Weed Control by Herbicides and Fertilizers Applied Separately or Combined on Kentucky Bluegrass Lawn

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캔터키블루그래스 잔디에서의 제초제와 비료의 단독과 혼용처리에 의한 잡초방제

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ABSTRACT

Incorporating herbicides application into a fertilization program has several benefits including saving time and reducing traffics on the lawn. Premixed products of fertilizers and herbicides are commonly known as Weed & Feed in the lawn-care industry. To compare Weed & Feed with separate applications of fertilizers and herbicides on a Kentucky bluegrass (*Poa pratensis* L.) lawn, a Weed & Feed 28-3-3, containing 0.64% 2,4-D, 0.31% MCPP, and 0.03% dicamba of active ingredients, was used in this study. The first application was in May, with the second in June or Sept. Herbicides in forms of 2,4-D (LV-4, 4EC), MCPP (4EC), and dicamba (Clarity, 4EC) were applied at rates equal to the amounts in Weed & Feed or at half of the rates. The dominant weed in both locations was common dandelion (*Taraxacum officinale* Weber.) in 2005 and 2004. A secondary weed was Canada thistle (*Cirsium arvense* (L.) Scop.) in 2004 and broadleaf plantain (*Plantago major* L.) in 2005. When applied in May and June, fertilizer plus full rate of herbicides treatment achieved 112.3 and 83.7 days of acceptable turf quality in 2004 and 2005, respectively. During the same period, Weed & Feed resulted in 58.7 and 24.3 days of acceptable turf quality, respectively. Our study showed that Weed & Feed was generally as effective in weed

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control as the same amount of fertilizer plus half rates of herbicides sprayed although results may vary due to the timing of application. Fertilizer plus full rates of herbicides provided the same or better results of weed control than Weed & Feed.

Key words: broadleaf, feed, postemergence, *Poa pratensis, Taraxacum officinale,* turf,

INTRODUCTION

The practice of tank-mixing herbicides with liquid fertilizer can be traced back to the 1960s. Some benefits of successful combination include time efficiency, ease of application, and reduced wear and traffic on the turf(Petty, et al., 1971; Worsham, 1969). Fertilizer and herbicide combinations, called Weed & Feed by some manufacturers, are becoming more popular due to the aforementioned reasons. Another factor that may have promoted granular formulation of herbicide and fertilizer is a public perception. A homeowner may think that pesticides applied by a spreader together with fertilizers are less toxic than pesticides applied from a sprayer.

Not all products are mixable for several reasons(Martens, et al., 1978; Meyer, et al., 1973; Wigfield and McLenagham, 1990). An optimum timing for fertilizer application may not be ideal for effective weed control from herbicides, and vise versa. In addition, some states mandate the amount and frequency of fertilizer applications and therefore limit the use of Weed & Feed. For these reasons, studying and comparing system effectiveness and efficiency in weed control and general turf quality are necessary. We hypothesize that mowing, fertilization and other cultural practices with separate herbicides application may have different effectiveness in weed control and/or may reduce the herbicide rate and achieve the same or better turf quality as used in full rate.

The primary objective of this study was to compare Weed & Feed with separate applications of fertilizers and herbicides at different times under home-lawn conditions. A second objective was to investigate the weed control effects of multiple applications of Weed & Feed with sub-lethal rates of active ingredients. The study was to gain information under home lawn management regime in cold and semiarid regions. Some of the major weed problems in this region are broad-leaf perennials. In this study, a broad-leaf weed control product was used as a post-emergence treatment that is readily available in local garden centers. The application timing was designed to follow the common practice of fertilization and the availability of Weed & Feed products in this region.

MATERIALS AND METHODS

Research was conducted in 2004 and 2005 at different locations in Fargo, North Dakota. The soil was Fargo-Ryan silty clay [(fine, montmorillonitic, frigid Vertic Haplaquall)-(fine, montmorillonitic, Typic Natraquoll)] with a pH of 7.8 and organic matter content of 3.1%. The turf was established one year before each study from 'Park' Kentucky bluegrass (*Poa pratensis* L.) in the selected locations that had natural perennial broadleaf weed infestations. A starter fertilizer with an analysis of 18N-10.56P-9.96K was broadcast at planting at a nitrogen (N) rate of 24 kg/ha on August 19 and 24, respectively. Another N at the rate of 48.8 kg/ha was applied in September during the seeding year with a fertilizer of 28N-1.3P-8.3K. The research plots were mowed at 6.5-cm height. Irrigation was applied to prevent summer dormancy. The experiment was a randomized complete block design with each treatment plot measuring 6 m^2 (2 m by 3 m) and in three replicates.

It is a common practice in the region to fertilize lawns in spring if only one application is planned. When two applications are desired, some people apply the second application in September while others prefer June. Fertilizing lawns during the mid summer is not recommended. Accordingly, treatments were designed to fit this practice. The first application was planned for 25 May, with the second on 25 June or 25 Sept. The actual application dates were within two days of the targeted dates due to weather constrains. Weed & Feed 28-3-3(Pursell Industries Inc., Sylacauga, AL) used in this study contained 0.64% 2,4-D, 0.31% MCPP, and 0.03% dicamba of active ingredients on a weight basis. Treatments are listed in Tables 1 to 3.

The lawn was watered for 5 minutes prior to Weed & Feed applications to provide moisture on the leaf blades as recommended by the manufacturer. Weed & Feed or fertilizer was spread uniformly at an N rate of 48.8 kg/ha each time conforming to the recommended rate of Weed & Feed label instructions. Fertilizer used had the same nutrient components and rates as the Weed & Feed treatments. Fertilizer treatments were applied at the same time as Weed & Feed treatments. However, herbicides, as required, were spread in a separate application after the turf surface was dry and irrigation was held for 24 hours after spraying. Herbicides in forms of 2,4-D(LV-4, 4EC), MCPP(4EC), and dicamba(Clarity, 4EC) were applied at rates equal to the amounts in Weed & Feed or at half of the rates. Herbicides were applied with a CO2-pressurized hand-held 97-cm boom sprayer equipped with three Teejet 8002VS nozzles(Bellspray, Inc., Opelousas, LA) at a pressure of 240 kPa. Spray

volume was 133 L/ha.

Number for each weed species was counted in each plot right before the first treatment was applied on 25 May. Numbers of weeds were monitored two weeks after each treatment and at the beginning of August and September. Weed percentage control was calculated from plant number change divided by original number. Turf quality was evaluated from the integral estimate of color, density, and weed populations in a 1 to 9 scale where one is brown turf or full of weeds, 6 is minimum acceptable, and 9 is the healthy turf with no weeds.

Data were analyzed by conducting F-tests using mixed model procedure in SAS (SAS 9.1, SAS Institute Inc., Cary, NC). Duncan's multiple range tests were used for the comparison of treatment means upon a significant F-test treatment effect.

RESULTS AND DISCUSSION

The dominant weed in both locations for this study was common dandelion (*Taraxacum officinale* Weber.) with the population much higher in 2005 than in 2004. A secondary weed was Canada thistle [*Cirsium arvense* (L.) Scop.] in 2004 and broadleaf plantain (*Plantago major* L.) in 2005. White clover (*Trifolium repens* L.) existed in small amounts and uneven distribution during the two years of study. The influence of white clover was included in ratings of turf quality, but individual data for white clover are not reported.

One application of fertilizer and herbicides in full rate had the same or better d andelion control results compared with Weed & Feed in 2004 and 2005, regardless of application time(Table 1). In both years, there were cases where negative dandelion control results existed when Weed & Feed or fertilizer with half rate of herbicides was used in May. This may have been caused by the germination of dandelion in areas where canopy was opened from the first application. The full rate of herbicide perhaps killed the germinating seeds while the half rates did not. Weed & Feed generally had the same dandelion control results as fertilizer with half rates with one application.

The results of dandelion control by treatments that had fertilization in one month and fertilization plus herbicides at half rate in another month were not the same between 2004 and 2005. Fertilization in June following fertilizer/herbicides in May improved dandelion control from 11% to 72% in 2004. However, fertilization in June following the application of fertilizer and half rate herbicides in May actually

Table 1. Percentage weed control from applications of Weed & Feed or separate applications of fertilizer and herbicides.

Treatments				Weed control (%)			
1st Application		2nd Application		Common dandelion		Canada thistle	Broadleaf plantain
Chemical	Time	Chemical	Time	2004	2005	2004	2005
W & F[z]	May			-18e	30cd	-89g	67bcde
F[y] and H[x] 1X[w]	May			100a	48bc	66ab	90ab
F and H ½ X[v]	May			11de	-17ef	-41f	60cde
W & F	June			69abc	20cd	50bcd	57def
F and H 1X	June			75ab	33bcd	43bcde	88abc
F and H ½X	June			35dc	30cd	24de	55def
W & F	May	W & F	June	70abc	45bc	60bc	90ab
F and H 1X	May	F and H 1X	June	100a	89a	90a	98a
F and H ½X	May	F	June	72abc	-26ef	33bcde	83abcd
F	May	F and H ½X	June	27d	3de	40bcde	84abcd
W & F	May	W & F	September	100a	33bcd	30cde	84abcd
F and H 1X	May	F and H 1X	September	100a	72ab	54bcd	92ab
F and H ½X	May	F	September	13de	0def	25de	79abcd
F and H ½X	May	F and H ½X	September	39bcd	51bc	38bcde	68abcde
F	May	F and H ½X	September	33dc	42bc	15e	30f
W & F	September			0de	20cd	15e	46ef
F and H 1X	September			29d	39bc	42bcde	60cde
F and H ½X	September			0de	23cd	15e	45ef
Blank Control				0de	-36f	-188h	3g

[z]Weed & Feed 28-3-3 contained 0.64% 2,4-D, 0.31% MCPP, and 0.03% dicamba of ai on weight basis. The N rate used was 48.8 kg/ha.
[y]Fertilizer had an analysis of 28N-1.32P-2.49K with the same analysis as in Weed & Feed 28-3-3.
[x]Herbicide was from 2,4-D (LV-4, 4EC), MCPP (4EC), and dicamba (Clarity, 4EC).
[w]Applicaton rate was the same as used in Weed & Feed 28-3-3.
[v]Application rate was half the rate as used in Weed & Feed 28-3-3.

increased dandelion population with a reduced control rate of -26%, which compared with 30% control by May application of fertilizer and half rate herbicides. Fertilization in May followed by application of fertilizer and herbicides at half rate in September had the highest dandelion control rate of 42% among the treatments of the same components in 2005(Table 1). One of the reasons for the discrepancy between two years might be because of the higher dandelion population in 2005.

Two applications of Weed & Feed or fertilizer plus full rates of herbicides in 2004 resulted in the same control(Table 1). In 2005, however, two applications of fertilizer plus full rates of herbicides had the same or better dandelion control. It took two applications to exceed 70% control of dandelion in 2005, which was achieved with one application in 2004 due to the higher weed populations in 2005. Two applications of

fertilizer plus half rates of herbicides in May and September, respectively, had the same or better control than that of one application of Weed & Feed in both years(Table 1). The results indicated that timing of applications affects the dandelion control.

The results from the 2004 study showed that one application of Weed & Feed or fertilizer plus half rate herbicides in May had negative Canada thistle control due to its regrowth. Weed & Feed or fertilizer plus half rates of herbicides in June produced better control than in May and September(Table1). One application of fertilizer plus full rates of herbicides in three different months achieved the same Canada thistle control ranging from 42 to 66%.

The best Canada thistle control(90%) was associated with two consecutive applications of fertilizer plus full rates of herbicides in May and June(Table1). Applying fertilizer plus half rate herbicides in one month and fertilizing in another month showed no differences among four different timings. The benefit of an extra fertilization in Canada thistle control existed only compared with one May application of Weed & Feed or fertilizer and half rate herbicides.

The 2005 study showed that Weed & Feed or fertilizer plus half rates of herbicides provided similar broad-leaf plantain control during the season regardless of application timing(Table 1). Fertilizer plus the full rate of herbicides in May or June was as effective as two applications for broad-leaf plantain control ranging from 88% to 98%. Fertilizer, in addition to fertilizer plus half rates of herbicides applied in a different month resulted in the same broad-leaf plantain control as two applications of Weed & Feed or fertilizer plus herbicides. These results indicated that fertilization had synergistic effect on broad-leaf plantain control.

There were 123 d from the start of treatment to final evaluation in both 2004 and 2005. Fertilizer and herbicides at full rates applied in May and June resulted in the longest dandelion-free period for 82 and 64 d in 2004 and 2005, respectively. One application of fertilizer plus full rates of herbicides resulted in more dandelion-free days than Weed & Feed or fertilizer plus half rates of herbicides in May only while all three treatments gave similar dandelion-free days in other months for both years(Table 2). Sub-lethal herbicides with fertilizer had a similar dandelion-free duration as from Weed & Feed treatment ranging from 0 to 27.7 d, regardless of additional fertilization in a different month.

Two consecutive applications of Weed & Feed or fertilizer plus full rates of herbicides in May and June had the longest Canada thistle-free period of 93 d in 2004. Applied in May and September, Weed & Feed gave similar Canada thistle-free

Table 2. Weed-free days from applications of Weed & Feed or separate applications of fertilizer and herbicides.

Treatments				Weed-free days			
1st Application		2nd Application		Common dandelion		Canada thistle	Broadleaf plantain
Chemical	Time	Chemical	Time	2004	2005	2004	2005
W & F[z]	May			3.7c	0.0b	0.0f	0.0c
F[y] and H[x] 1X[w]	May			58.3ab	54.0a	44.7cde	45.3ab
F and H ½X[v]	May			0.0c	4.0b	3.7f	0.0c
W & F	June			27.7bc	0.0b	58.3cde	0.0c
F and H 1X	June			17.3bc	9.3b	23.7ef	18.7bc
F and H ½X	June			17.3bc	9.3b	0.0f	11.0c
W & F	May	W & F	June	17.3bc	15.0b	72.0ab	11.0c
F and H 1X	May	F and H 1X	June	82.0a	64.0a	93.0a	69.3a
F and H ½X	May	F	June	27.3bc	8.0b	34.7de	4.0c
F	May	F and H ½X	June	38.3abc	9.3b	0.0f	0.0c
W & F	May	W & F	September	54.7ab	0.0b	21.0ef	11.0c
F and H 1X	May	F and H 1X	September	62.0ab	13.3b	68.3abc	41.3ab
F and H ½X	May	F	September	27.3bc	13.3b	37.3de	9.3c
F and H ½X	May	F and H ½X	September	27.3bc	13.3b	41.0de	4.0c
F	May	F and H ½X	September	17.3bc	0.0b	0.0f	0.0c
W & F	September			0.0c	0.0b	0.0f	0.0c
F and H 1X	September			3.7c	0.0b	0.0f	0.0c
F and H ½X	September			0.0c	0.0b	0.0f	0.0c
Blank Control				0.0c	0.0b	0.0f	0.0c

[z]Weed & Feed 28-3-3 contained 0.64% 2,4-D, 0.31% MCPP, and 0.03% dicamba of ai on weight basis. The N rate used was 48.8 kg/ha.
[y]Fertilizer had an analysis of 28N-1.32P-2.49K with the same analysis as in Weed & Feed 28-3-3.
[x]Herbicide was from 2,4-D (LV-4, 4EC), MCPP (4EC), and dicamba (Clarity, 4EC).
[w]Applicaton rate was the same as used in Weed & Feed 28-3-3.
[v]Application rate was half the rate as used in Weed & Feed 28-3-3.

period as from fertilizer plus half rates of herbicides of 21 and 41 d, respectively.

Fertilizer plus full rates of herbicides gave longer Canada thistle free period(68.3 d) than Weed & Feed or fertilizer plus half rates of herbicides applied in May and September. With one application, fertilizer plus full rates of herbicides gave the same or better results of Canada thistle-free period than Weed & Feed, which provided similar results as fertilizer plus half rates of herbicides except in June(Table 2).

One application of fertilizer plus full rates of herbicides in May or two applications in May/June and May/September resulted in significantly more broad-leaf plantain free days than other treatments ranging from 41.3 to 69.3 d in 2005(Table 2). Fertilizer plus full rates of herbicides was more effective in maintaining turf free of broad-leaf plantain than Weed & Feed, which had similar results as fertilizer plus half rates of

Table 3. Overall turf quality as affected by applications of Weed & Feed or separate applications of fertilizer and herbicides.

Treatments				Days of acceptable turf quality	
1st Application		2nd Application			
Chemical	Time	Chemical	Time	2004	2005
W & F[z]	May			27.3def	0.0d
F[y] and H[x] 1X[w]	May			92.3abc	18.3bcd
F and H ½X[v]	May			17.3def	0.0d
W & F	June			58.7bcde	0.0d
F and H 1X	June			34.0def	36.7b
F and H ½X	June			34.0def	11.0cd
W & F	May	W & F	June	58.7bcde	24.3bcd
F and H 1X	May	F and H 1X	June	112.3a	83.7a
F and H ½X	May	F	June	36.3def	0.0d
F	May	F and H ½X	June	64.0abcd	0.0d
W & F	May	W & F	September	62.0abcd	0.0d
F and H 1X	May	F and H 1X	September	98.0ab	40.0b
F and H ½X	May	F	September	29.3def	0.0d
F and H ½X	May	F and H ½X	September	19.7def	29.0bc
F	May	F and H ½X	September	40.0cdef	0.0d
W & F	September			5.0ef	0.0d
F and H 1X	September			5.0ef	0.0d
F and H ½X	September			5.0ef	0.0d
Blank Control				0.0f	0.0d

[z]Weed & Feed 28-3-3 contained 0.64% 2,4-D, 0.31% MCPP, and 0.03% dicamba of ai on weight basis. The N rate used was 48.8 kg/ha.
[y]Fertilizer had an analysis of 28N-1.32P-2.49K with the same analysis as in Weed & Feed 28-3-3.
[x]Herbicide was from 2,4-D (LV-4, 4EC), MCPP (4EC), and dicamba (Clarity, 4EC).
[w]Applicaton rate was the same as used in Weed & Feed 28-3-3.
[v]Application rate was half the rate as used in Weed & Feed 28-3-3.

herbicides.

Fertilizer plus full rate of herbicides had longer days of minimum acceptable turf quality than that of Weed & Feed or fertilizer plus half rates of herbicides with one application in May 2004(Table 3). Treatments with one application applied in June or September in 2004 were not different in days of acceptable turf quality. Similar results were found in 2005, except significant differences in June not in May and September. The differences between two years may have been the results of higher weed population in 2005.

With two applications, fertilizer plus full rate of herbicides provided the same or more total days of minimum acceptable turf quality than Weed & Feed in 2004 and 2005. On the other hand, Weed & Feed achieved no more days of acceptable turf quality than fertilizer plus half rates of herbicides applied twice in both 2004 and

2005. When applied in May and June, fertilizer plus full rate of herbicides treatment achieved 112.3 and 83.7 d with turf quality above minimum acceptable level in 2004 and 2005, respectively. During the same period, Weed & Feed resulted in 58.7 and 24.3 d of acceptable turf quality, respectively.

The ultimate goal of a fertilization and herbicide program is to maintain the longest period of quality turf. Since the number of degrees of freedom in a statistical analysis limits pair-wise comparisons, we conducted contrasts between treatments of special interests as designed in the objectives of this study, using a t-test and very conservative Tukey adjusted test (data not reported). Due to higher weed population, fewer days of minimum quality were observed in the 2005 study. However, the results in 2005 provided better separations between treatments and more confidence in the differences as shown in the significances at Tukey adjusted p-values.

Bundling fertilizer and herbicides together reduces the flexibility of choosing application time, rate, and types of chemicals. The best window for applications of weed control treatments was shown to be variable with different weeds, especially when only one application of Weed & Feed or fertilizer plus half rates of herbicides was available. June was the best timing for control of dandelion and Canada thistle, while the effectiveness was similar across timings for broad-leaf plantain. Weed population density and distribution also affected herbicide efficacy for all treatments. Localized weed distribution may not justify a broadcast application of Weed & Feed. Although it is possible to eliminate broad-leaf plantain in one year, multiple years and/or multiple applications strategies may be needed for Canada thistle control(Donald, 1992).

Different chemicals provide control of different weed spectrums. Canada thistle control with 2,4-D was reported as low(Beck and Sebastian, 2000; Donald, 1993). Combination of 2,4-D diethylamine salt, MCPP, and dicamba combination was reported unsatisfactory for common dandelion control(Anderson and Weeks, 1987). Repeated fall application of 2,4-D was less effective than dicamba in uncropped, untilled farmland(Donald, 1993). 2,4-D was effective for broad-leaf plantain control, but the only non-phenoxy tank-mix that provided the same control was clopyralid and triclopyr (Neal, 1990).

Maintaining a healthy and dense turf by basic cultural practices is considered the best management practice for weed prevention and control. Mowing as a primary turf cultural practice may change weed biology and affect control by other methods. Beck and Sebastian(2000) reported that mowing once did not improve Canada thistle control by dicamba or 2,4-D. In their study, mowing two or three times prior dicamba or 2,4-D treatment improved control but the results were still not acceptable. Our

results agree with Beck and Sebastian's finding since control of common dandelion or Canada thistle was not effective from a single application in May only of Weed & Feed or fertilizer and herbicides, when the turf was mowed only twice. Higher grass density helped to compete with Canada thistle therefore improved control efficacy of herbicide(Beck and Sebastian, 2000; Wilson and Kachman, 1999).

Fertilizing the lawn at a time that helps to maintain a healthier turf can make weeds more vulnerable to herbicides and is a demonstrated strategy in chemical weed control in turf(Christians, 2004). Fertilization was reported to be effective in improving herbicide efficacy and replacing certain amount of herbicides in common dandelion control(Johnson and Bowyer, 1982; Murray et al., 1983), which is consistent with our results.

Our study demonstrated that Weed & Feed was generally as effective in weed control as the same amount of fertilizer plus half rates of herbicides sprayed although results may vary due to the timing of application. Fertilizer plus full rates of herbicides provided the same or better results of weed control than Weed & Feed. Interactions between herbicides and cultural practices in weed control need to be considered in practice and may be specific to certain weed species.

국 문 요 약

잔디밭 관리 시 제초제와 비료의 혼합 처리는 시간 절약 및 답압 감소 등 여러 가지 장점이 있다. Weed & Feed는 제초제와 비료를 혼합 조제한 제품이다. 본 실험은 캔터키 블루그래스 잔디밭에서 비료 및 제초제를 단독으로 처리할 때와 Weed & Feed를 사용할 경우 그 효과를 비교하기 위해서 시작되었다. 실험에 사용한 Weed & Feed 28-3-3에는 세 가지 제초제 - 2,4-D 0.64%, MCPP 0.31% 및 dicamba 0.03%가 혼합 조제된 약제이다. 첫 번째 처리는 5월에 실시하였고, 두 번째 처리는 6월 또는 9월에 실시하였다. 단독으로 사용한 제초제는 2,4-D(LV-4, 4EC), MCPP(4EC) 및 dicamba(Clarity, 4EC)로 Weed & Feed의 50% 및 100% 수준으로 적용하였다. 실험기간 동안 우점 잡초는 민들레였으며, 제2 우점종은 2004년에는 엉컹키, 2005년에는 왕질경이로 나타났다. 실험결과 5월과 6월에 비료와 100% 수준의 제초제를 처리할 경우 수용할 수 있는 잔디밭 품질 유지기간은 각각 112.3일과 83.7일 정도로 나타났다. 하지만 Weed & Feed를 사용할 경우에는 각각 58.7일과 83.7일로 나타났다. Weed & Feed 효과는 사용 시기에 따라 차이는 있지만 비료와 50% 수준의 제초제를 처리한 것과 유사한 효과가 있는 것으로 나타났다. 잡초방제 시 Weed & Feed에 비해 비료와 100% 수준의 제초제를 직접 처리하는 것은 Weed & Feed를 사용하는 그 이상의 효과가 있는 것으로 나타났다.

주요어: 광엽잡초, 민들레, 발아 후 처리제, 잔디, 캔터키 블루그래스

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