Progress Report

An Evaluation of Equipment used by Willamette Valley Grass Seed Growers as a Substitute for Open-field Burning

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This "progress report" is envisioned as the first in a series of reports that will summarize research activities related to finding nonthermal systems for producing quality grass seed crops in Oregon. With only a few exceptions, post-harvest treatments were continued following the 1991 harvest at all sites mentioned in this report. This project is continuing through the 1991-92 crop year with funding from the ODA's Alternative to Open Field Burning Research Program.

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INTRODUCTION:
Recent restrictions to open field burning have intensified the need to develop alternative methods for handling grass seed crop residues. This program was initiated to evaluate several different straw-stubble management techniques in a research effort designed to identify alternatives to burning grass seed crop residue after harvest. Evaluation of crop growth and yield responses to various methods of residue removal were accomplished in 1990 and 1991 following treatments imposed after harvest in 1990. The results summarized in this report provide a first year data base for these treatments.

The investigation was divided into two phases, a long term study using new grass seed stands where detailed information was collected on tiller development as well as seed yield and yield components (Table 1), and a second phase where special techniques were evaluated in older grass seed stands for effects on seed yield (Table 2). Plots were established in grower fields at 13 different locations, mostly in the south valley, and focused on tall fescue and perennial ryegrass. The intent is to follow these treatments over a several year period in order to fully evaluate the effect of the residue treatment over time as the grass seed stands age.

METHODS:
The treatments selected for study were located on grower fields in large plots (100 foot wide by 400 foot long) to allow for standard swathing, combining and other field operations using grower equipment. Residue management treatments were established after harvesting the 1990 seed crop using grower equipment where available. Plot harvesting was accomplished with grower swather and combine equipment.

Tillers from each treatment at the seven locations of the long-term study were sampled (two 1 foot sections of row) in the fall, spring and just prior to harvest to determine the number per area and size class. Tiller samples were separated by hand into different stem base sizes (1, 2, 3, 4, and >4 mm) and the number in each class was counted. In addition, at harvest the tillers were separated into vegetative or fertile classes. Potential yield was determined by counting the number of spikelets per inflorescence and the number of florets per spikelet from inflorescence samples taken at early bloom. Observations of weed control were made periodically during the fall, winter and spring.

At seed maturity, four samples (swaths) were taken from each treatment. Each of the four swaths (400 feet long) was combine harvested and weighed separately using grower trucks and portable scales. Combined seed samples from the long-term study plots were analyzed for purity at the OSU Seed Laboratory and an assessment for the presence of ergot and blind seed disease was made by the USDA-ARS National Forage Seed Production Research Center.

An outline of the data collected is presented in Table 3. All data collected during the 1990-1991 crop year were summarized and mean values were graphed to facilitate interpretation.

RESULTS:
Findings are discussed for each residue removal treatment in the following narrative. Information on tillering patterns, disease and weed control are also presented.

Residue Removal Treatments
Chop all straw back: Flail chopping all of the straw and stubble back on the field three times after harvest gave good subsequent seed yield, particularly in tall fescue (Figures 1-9). Yields were equal to or better than other treatments in most of the locations. Fertile tiller number (number of inflorescences) per unit area was related to final seed yield and was also usually higher in this treatment (Figures 14-20). Flail chopping three times reduced the size of the straw particles so that decomposition on the soil surface occurred; thus, by harvest time little straw remained. Although the ryegrass stands where this was done did not look as vigorous as tall fescue in the fall and winter, they recovered and yielded well in most cases. The problem with this treatment was the increase in weed and seedling problems. The herbicide program was not as effective in these tests where all the residue was left on the soil surface. Please note that chopping all the straw back on the soil surface was done earlier in the year (dates for each of the treatments are placed above the bar in the figures) and this seems to be important to the subsequent productivity of the treated plots. As will be pointed out later, delaying residue removal until later in the season was unfavorable to seed yield.

Bale and flail: The seed yield and fertile tiller number with this treatment was comparable to chopping all straw back (Figures 1-9 and 14-20). Since only the stubble was chopped back on the soil surface, better weed control was usually obtained. However, weed and seedling problems were more severe than in treatments where more of the residue was removed (i.e., vacuum-sweep). As in chop all straw back, bale and flail reduced stubble height close to the soil surface and was done earlier in the year. These factors, early removal and close clipping, seem to benefit subsequent seed yield.

Bale only: The response to just baling off the straw was somewhat poorer than for the treatments which reduced the stubble, at some locations (Figures 1-9 and 14-20). More, and taller, aerial tillers were observed on plants in the fall where this treatments was applied; the greater height of the remaining stubble contributed to this situation. The shading of newly developing basal tillers by the aerial tillers and stubble or some other factor related to the thicker stubble remaining may have been responsible for these differences. However, at some sites little difference in seed yield or tillering was observed. Weed problems were similar to those in the bale and flail treatment.

Vacuum-sweep: Removal of crop residue and shattered seed is much more complete with this treatment in comparison with other mechanical methods. As a result, superior weed and seedling control was observed through harvest. Seed yield, however, was depressed a little in many of the test sites with this treatment (Figures 1-9). The sites where fall tiller regrowth and development were most affected by the vacuum-sweep treatment were Falk's Carefree tall fescue (Figure 17) and Wirth's SR-4100 perennial ryegrass (Figure 18). At these two locations, the vacuum-sweep was both later than usual and close enough to the ground to cause scalping in the plant crown. Delayed tiller regrowth in the fall had a greater impact on fertile tiller number at harvest with tall fescue than with perennial ryegrass at these two sites. Seed yield, however, was reduced in both species when compared with other treatments that were applied earlier in the season. In 1990, only one site was treated early in the season (Figure 6) and in this case seed yield was not depressed. It will be interesting to see the results in 1992 since vacuum-sweep was done more timely and without scalping in the fall of 1991. Comparisons of vacuum-sweep and burning (propane or special machine) were made on established stands of bluegrass, perennial ryegrass, and tall fescue in the Hubbard area (Figures 11-13). Tall fescue and ryegrass responded favorably to this non-thermal method of removal, but bluegrass seed yields were somewhat poorer where burning was not done.

Open burn versus non-burn: Some comparisons of open burning and non-thermal residue removal were established on older stands of tall fescue, perennial ryegrass and bluegrass. On an older (8 year) stand of Mojave tall fescue open burning was compared to baling only. One site had never been burned and had the straw baled off each year while the other site had always been burned. The results (Figure 10) show a slight benefit for burning although differences were not great. (The same result was observed in 1990.) Burning had been done early in each of the last three years. In contrast, late burning in a new tall fescue field (Figure 4) resulted in lower yields as compared to other residue removal methods. In ryegrass, (Figure 8) late burning was not different from other methods of removal of residue. The other sites where burning was compared to vacuum-sweep were discussed earlier in this report

Dethatching: The potential benefits of this technique (Lely Dethatcher) as a low cost stubble management treatment in ryegrass were observed following the first year of testing in 1990. Seed yield was equal to or better than the other stubble management treatments on a limited number of test sites studied in 1991 (Figures 1, 8 & 9). The ability of this machine to rake straw from the crown area and to spread the straw remaining after baling is likely the basis for the results observed.

Needle-nose rake: This experimental machine, developed in 1991, is designed to remove all straw from the field - including the residue within the crown area of the crop. Results will not be available until 1992 but observation of plots established after harvest in 1991 look promising. Good regrowth and weed control were observed where the straw was baled off then the stubble flailed and the remaining residue raked off with the new rake.

Tiller Development

Tiller number: Results show the expected increase in tiller number from fall to spring, and a loss (mortality) of tillers prior to harvest (Figures 14-20). This was true for all residue removal treatments, however, late removal treatments that reduced fall tiller development and seed yield (e.g., Figure 17) resulted in higher numbers of spring tillers. Ryegrass had a higher number of tillers per unit area than tall fescue.

Vegetative - fertile tillers: As expected, ryegrass had a higher number of fertile tillers per unit area than did tall fescue (Figures 21-27). Tall fescue, however, had a greater number of seeds per fertile tiller (data not shown). In both species, harvested seed was considerably less than the potential number of seed sites determined by counting the number of spikelets per inflorescence and florets per spikelet (data not shown). Only 20-30% (depending on species and location) of the potential seed sites actually resulted in a harvested seed. Sterile florets, seed abortions and seed shattering contribute to the loss. The various residue removal treatments did not show any differences in this characteristic (floret site utilization).

Species did differ in the relative number of vegetative versus fertile (reproductive) tillers (Figures 21-27). Tall fescue had a greater ratio of vegetative tillers to fertile tillers. The significance of this ratio to continued productivity and seed yield remains to be determined, but the presence of more vegetative tillers at harvest is expected to contribute to stand longevity. The residue removal treatments did not show any consistent differences in ratios of vegetative to fertile tillers.

Aerial tillers: The development of aerial tillers from elevated nodes seems to be related to the presence of the old stubble. Fewer aerial tillers were present when the stubble was clipped back close to the ground early in the post-harvest period. The aerial tillers present in the fall do not survive and are absent in the spring. What effect they have on yield and development remains to be established, but they do appear to be a waste of resources, and by shading the developing new basal tillers may reduce productivity.

Tiller size classes: The pattern of tillering and the size class distribution were not different across the various residue removal treatments for this first year of treatments (data not shown). As expected, tall fescue had larger tiller stem bases than perennial ryegrass. None of the small (1mm) tillers became reproductive in tall fescue but a small percentage of the this size class did become fertile in ryegrass. Most of the fertile tiller population came from the 2mm size class in ryegrass while the 3mm size class provided the greater number of fertile tillers in tall fescue. The 2mm size class was the predominate tiller size in ryegrass while in tall fescue, both 2mm and 3mm size tillers were present in large numbers. In tall fescue, the average stem diameter for fertile tillers was greater then the average vegetative tiller diameter, however, in perennial ryegrass, stem diameter was not as strong an indicator of the tiller being fertile. This reflects the results previously mentioned as to the ratio of fertile to vegetative tillers. Perennial ryegrass is able to produce a fertile tillers later in the crop cycle than tall fescue as shown in the different response the two species had to later residue treatments.

Seed Purity and Disease

Seed from each of the four samples of each residue removal treatment in the long-term study were analyzed for "purity" by the OSU Seed Laboratory. No major differences in seed purity (weed seeds, other crop species, inert matter) were observed in the samples. In addition, no presence of ergot or blind seed disease has been found in the samples studied to date.

CONCLUSIONS

1. Differences in seed yield were not great across the various residue removal treatments, particularly when the treatments were done early in the post-harvest period.

2. Chopping all the straw back on the soil surface gave good seed yields and straw decomposed on the surface prior to subsequent harvest. Bale and flail was also an effective treatment. Both of these techniques chop the stubble close to the soil surface which may be important to subsequent tiller development and seed yield.

3. Late season post-harvest removal of residue and the concomitant late defoliation of the tillers can be detrimental to subsequent seed yield, particularly in tall fescue.

4. Weed and seedling control was poorest where residue was chopped back on the soil surface. Herbicide effectiveness was reduced in these situations.

5. Vegetative versus fertile tiller number varied with species; tall fescue had a greater ratio of vegetative to fertile tillers than ryegrass, which was just the opposite. This may have implications in stand longevity.

6. Spring mortality of tiller populations was evident from tiller sample analyses. The survival of some of these late tillers as vegetative tillers was more apparent in tall fescue than in perennial ryegrass.

7. Fertile tiller number is directly related to seed yield in both tall fescue and perennial ryegrass.

8. Results are for the first year following residue treatments and were expected to show less yield response to different residue treatments. Treatments must be evaluated over a several year period to determine the cumulative effects on stand growth patterns of the quite different residue removal treatments.

Table 1. LONG TERM RESIDUE REMOVAL TREATMENT STUDIES

PERENNIAL RYEGRASS

SR4100 perennial ryegrass
- Don Wirth
  - Bale straw
  - Bale and flail stubble
  - Chop straw and stubble back on field (3 times)
  - Vacuum-sweep (Rear's Crew-cutter)
  - Reclip and loaf (remove residue with Hesston Stakhand)

F7 perennial ryegrass
- Dennis Glaser
  - Bale straw
  - Bale and flail stubble
  - Chop straw and stubble back on field (3 times)
  - Vacuum-sweep
  - Propane after vacuum-sweep

SR4200 perennial ryegrass
- Clarence Venell
  - Bale straw
  - Bale and flail stubble
  - Chop straw and stubble back on field (3 times)
  - Vacuum-sweep

TALL FESCUE

Arid tall fescue
- Don Wirth
  - Vacuum-sweep
  - Chop straw and stubble back on field (3 times)
  - Bale straw
  - Bale and Lely dethatch
  - Bale and Lely dethatch plus flail chop late

Carefree tall fescue
- Aart Falk
  - Bale straw
  - Bale and flail stubble
  - Chop straw and stubble back on field (3 times)
  - Vacuum-sweep
  - Open burn (late)

8855 tall fescue
- Dennis Glaser
  - Vacuum-sweep
  - No removal

Cochise tall fescue
- George Pugh
  - Bale straw
  - Bale and flail stubble
  - Chop straw and stubble back on field (3 times)
  - Vacuum-sweep
  - Propane after vacuum-sweep

Table 2. MANAGEMENT TREATMENT STUDIES ON OLDER GRASS STANDS

PERENNIAL RYEGRASS

Regency perennial ryegrass
- Ken and Jack Sayer
  - Open burn
  - Bale straw
  - Reclip
  - Reclip and Lely dethatch
  - Chop straw and stubble (one time)

Regal perennial ryegrass
- Wendell Manning
  - Bale straw
  - Bale, reclip and Lely dethatch
  - Chop straw and stubble (4 times)
  - Chop stubble (one time)
  - Vacuum-sweep

Manhattan II perennial ryegrass
- Bill Rose
  - Propane burn
  - Machine burn (improved field burning machine)
  - Vacuum-sweep

TALL FESCUE

Mojave tall fescue
- Clarence Venell
  - Bale straw
  - Open burn

Eldorado tall fescue
- Bill Rose
  - Propane burn
  - Vacuum-sweep

BLUEGRASS

Challenger bluegrass
- Bill Rose
  - Machine burn (improved field burning machine)
  - Vacuum-sweep

Table 3. DATA COLLECTION (Long term residue removal treatment only)

<u>Data Collection</u>

<u>Fall-winter</u>

1. Regrowth tiller density - size
2. Weed control observations

<u>Spring</u>

1. Tiller number and size
2. Seed head number and potential yield
3. Seed yield and yield components
4. Seed quality - weeds, disease, etc.

Arid Tall Fescue - Wirth Farm
Seed Yields, 1991

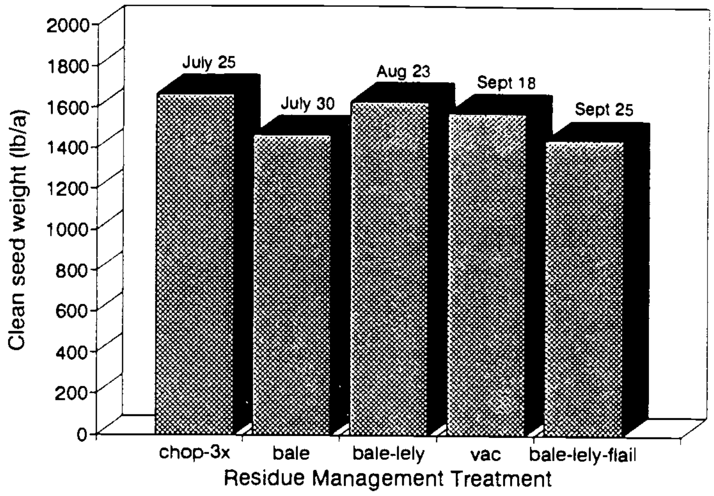


Figure 1

Cochise Tall Fescue - Pugh Farm
Seed Yields, 1991

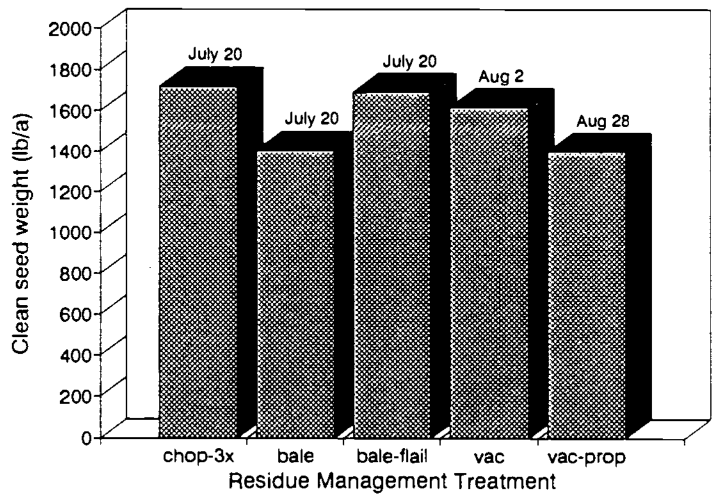
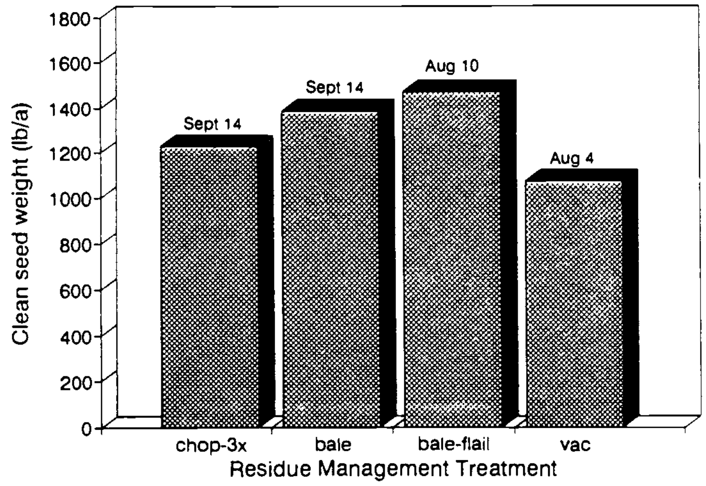


Figure 2

8855 Tall Fescue - Glaser Farm
Seed Yields, 1991



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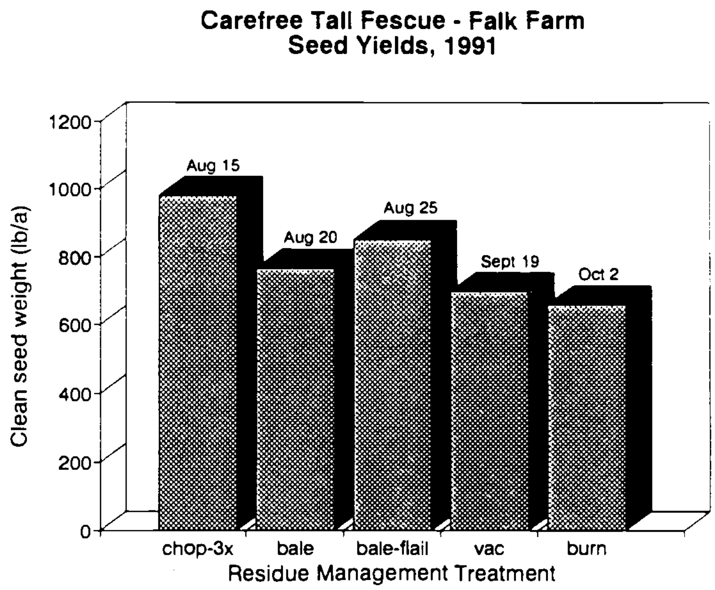

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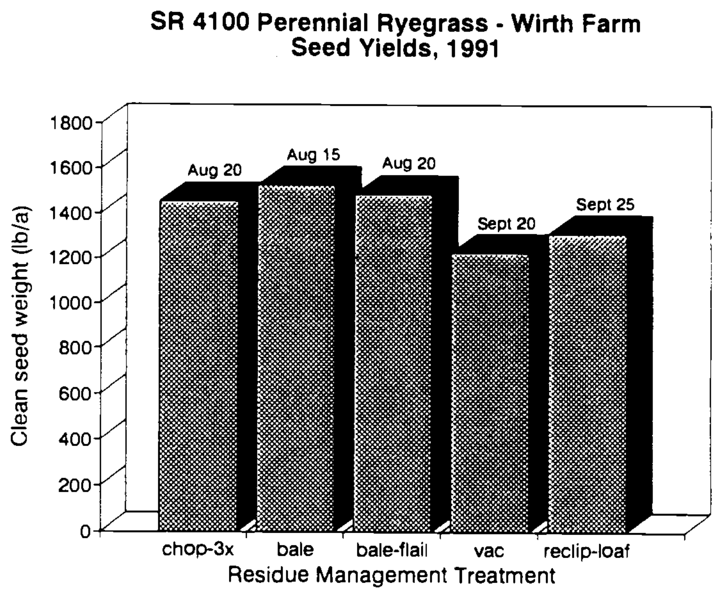

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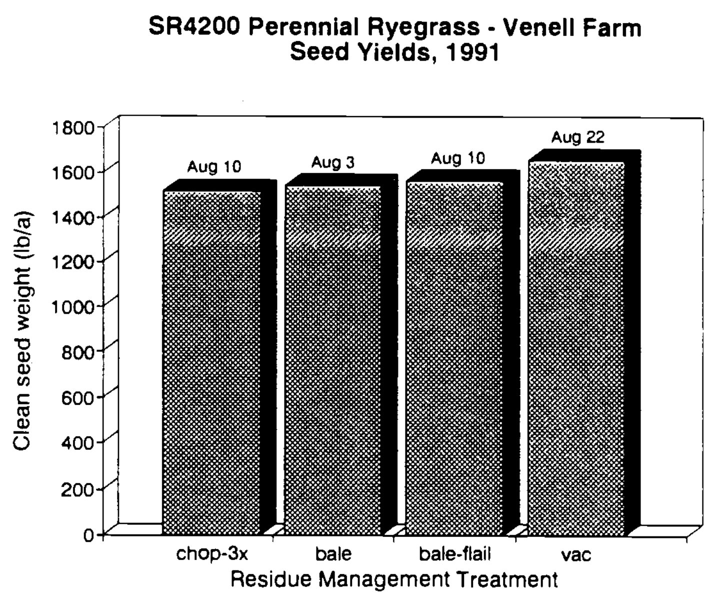

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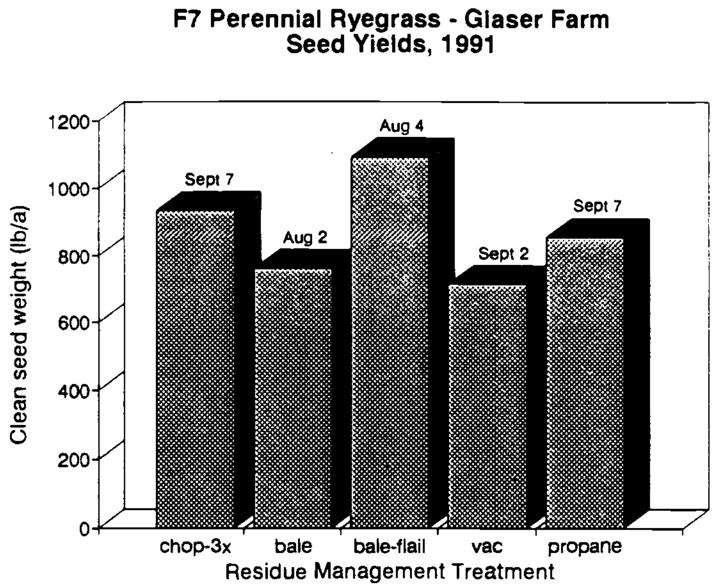

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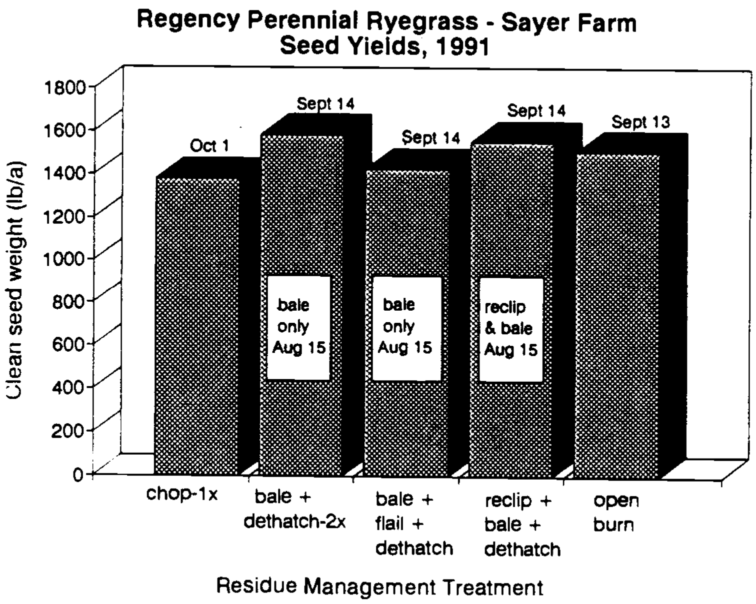

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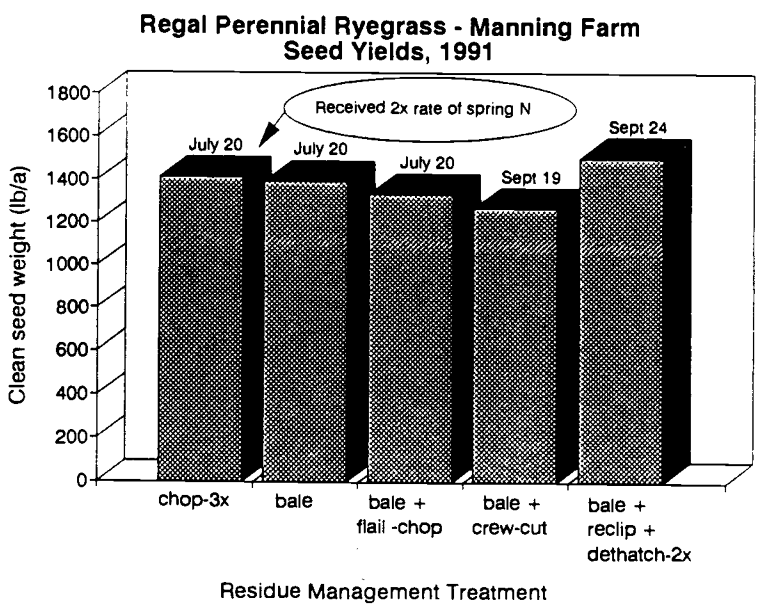

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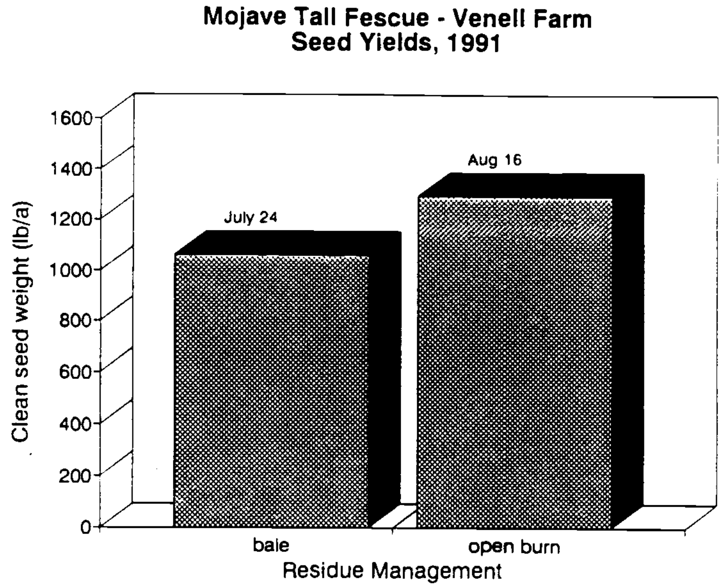

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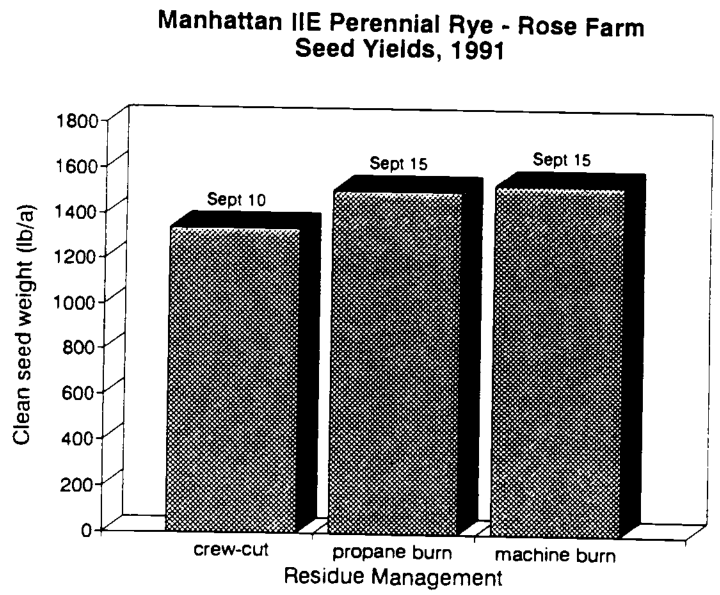

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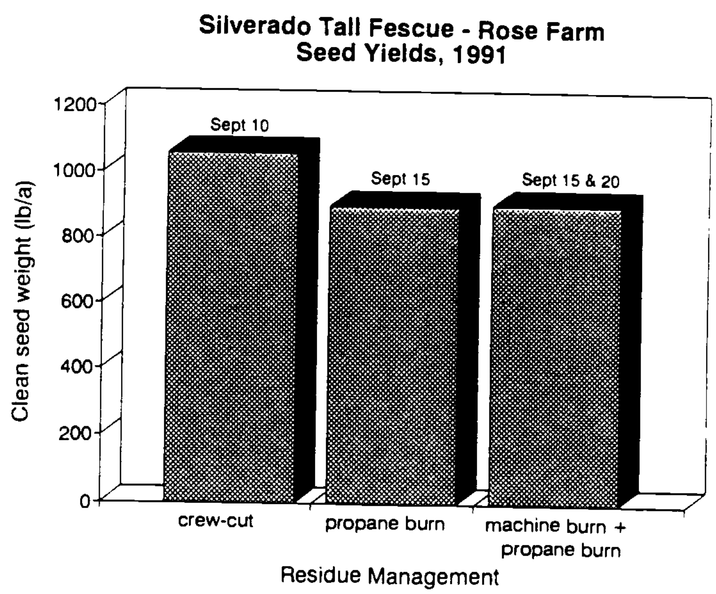

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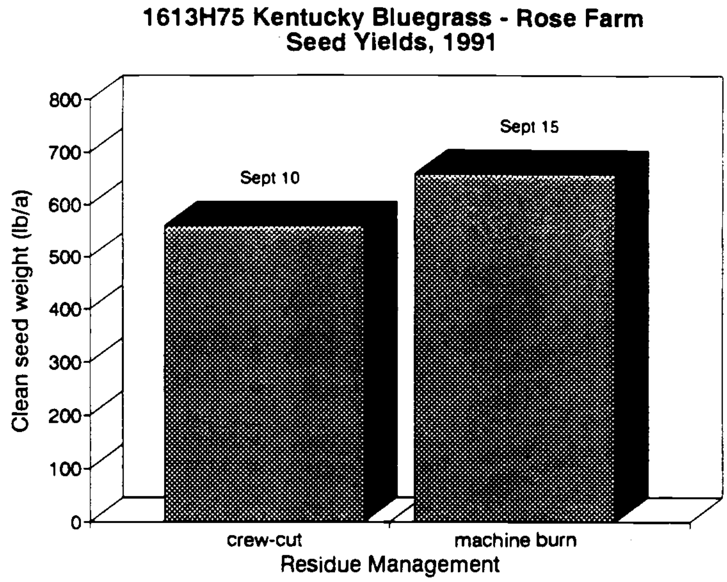

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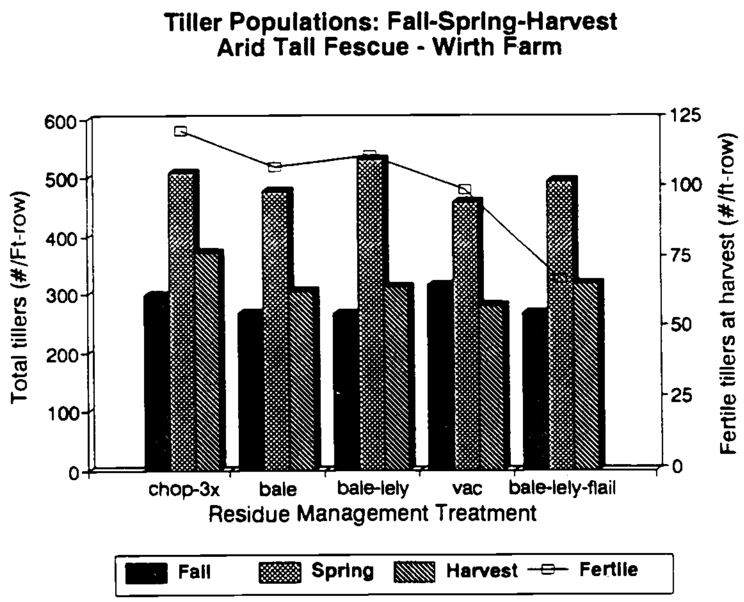

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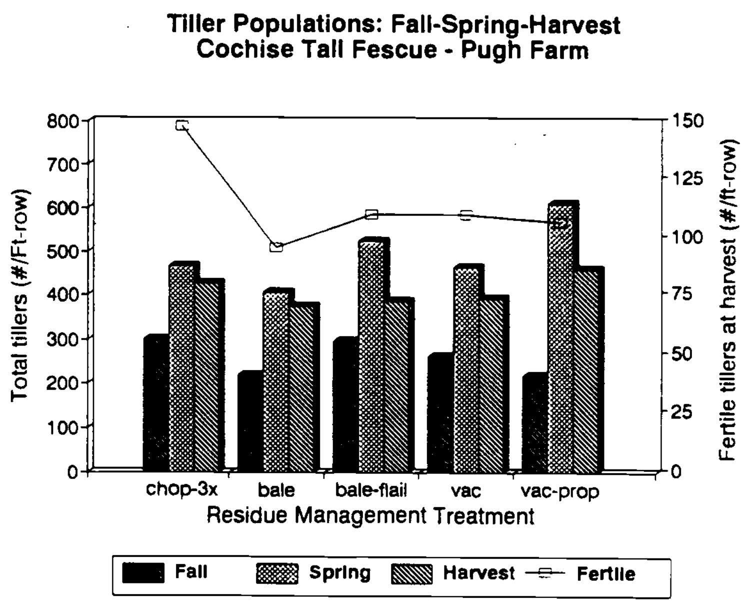


Figure 15

Tiller Populations: Fall-Spring-Harvest
8855 Tall Fescue - D. Glaser Farm

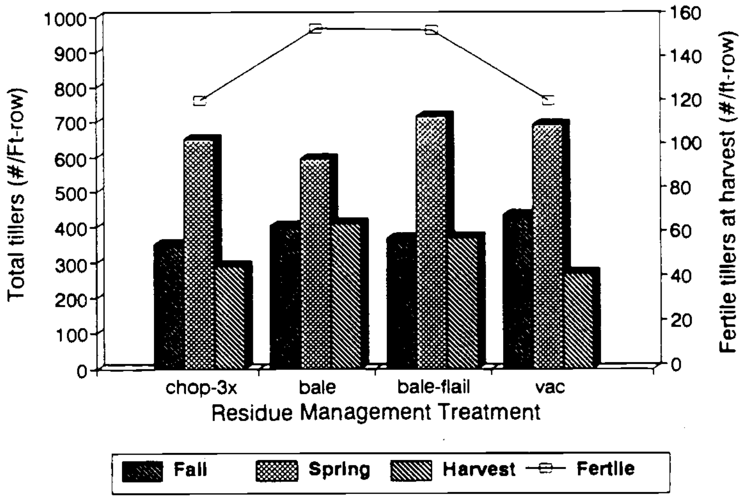


Figure 16

Tiller Populations: Fall-Spring-Harvest
Carefree Tall Fescue - Falk Farm

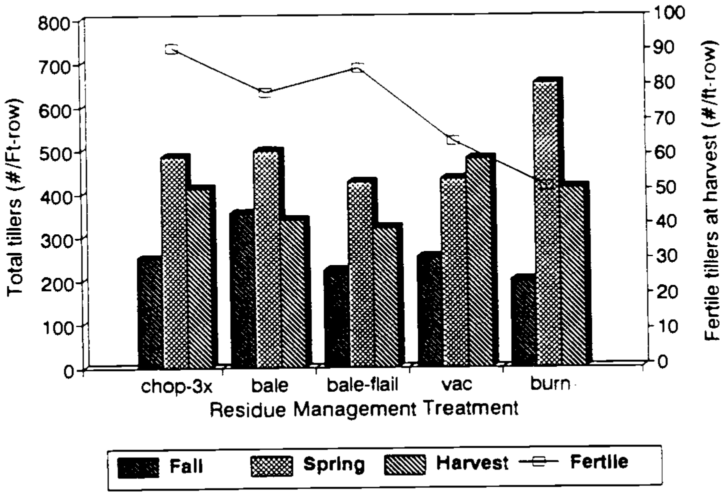
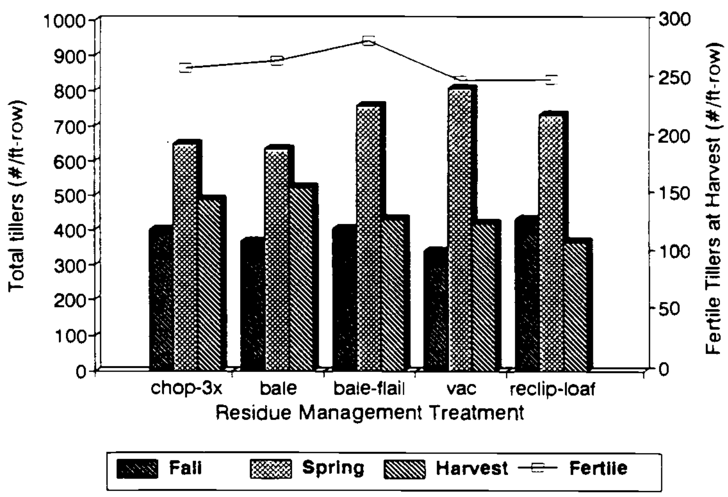


Figure 17

Tiller populations: Fall-Spring-Harvest
SR-4100 Perennial Rye. - Wirth Farm



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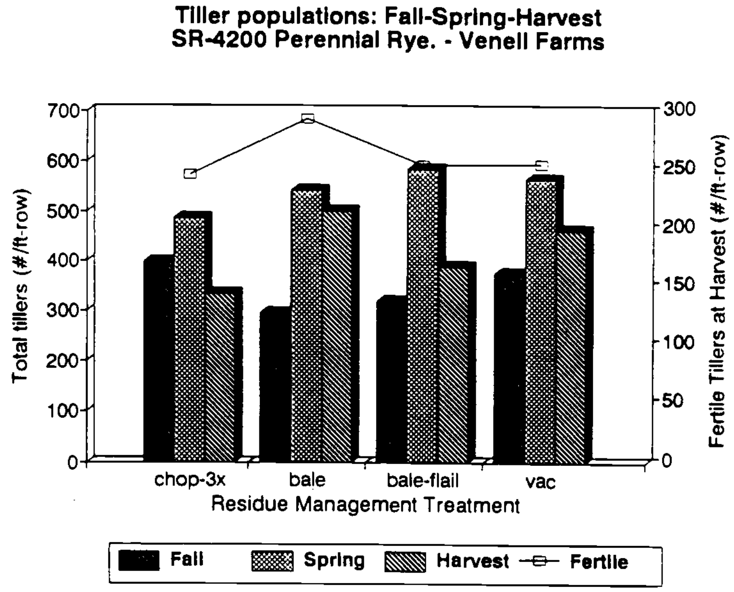

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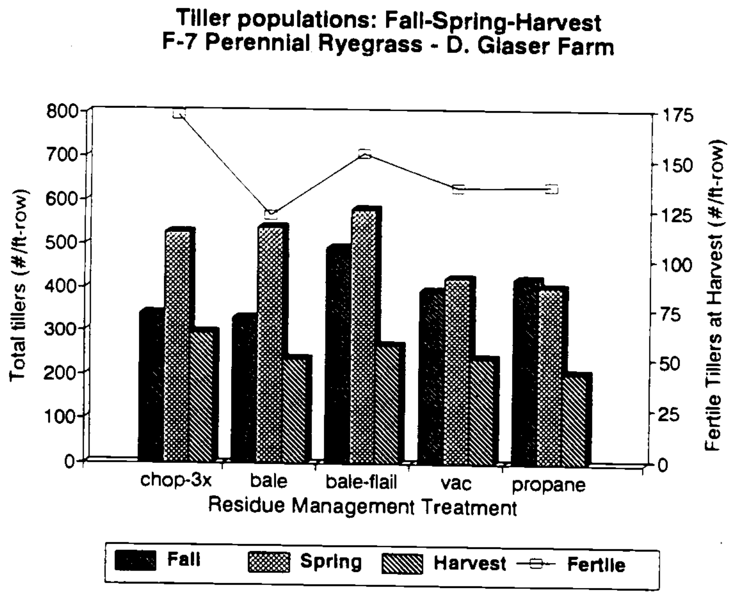

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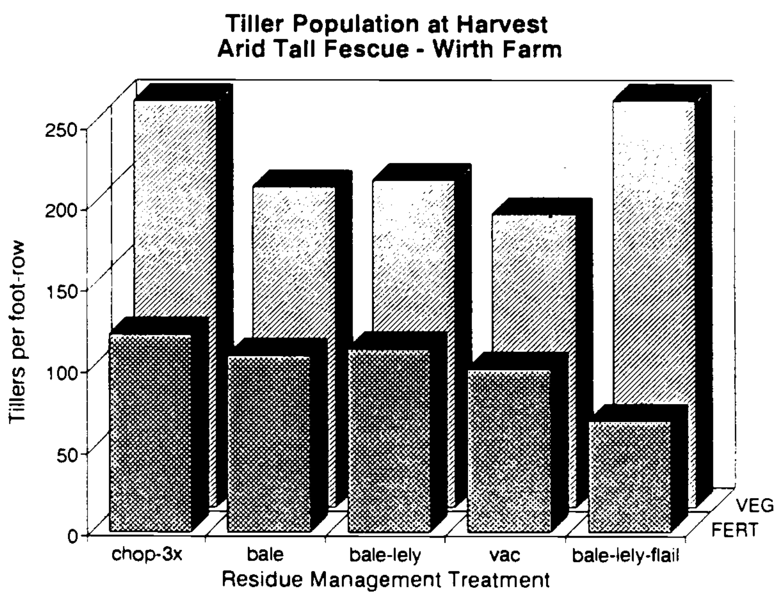

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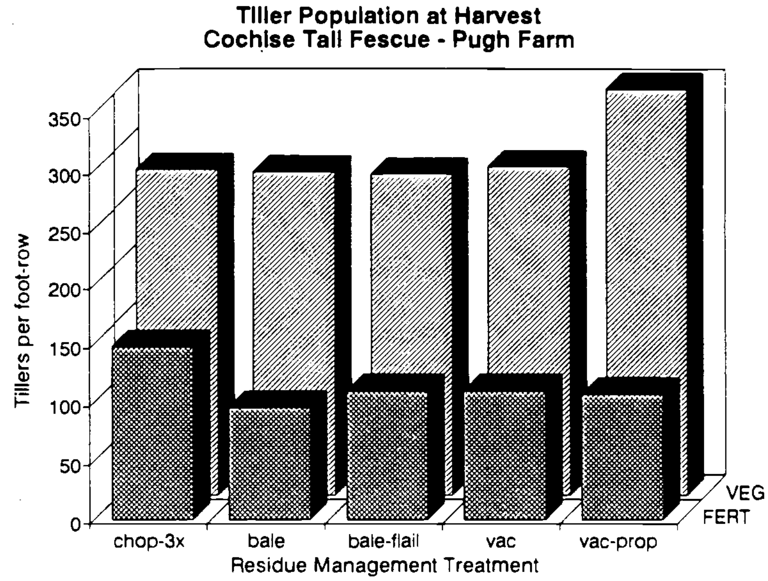

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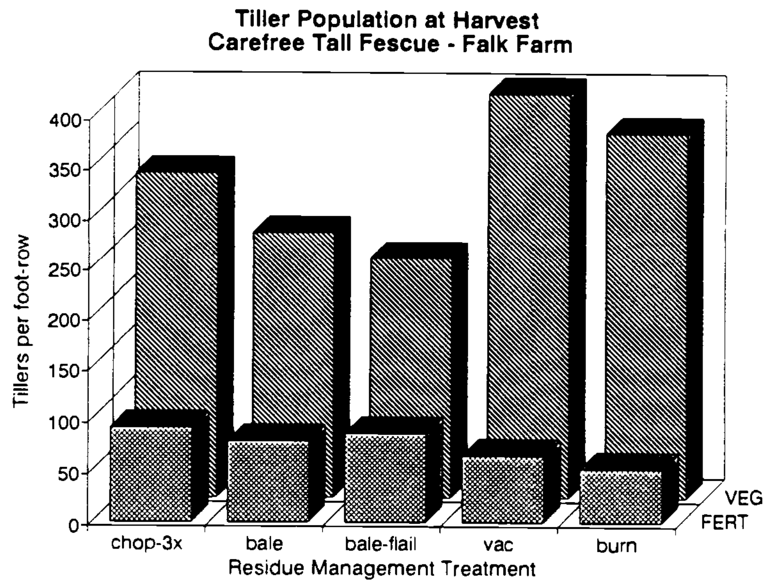

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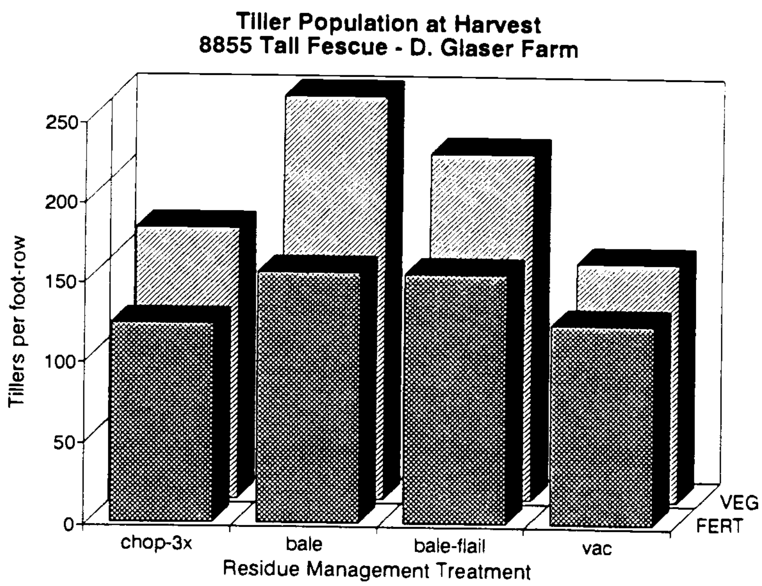

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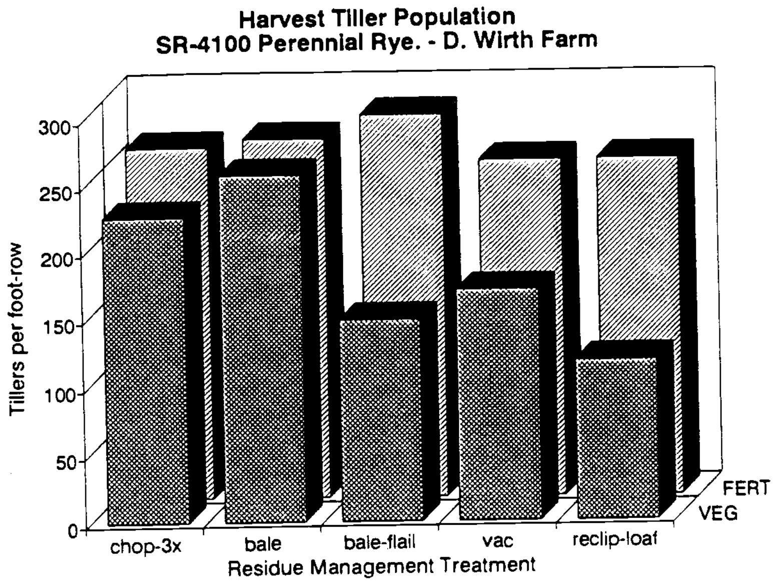

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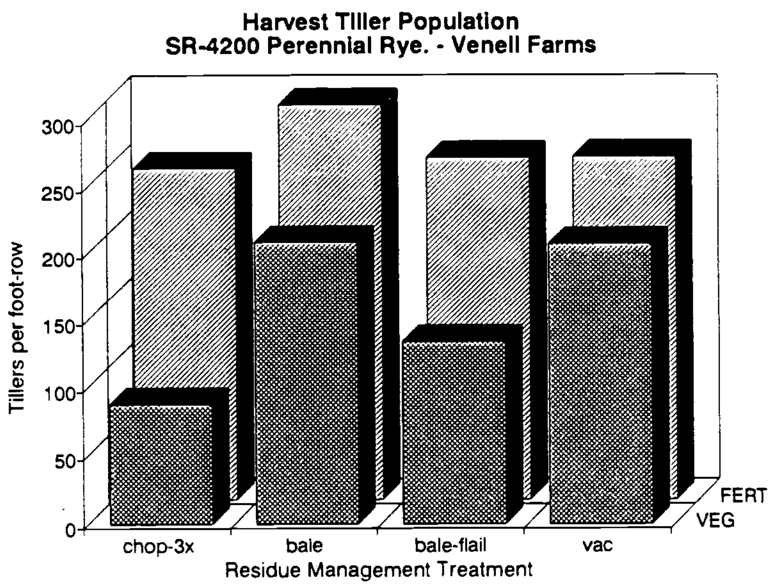

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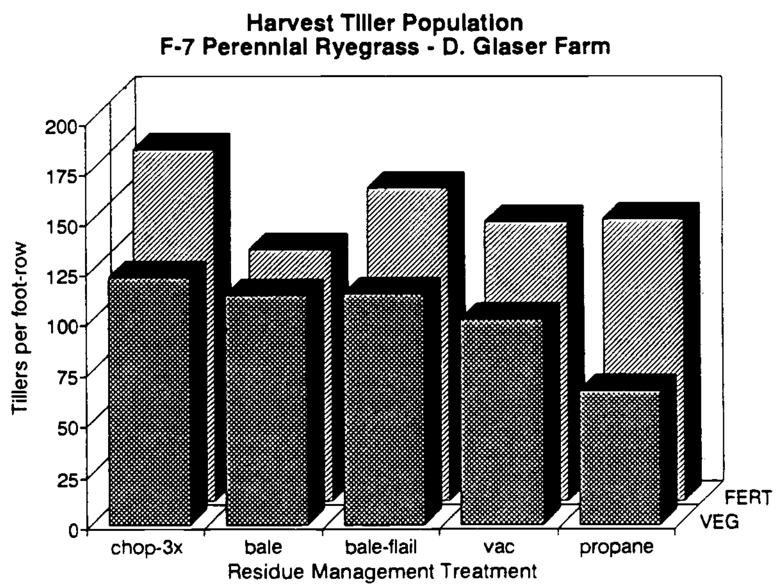

Figure 27

Appreciation is expressed to the following cooperators:

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