertile tiller numbers. Overall second year seed yields were comparable to third year seed yields with non-aggressive varieties slightly out-yielding aggressive varieties. Thousand seed weight and seed germination percentages were comparable among all treatments.

Introduction

The intermountain region of Idaho, Washington and Oregon are stable suppliers of high quality Kentucky bluegrass *(Poa pratensis L.)* seed. The cool winter climate and hot dry summers favor Kentucky bluegrass seed production. Since the 1950s the industry has increased from a few acres of the cultivar 'Marion' to production of over 100,000 acres and over 100 cultivars. This intermountain region has produced a stable supply of over 60 million pounds annually, which makes this region the primary producer for the world.

In the early development of Kentucky bluegrass seed production, growers became aware of the importance of post-harvest residue removal. Open-field burning was adopted as the standard practice for post-harvest residue removal and primarily for the suppression or elimination of diseases (Hardison 1976). Hardison in 1980 reviewed the history of field burning on perennial grass seed production, which started in the early 1950s for Kentucky bluegrass, primarily for control of Ergot and Silvertop disease. Burning also has partial control of Stripe smut , Flag smut, Rusts, Powdery mildew, Leaf rust and other leaf diseases on Kentucky bluegrass according to Hardison 1980.

Post-harvest open-field burning has been responsible for maintenance of yield and high quality seed production in the Pacific Northwest. However, increased concern for air quality has pressured growers to find alternative ways of removing debris after harvest. Pumphrey in 1965 demonstrated that seed yields of Kentucky bluegrass were highest where residue was removed prior to the initiation of fall regrowth. Complete residue removal by mechanical means or by burning showed the highest seed yields, and statistically there were no differences between the two methods. He also showed that the more complete the residue removal, the better the chance for increased yields at the following seed harvest. Canode and Law (1977) concurred with these findings. Their data showed that open-field burning of residue may maintain the productivity of the stand for several years longer than mechanical removal, and that thatching, mulching, gapping or increasing the row spacing did not appear to be economically acceptable alternatives. Gapping was accomplished by tilling across rows every other 30 cm to give an appearance of blocks of grass rather than rows. Canode and Law further reported that alternate year burning with straw removal in the year of non-burning, and high levels of continuous mechanical residue removal gave increased yields compared to straw removal alone. However, seed yields under these management strategies were less than under annual burning alone. In earlier studies by Evans and Canode in 1971, and Canode in 1972, the use of cultivating, gapping and mechanical removal was investigated. Cultivating seemed to remove productive tillers from the outer edge of the row, while the centers of the row become unproductive in older stands. The results indicated that Kentucky bluegrass can be grown in wider rows to give the same results as cultivating. Gapping reduced seed yield in the second year stands and increased seed yield in the third. Gapping in the establishment year significantly increased production in the fourth crop, where residue was removed mechanically. Mechanical removal of residue resulted in higher seed yields than did burning of the residue in the second and third year seed crop. Burning gave higher seed yields in the fourth and fifth crops.

Chilcote and Youngberg in 1975 reported on non-burning techniques of post-harvest residue removal. They used a hay rake treatment, a so-called "close cut" treatment by using a rotary mower followed by a street sweeper and a flail-chop treatment. The close-cut treatment removed the most residue. The flail chop was intermediate and the hay rake removed the least residue. In all instances raking and flail-chop removal of residue were found to be inferior to open burn. However, seed yield reduction as a result of these mechanical removal techniques was very dependent on grass seed species. Orchardgrass, for example, was able to maintain seed yield under a mechanical removal program, whereas fine fescue and Kentucky bluegrass were very sensitive and showed considerable yield reduction after just one year of non-burning.

With new technology in equipment available, this study's objectives was to: 1) demonstrate different mechanical residue management practices; 2) determine crop growth and development of Kentucky bluegrass with reduced smoke impact management treatments; and 3) compare the mechanical treatments to open-field burning for seed yield and seed quality.

Materials and Methods

Two on-farm sites were established in 1991 in central Oregon to evaluate the full compliment of the latest technology for mechanical post-harvest residue removal on Kentucky bluegrass seed production. Additionally two more fields were added in 1992 and in 1993 (for a total of six fields) for a comparison over time.

Because the primary focus for the study was to evaluate the most advanced technology in post-harvest residue equipment, we needed to identify what extent of residue removal was desired. The most common practice of open field burning leaves the field absent of any non-combustible debris and also eliminates debris around the crown of the plant. This cleansing of the soil surface allows maximum light penetration as well as allowing maximum efficiency for pesticide applications. Mechanical residue removal can be accomplished by using various methods. Each method varies in the amount and efficiency of soil cleansing. New equipment used for the study included a Wheel Rake, which has stiff tines to scratch the residue, thatch and remove debris from around the crowns, and a redesigned Grass Vac, both developed by Rear's Manufacturing in Eugene, Oregon. The Grass Vac machine enabled us to clip and vacuum remove the stubble to a 1 inch height. With the Wheel Rake, the bulk of the residue is windrowed, which is baled or otherwise disposed of. Other equipment utilized included a flail mower and a propane flamer with conventional nozzle spacing at 40 psi. Propane flaming after vacuum sweep or wheel rake results in relatively little smoke.

Commercial grass seed fields in central Oregon normally have a large portion of the crop residue removed as baled straw, followed by open-burning of stubble, propane burning or both. Thus, this "field treatment" was compared with several alternative methods of stubble management. Treatments included (1) field treatment; (2) bale-only (no subsequent stubble management); (3) flail chop (flailing all the stubble back on the ground); (4) rake (Wheel Rake); (5) rake plus propane (6) vacuum sweep (mechanical removal of stubble after baling with a Grass Vac); and (7) vacuum sweep plus propane. The treatment plot size was 100 x 22 ft.

Data were collected for vegetative tiller development, fertile tiller development, seed yield, and seed quality. All other management practices such as fertilizing, irrigating, and pest control were done as the normal grower practices for the individual fields. Harvest was completed with the use of conventional equipment and sub-samples were collected to obtain a percent clean out. Seed was cleaned and 1,000 seed weight and germination percents were determined.

Results and Discussion

Significant differences in seed yield resulted from the various management treatments. Seed yields are reported as pounds per acre of clean seed. Figure 1 and 3 shows seed yields and fertile tiller number for aggressive variety types in 1993. Figure 2 and 4 shows seed yields and fertile tiller number for non-aggressive variety types in 1993. Figure 5 shows seed yields and fertile tiller numbers for non-aggressive variety types in 1992. Figure 6 shows seed yields and fertile tiller numbers for aggressive variety types in 1992. The highest yields consistently were produced where the residue was removed completely either by mechanical means or by burning. Bale-only treatment resulted in the least seed yield as well as the lowest number of fertile tillers. Differences in seed yield by variety type were observed in our study. In 1992 the aggressive variety showed a significant need for a more complete residue removal. However, in 1993 the aggressive variety did not need complete residue removal. The winter of 1992 was dryer than the winter of 1993, which may have effected the need for completeness of residue removal.

Tiller development: The general trend of fertile tiller numbers was the same as the trend for seed yield (figures 1-6). Fall and spring vegetative tiller development showed no differences among treatments, with the exception that plants in the bale-only treatment had fewer tillers.

Seed quality: Seed quality was determined by observing germination percentage and by measuring 1,000 seed weight. Seed quality was not affected by different residue management treatments (data not shown).

Our results support general grower experiences with respect to open-field burning vs bale-only treatment. The bale only treatments showed etiolated regrowth in the fall, which is in agreement with Canode and Law (1975, 1977) as well as Ensign, et al. (1983), who conducted a study with shading of Kentucky bluegrass. They concluded that seed yield from plants shaded at 62 percent for 150 days did not differ from plants where the residue was only baled off. Field burning encouraged higher fertile tiller numbers and yield. This increase was true for the older stands, but was even more pronounced on younger stands.

In general, mechanical removal performed much better in our studies compared to bale-only treatment. However, compared to open-field burning, removal of residue with vacuum-sweep or vacuum-sweep followed by propane flaming were not quite as reliable. It is likely that mechanical means of straw removal will elevate the cost of production over the cost of open-field burning, both by requiring additional equipment purchase and usage and by depressing yield. For non-aggressive varieties, these mechanical means of residue removal may prove adequate. The rake plus propane treatment showed good promise in the first year of use as a cheaper more efficient mechanical stubble removal technique.

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Figure 1. Rugby Kentucky Bluegrass
Siegenhagen Farm, 1993
Third Harvest

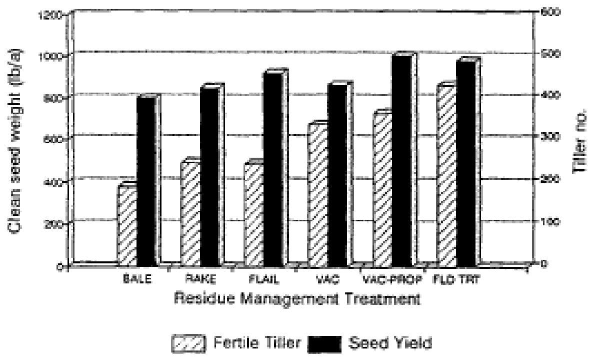

Figure 2. Abbey Kentucky Bluegrass
Siegenhagen Farm, 1993
Third harvest

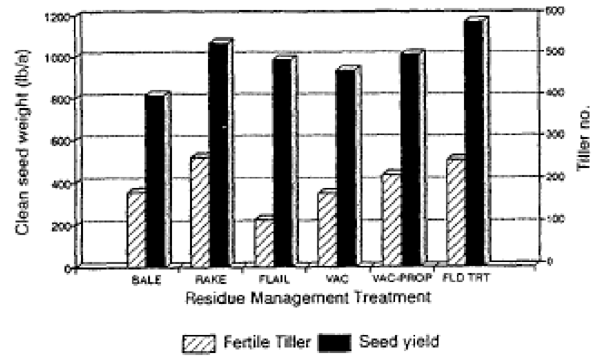

Figure 3. Rugby Kentucky Bluegrass
Brad Klann Farm, 1993
Second harvest

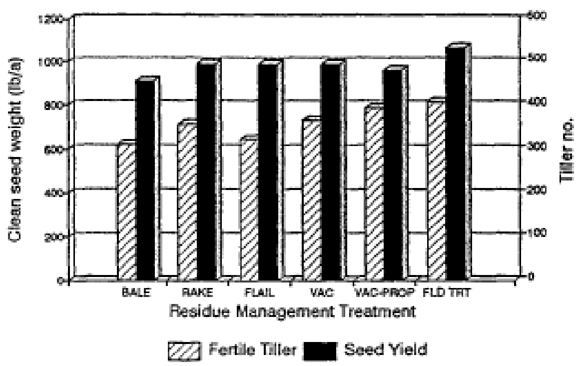

Figure 4. Merit Kentucky Bluegrass
Brad Klann Farm, 1993
Second harvest

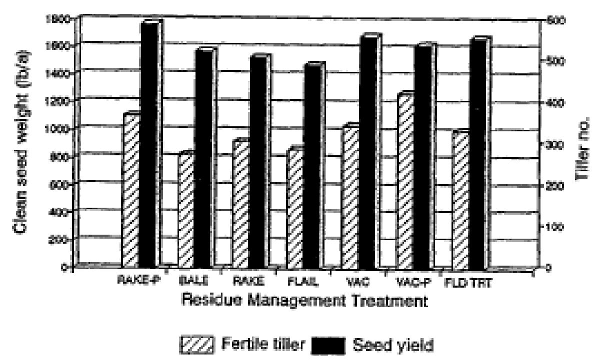

Figure 5. Abbey Kentucky Bluegrass
Siegenhagen Farm, 1992
Second harvest

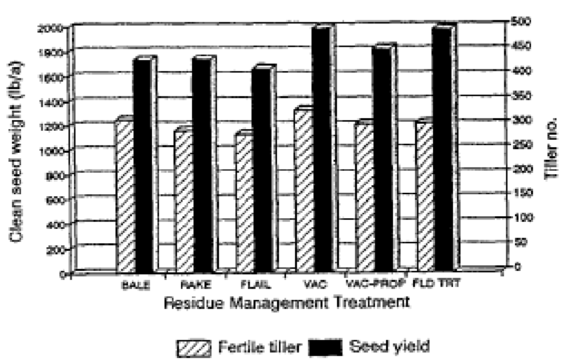

Figure 6. Rugby Kentucky Bluegrass
Siegenhagen Farm, 1992
Second harvest