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# Sod-Seeding Alfalfa into Cool-season Grasses and Grass-Alfalfa Mixtures Using Glyphosate or Paraquat

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## Abstract

**Sod-seeding alfalfa into swards of smooth and meadow bromegrass, tall and intermediate wheatgrass, and orchardgrass and mixtures of these grasses with alfalfa using glyphosate or paraquat to suppress the existing vegetation was evaluated. Glyphosate (1.7 kg/ha) or paraquat (0.6 kg/ha) was applied 12 days prior to sod-seeding alfalfa (645 PLS/m²). Glyphosate completely suppressed or killed all the grasses and as a result, excellent stands of alfalfa were obtained producing 5.8 to 6.4 Mg/ha the establishment year at Mead, Neb., without irrigation. The grass-alfalfa mixtures were also converted into pure stands of alfalfa by using glyphosate. Glyphosate suppressed but did not kill the existing alfalfa. Sod-seeding in pure stands of grasses following paraquat application produced stands that were approximately 50% grass and 50% alfalfa. Paraquat had a limited suppressive effect on alfalfa and sod-seeded alfalfa did not become established in plots containing old alfalfa.**


Hayfields and pastures of cool-season grasses and alfalfa (*Medicago sativa* L.) are important forages on many ranches and farms. Cool-season grasses need nitrogen fertilization to maintain maximum productivity. Seeding legumes into grass pastures and hayfields could reduce nitrogen fertilizer requirements. Sod-seeding legumes may reduce tillage needs for establishing legumes or grass-legume mixtures but competition from existing vegetation must be suppressed for the seeded legume to become established.

Recent research on the use of glyphosate [N-(phosphonomethyl) glycine] and paraquat [1,1′-dimethyl-4,4′-bipyridinim ion] to kill or suppress existing vegetation when seeding legumes into grass sod has shown that glyphosate almost completely suppresses perennial grasses and results in almost pure stands of legumes but that paraquat only temporarily suppresses the grasses and mixed stands of grasses and legumes are obtained (Groya and Sheaffer 1981, Muller-Warrant and Koch 1980, Olsen et al. 1981, Sheaffer and Swanson 1982, and Welty et al. 1981).

Previous research on the use of glyphosate or paraquat in sod-seeding has been on grass swards. However, it may often be desirable to renovate old pastures or hayfields that already have some legumes in them. This research evaluated the effectiveness of sod-seeding alfalfa into smooth bromegrass (*Bromus inermis* Leyss.), meadow bromegrass (*B. biebersteinii* Roem and Schult.), intermediate wheatgrass (*Agropyron intermedium* (Host) Beauv.), tall wheatgrass (*A. elongatum* (Host) Beauv.), and orchardgrass (*Dactylis glomerata* L.) swards and mixed swards of these grasses with alfalfa using glyphosate or paraquat to suppress the existing vegetation. Intermediate and tall wheatgrasses and meadow bromegrass are important forage components of many western livestock operations and the effectiveness of glyphosate and paraquat in suppressing these grasses during sod-seeding has not been reported.

## Materials and Methods

The research was conducted at the Mead Field Laboratory of the Nebraska Agricultural Experiment Station, located about 32 km west of Omaha. Two adjacent experimental areas on a Sharpsburg silty clay loam (Typic Argiudoll) were used. Both areas were seeded in 1977, one in the spring and the other in the fall, to replicated plots of 'Lincoln' and 'Rebound' smooth bromegrass, 'Regar' meadow bromegrass, 'Slate' intermediate wheatgrass, 'Platte' tall wheatgrass, 'Sterling' orchardgrass, 50-50 mixtures of each grass with 'Dawson' alfalfa, and Dawson alfalfa. Procedures for both experimental areas were the same except for the date of seeding.

Good stands were obtained on all plots. However, in the fall-seeded experiment, orchardgrass winter killed the first winter so the plots originally seeded to orchardgrass were roto-tilled and seeded to alfalfa in the spring of 1978. The experimental design was

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a randomized complete block with 6 replications. The plots were 4.3 m long and 1.2 m wide and were separated on the ends by 1.2-m wide alleys that were seeded to tall fescue (*Festuca arundinacea* Schreb.) in the spring-seeded experiment and to crested wheatgrass (*Agropyron cristatum* (L.) Gaertn.) in the fall-seeded experiment.

In 1978, 1979, and 1980 these experiments were maintained as high production irrigated hayland and were harvested on a 4-cut alfalfa schedule. In the early spring of 1981 there were excellent stands in all plots of both experimental areas.

On April 9, 1981, the spring-seeded area was broadcast sprayed with 1.7 kg/ha of glyphosate and the fall seeded area was broadcast sprayed with 0.6 kg ion/ha of paraquat. The surfactant, X-77, was used with the paraquat and 21.4 l/ha $H_2O$ was used as the carrier for both herbicides. Hereafter in this paper the 2 areas will be referred to by their respective herbicide treatments, i.e., glyphosate or paraquat treated area. All grasses and the alfalfa had initiated vegetative growth at the time of spraying. Alfalfa was sod-seeded into both areas on April 21, 1981, at the rate of 645 PLS/$m^2$ using a John Deere[1] power-till drill perpendicular to the direction seeded in 1977.

On July 7, August 18, and October 21, 1981, both areas were harvested for forage yield using a flail-type plot harvester that harvested a 0.9 m wide swath out of the center of each plot. The third cut was harvested following a frost (0° C) on October 19, 1981. The cutting height for all harvests was 10 cm. The percentage of harvested forage that was perennial grass or legume was determined for each cut by visual estimation of the standing forage at harvest. The percentage of alfalfa that was from the newly seeded (new) or from established plants (old) was also visually evaluated for the first harvest for both areas. This was possible because the old alfalfa was past full bloom and the new alfalfa had not flowered. It was also possible to differentiate between old and new alfalfa at second harvest on the paraquat area. Visual estimates were made to quantify botanical changes in the swards following treatment with herbicides.

Stand counts were made during the last week of April 1982. Alfalfa stand counts were determined by frame counts. A metal grid containing 25 squares, each 15 cm × 15 cm was placed on each plot and the number of squares containing an alfalfa plant were counted. This procedure was repeated on a different area of the same plot. Since 50 squares were read, stand percentage was calculated as 2 × the total number of squares that contained an alfalfa plant. Grass stands were obtained using the same procedure. Stand counts of 50% for both grass and alfalfa would indicate that 25 of the 50 squares that were read contained at least one alfalfa plant and 25 squares (but not necessarily the same squares as for alfalfa) contained at least 1 grass plant. The experimental areas did not receive any irrigation in 1981 or 1982.

**Table 1. Establishment year productivity of alfalfa sod-seeded into established swards of cool-season grasses, alfalfa, and cool-season grass-alfalfa mixtures with preseeding applications of glyphosate and paraquat and the resulting grass and alfalfa stands.**

| | Means | | | | | | | | Stands | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Harvest 1 | | | Harvest 2 | | | Harvest 3 | | April 1982 | |
| | | Old | New | | Alfalfa[2] | | | | | |
| Entry (previous sward) | Yield[1] ($Mgha^{-1}$) | alfalfa[2] (%) | alfalfa[2] (%) | Yield[1] ($Mgha^{-1}$) | old (%) | new (%) | Yield[1] ($Mgha^{-1}$) | Alfalfa[2,3] (%) | Grass (%) | Alfalfa (%) |
| | | | | | Glyphosate Treated Plots | | | | | |
| Lincoln smooth brome | 1.12 | 0 | 100 | 2.98 | 100[3] | | 1.72 | 100 | 17 | 100 |
| Regar meadow brome | 0.99 | 0 | 100 | 2.89 | 100 | | 1.88 | 100 | 5 | 99 |
| Rebound smooth brome | 1.16 | 0 | 100 | 2.98 | 100 | | 1.86 | 100 | 1 | 99 |
| Slate intermediate wheatgrass | 1.25 | 0 | 100 | 3.14 | 100 | | 2.11 | 100 | 3 | 99 |
| Platte tall wheatgrass | 1.12 | 0 | 100 | 3.00 | 100 | | 1.88 | 100 | 10 | 98 |
| Sterling orchardgrass | 1.41 | 0 | 100 | 3.00 | 100 | | 1.97 | 100 | 4 | 98 |
| Lincoln + alfalfa | 2.64 | 37 | 63 | 3.56 | 100 | | 1.88 | 100 | 3 | 98 |
| Regar + alfalfa | 2.73 | 22 | 78 | 3.58 | 100 | | 2.06 | 100 | 5 | 99 |
| Rebound + alfalfa | 3.11 | 33 | 67 | 3.54 | 100 | | 1.99 | 100 | 0 | 96 |
| Slate + alfalfa | 3.07 | 28 | 72 | 3.65 | 100 | | 1.90 | 100 | 4 | 98 |
| Platte + alfalfa | 3.14 | 38 | 62 | 3.67 | 100 | | 1.88 | 100 | 3 | 96 |
| Sterling + alfalfa | 2.71 | 28 | 72 | 3.32 | 100 | | 1.94 | 100 | 3 | 97 |
| Dawson alfalfa | 3.76 | 60 | 40 | 3.54 | 100 | | 1.88 | 100 | 1 | 98 |
| LSD .05 | 0.23 | 14 | 14 | 0.17 | | | 0.07 | | 3 | 8 |
| | | | | | Paraquat Treated Plots | | | | | |
| Lincoln | 0.96 | 3 | 0 | 1.68 | 3 | 43 | 1.07 | 50 | 99 | 91 |
| Regar | 0.94 | 3 | 0 | 1.75 | 8 | 28 | 1.30 | 50 | 98 | 85 |
| Rebound | 1.05 | 3 | 0 | 1.99 | 2 | 45 | 1.34 | 60 | 88 | 96 |
| Slate | 2.02 | 7 | 0 | 1.86 | 0 | 55 | 1.43 | 63 | 92 | 97 |
| Platte | 1.90 | 0 | 0 | 1.75 | 0 | 55 | 1.23 | 62 | 91 | 75 |
| Lincoln + alfalfa | 4.97 | 72 | 0 | 4.03 | 50 | 10 | 1.88 | 63 | 87 | 69 |
| Regar + alfalfa | 4.90 | 82 | 0 | 4.02 | 55 | 12 | 2.08 | 73 | 73 | 60 |
| Rebound + alfalfa | 4.79 | 75 | 0 | 3.81 | 48 | 10 | 1.90 | 78 | 60 | 77 |
| Slate + alfalfa | 5.24 | 75 | 0 | 3.67 | 58 | 13 | 1.95 | 72 | 85 | 68 |
| Platte + alfalfa | 5.60 | 80 | 0 | 3.83 | 70 | 10 | 1.93 | 70 | 80 | 55 |
| Dawson alfalfa | 5.44 | 100 | 0 | 4.19 | 90 | 10 | 2.02 | 100 | 10 | 76 |
| LSD .05 | 0.48 | 11 | | 0.19 | 10 | 14 | 0.10 | 15 | 14 | 14 |

[1]Yields are reported on a dry weight basis. Mgha-1 = megagrams/hectare = metric tons/hectare = 0.446 U.S. tons/acre.
[2]Estimate of the composition of the harvested forage that was alfalfa. % grass = 100 - % alfalfa.
[3]Old and new alfalfa were undistinguishable.

## Results and Discussion

### Glyphosate Treatment

Excellent initial stands of sod-seeded alfalfa were obtained in the glyphosate area. The 12-day interval between spray and seeding allowed the glyphosate to completely suppress the grasses. At the first harvest in July the old alfalfa, i.e., that seeded in 1977, was in the green pod stage while newly seeded alfalfa was 20 cm tall. The newly seeded alfalfa comprised 100% of the forage harvested from what had previously been pure stands of grasses (Table 1). Glyphosate temporarily stunted but did not kill the old alfalfa plants. At first harvest the old alfalfa had recovered from the glyphosate treatment, and it provided 22 to 38% of the harvested forage on what had previously been grass-alfalfa plots and 60% of the forage in the pure alfalfa plots. By the second harvest at one-tenth bloom, it was difficult to distinguish between the old and new alfalfa, and the entire area looked like a solid stand of alfalfa. No grass was harvested from any of the plots because the grass foliage of surviving plants was shorter than the 10 cm harvest height. In the spring of 1982 alfalfa ranged from 96 to 100% (Table 1). Lincoln smooth bromegrass survived better than all other grasses, demonstrating both within and between species differences for tolerance to glyphosate.

### Paraquat Treatment

Excellent initial stands of sod-seeded alfalfa were also obtained in plots treated with paraquat. Paraquat, however, only temporarily suppressed the grasses and its effect on the old alfalfa was minimal. The 1.68 mg/ha more forage produced at first harvest from Dawson alfalfa plots treated with paraquat compared to plots treated with glyphosate illustrates the differences in suppressive effect of the herbicides (Table 1). At first harvest, the old alfalfa in the paraquat area was in the green pod stage and the new alfalfa was 8 cm tall. Since the new alfalfa was below the 10-cm cutting height, it was not a component of the harvested yield for any of the plots at first harvest (Table 1). At second harvest, the old alfalfa was at full bloom while the new alfalfa was at one-tenth bloom. In plots that had previously been grass-alfalfa mixtures or pure stands of alfalfa, it was estimated that 13% or less of the harvested forage was new alfalfa but it comprised about 45% of the harvested forage in plots that previously had been pure stands of grasses (Table 1). At third harvest we could not distinguish between old and new alfalfa plants. Grasses were an important component of the forage yield for all 3 harvests for those plots previously containing grasses (Table 1).

In plots that had previously been pure stands of grasses, nearly equal stands of grasses and alfalfa were obtained by sod-seeding with paraquat. Grass stands in plots that had previously been grass-alfalfa mixtures were slightly higher in most instances than alfalfa stands in the same plots. Alfalfa stands in plots that had previously been grass-alfalfa mixtures were lower than alfalfa stands in what had been pure stands of grasses. In the paraquat area in the spring of 1982, all alfalfa in plots that previously contained alfalfa (1977 seeding) were old alfalfa plants. These alfalfa plants were large randomly distributed plants while those in plots that were previously had been all grass were much smaller and in rows. Apparently sod-seeded alfalfa did not become established in plots containing old alfalfa in the paraquat area because of either excessive competition or alleopathic effects of the old alfalfa. Newly seeded alfalfa did emerge and could be seen in rows in plots that contained old alfalfa but these seedlings did not survive the first year.

Although stand counts were not taken prior to spraying with glyphosate or paraquat, the excellent stands that were present in both sets of plots prior to spraying can be shown by surviving grass and old alfalfa stands in the paraquat plots in the spring of 1982. As pointed out previously, alfalfa plants in the original grass-alfalfa plots in the paraquat study were all old plants. By the time of this study some of the pure stands of Dawson alfalfa had been invaded by some grasses (primarily Kentucky bluegrass *(Poa pratensis* L.)), which accounts for the grass stands listed in Table 1 for Dawson alfalfa. Also, a few old alfalfa plants occurred in some of the grass plots.

## Conclusions

The first year yields of 5.8 to 6.4 Mg/ha of alfalfa obtained by sod-seeding alfalfa using glyphosate could be obtained in many regions of the U.S., particularly if supplemental irrigation was used. These results demonstrate that sod-seeding with glyphosate could convert grass and grass-alfalfa stands into essentially solid stands of alfalfa. Glyphosate should not be used, however, if a grass-alfalfa mixture is desired.

Sod-seeding alfalfa using paraquat in pure stands of cool-season grasses could be used to establish mixed stands of grass and alfalfa. Because paraquat has only a limited suppressive effect on alfalfa, its usefulness in seeding alfalfa into mixed stands of grass and alfalfa is questionable.

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