Velocity Herbicide for Poa Control in Overseeded Turf

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Abstract

Velocity, (bis pyrobac-sodium) was applied at different ai/a rates in multiple application series to evaluate treatments for post emergence seed head and vegetative control of Poa annua var. annua. Velocity herbicide, when applied to perennial ryegrass overseed turf with heavy PA infestations, caused periodic discoloration of the ryegrass and yellowing/bronzing of the PA. The leaf yellowing of PA caused by Velocity is in contrast to color enhancement of PA from Proxy/Primo tank mixes. Seed head suppression of PA from Velocity was slightly greater in early April, than in early March. As cumulative treatment amounts of active ingredient of Velocity increased, the seed head suppression increased for treatments beyond the 30 + 30 gm ai/a rate. Above this rate, seed head suppression was increased, but not consistently with the applied active ingredient rate. Seed head suppression of PA on March 5 from Velocity ranged from 35% to 75% among Velocity treatments applied at 30, 45 and 60 grams ai/a. Embark alone had fair seed head suppression from early to mid-March, but decreased dramatically afterwards. There was no benefit of the 30 + 60 gm ai/a treatment, over the 60 + 60 gm ai/a treatment for seed head suppression of PA. Biological response in terms of absolute rate of ai/a applied and response to cumulative amounts of total Velocity were not consistent for PA seed head suppression or vegetative control. No product affectively reduced vegetative control of PA in a highly infested stand of PA which was 40-50% PA. If Velocity is to be competitive against other PA seed head reducing products, rate structures and timings may have to be amended for more multiple applications.

Introduction

Poa annua (PA) is the most prevalent and ubiquitous weed in cool season turfs, which includes overseeded bermudagrass. Overseeding with a cool season grass in the late summer/early fall invites infestations of Poa annua, which germinates essentially the same time as that of the ryegrass. If PA becomes established, then subsequent seed head formation becomes an issue with the golfer who understands little of the biology of PA. This study investigated rates and timings of bis-pyrobac-sodium (Velocity) for evaluation for both vegetative control/suppression and seed head control/suppression of PA when applied post emergence on bermudagrass turf which was overseeded the previous fall with turf-type perennial ryegrass.

Materials and Methods

A putting green surround area outside the number 18 green at the C. C. G. V. Golf Course was used for this test. The area has a history of high PA infestation. Treatments consisted of a low application rate of Velocity of 30 grams ai/a, applied twice, three different treatments which were comprised of two split applications which totaled 90 gm ai/a, a three applications split sequence totally 90 gm ai/a (with and without iron). Additional treatments of Proxy/Primo, Proxy/Primo/Embark and Embark alone (applied twice) were also included. See Appendix Table –A- for all treatment/application dates.

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Application dates were February 19, March 5, and March 19 2004. Plot size was 7'x 6', with each plot having its own randomized untreated half (NTC). Treatments were applied using a Co_2 backpack sprayer using a three-nozzle beam featuring 8004 nozzles on 20-inch spacing. The spray volume solution delivery rate was 84 GPA. Ferrous sulfate was applied to one treatment of Velocity to see if leaf yellowing would be decreased.

Turfs were evaluated on six dates from February 19 to April 7 for applicable responses of seed head suppression, percent plot Poa, color, quality and injury when appropriate. Both absolute plot values and percent control [1-(trt/control) X 100] are included where applicable in the data results and discussion. Seed head suppression index values (as requested) were formulated before analysis by converting a nominal discrete suppression scale (1-6) into to a seed suppression index for 0-100 values. Since timing and application amounts were not balanced, treatments were analyzed as specific rate/timing combinations.

The test design was a RCB design with four replications. All data was subjected to the analysis of variance technique using SAS mainframe software. An LSD value was computed for use as the treatment mean separation statistic only if the F ratio for treatments occurred at a P level of 0.05 or less. Appropriate tables and figures are provided too simplify and enhance the discussion.

Results and Discussion

<u>February 19, 2004</u>
On February 19 the first treatment series were applied and existing Poa density (percent plot PA values) were assigned to plots. The PA density proved to be truly random and as the anova F ratio for the treatment main effect was less than 1.0. PA percent plot cover ranged from 41-51% plot cover at the beginning of the test March 5, 1004 (Table 1, Figure 1).

<u>March 5, 2004</u> (14DAT/1).
On March 5 the treatment main effect was statistically significant for absolute PA percent plot cover, seed head suppression index, and the degree of injury to ryegrass. Absolute PA canopy cover percentage ranged from 26. % (Proxy/Primo) to 43% for the 60 gm ai/a treatment of Velocity (Table 1, Figure 2). Based on the absolute percentage of PA present, Proxy/Primo was the only treatment statistically different from other treatments. Percent PA control showed that the treatment main effect was significant, but in actuality PA was more evident in the treated plots. This may be an artifact that Velocity causes extreme yellowing of the Poa annua, which makes the PA 'highly visible'. The 45 and 60 gm ai/a (applied once at this time) had 11 and 18% vegetative Poa annua control, while all other Velocity treatments showed no or negative control (Table 2, Figure 3). This again may be due to the "firing up" of the PA, which did not occur in the non-treated plots. This agrees circumstantially also that Proxy/Primo/Embark had no vegetative control, since this product combination darkens the turf color (and would look similar to that of the untreated controls).

On March 5, the seed head suppression index was significant for treatments as the mean index scores ranged from 16 (non-treated control) to 75 (moderate suppression). The Velocity treatments responded in a linear fashion to herbicide rate, with 60 gm ai/a averaging a seed head suppression index mean value of 43. The 30 gm ai/a provided SHSI values of 50, 45 35 and 50 among the four treatments which received 30 gm ai/a from the first application. Proxy/Primo and Embark alone had mean SHSI values of 25 (Table 3).

Degree injury and percent injury to the existing rye was affected by treatments on March 5, 2004. The Embark caused noticeable injury (mean injury = 4.0) and the largest plot percentage showing injury to the existing rye (60% injured). Proxy/Primo caused slight injury to the ryegrass (degree = 1.8) on 15% of the plot (Table 4).

The four treatments which had 30 gm ai/a applied once to date had low injuring scores (1.3, 2.0, 2.0) (Table 4). At high rate of Velocity (60 gm ai/a), ryegrass injury occurred on 40% of the plot, taking the form of twisted leaves, and loss of leaf sheen. The degree of injury score for this treatment was 3.0 (slight / moderate). Again, Embark caused the most discoloration (Table 4).
<u>March 19, 2004</u> (29 DAT/1 : 14 DAT/2)

By March 19, the second sequential repeat applications had been applied 14 days previously. The treatment main affect was significant for absolute PA plot cover, for actual Poa control (versus controls); seed head suppression index, degree injury and percent plot injury to Poa (only), and for overall turf quality.

Absolute PA plot cover mean values occurred in a range from 27% (Proxy/Primo/Embark) to 56% (Velocity at 0.30 + 0.30 gm ai/a) (Table 1, Figure 4). Among Velocity treatments, the 30 + 60 gm ai/a had the lowest amount of visible PA (39%), while the 60 + 60 gm ai/a treated turfs averaged 44% in absolute PA plot cover (Table 1, Figure 4). When expressed in terms of Poa annua control (versus the non-treated turf), actual percent plot control of vegetative PA ranged from - 11% to 51% control (Table 2, Figure 5). Four of the Velocity treatments had no or negative percent weed control. Only the 45 + 45 gm ai/a Velocity treatment had 33% vegetative PA control, followed by Velocity at 26% for the 30 + 60 gm treatment (Table 2, Figure 5). The Proxy/Primo tank mix had 45% mean weed control, Embark had 37%, and Proxy/Primo/Embark had 50% control. These results are from turfs highly infested with Poa annua. Note that "negative control" means that there is more estimated PA in the treatments, than there are untreated controls. Note again, that the discoloration of PA from Velocity may bias ratings somewhat, from <u>underestimating</u> the PA amounts in the non-treated controls. Among Velocity treatments, there was a slight response for vegetative control based on cumulative ai/a, but the three 30 + 30 gm sequential application treatments had no affect (negative control). Note that the greatest amount of control was achieved on Velocity turfs was achieved on March 19 from the 45 + 45 ai/a treatment (33%) (Table 2, Figure 5).

On March 19, the treatment main affect was significant for the seed head suppression index, whereby mean index values ranged from 10 (little or no activity) to 65 (moderate to moderately strong activity). Proxy/Primo and Embark alone had the most seed head suppression (65), while the three-way tank mix of the above averaged only 45 on the SHSI (Table 3). Among Velocity treated turfs, mean index values ranged from 10 to 50. Velocity treatments that received 30 + 30 gm ai/a amounts had only trace to slight head suppression (10, 20, and 25). Only the highest combination rate of 60 + 60 gm ai/a of Velocity produced a seed head index of 50 (moderate, which was slightly less than that of Proxy/Primo and Embark alone) (Table 3).

Degree of injury to PA, and percent plot injury to the existing Poa annua was also affected by the treatments. At this time (two applications made), there was <u>no</u> injury to the PA from the non-Velocity treatments (Table 4). Among Velocity treatments, there was no rate response evident, as mean degree injury scores to the PA ranged from 1.3 (trace injury) at 30 + 30 gm ai/a to 4.8 (moderate-severe injury). The amount of Poa injured was directly related to the intensity of injury. Again, there was no biological response in relation to product amounts of Velocity applied.
Overall turf quality was affected by treatments which ranged from 4.5 to 7.8. A quality score of 5.0 is marginal while 6.0 is fully acceptable. Larger values indicate a more uniform and aesthetically pleasing turf condition. The Proxy/Primo, Embark alone, and three way tank mix had good turf quality (7.5-7.8), as did Velocity at the 60 + 30 gm ai/a treatment (mean quality = 7.5). The 30 + 60 gm ai/a treatment had a mean quality score of 6.3. The lowest quality score was that of the iron containing tank mix with Velocity at 30 + 30 gm ai/a (Table 5). Perhaps the iron made an extreme contrast between the greener ryegrass and the herbicide induced yellow PA.

<u>March 30, 2004</u> (40 DAT/1 : 25 DAT/3 : 11 DAT/3) .
On March 30, overall quality and seed head suppression scores were assigned to plots. Poa annua amounts and the percent plot weed control were not calculated because of an uneven mowing pattern executed across the test site. As a low maintenance site with large amounts of PA, mean treatment quality scores ranged from 3.4 to 6.8, with a test mean value of 5.0 (Table 5). Proxy/Primo and the Proxy/Primo/Embark tank mixes had the best quality scores (6.8 and 6.5, respectively), while the 45 + 45 gm ai/a Velocity turfs averaged 6.0. The 60 + 60 and 30 + 30 + 30 gm ai/a Velocity treated turfs had very low quality scores of 3.8 and 4.0, respectively (Table 5). By this date, nine treatments had received their second sequential application (made on March 19) ten days previously. Still, there was no rate response (for quality among Velocity treated turfs, of which six of the seven product treatments scored less than 6.0 for turf quality (Table 5).

<u>April 3, 2004</u> (44 DAT/1 : 29 DAT/2 : 15 DAT/3).
The main affect of herbicide treatments was significant for Poa control and the seed head suppression index, but not for the absolute PA plot percent cover on April 3, 2003. Percent PA plot cover ranged from 58% to 72% among treated turfs, while the NTC averaged 71% PA plot cover (Table 1, Figure 7). Again, absolute PA levels were not affected by treatments, but in relationship to their respective NTC plots, the treatment effect was statistically significant.

On this date only, (1) the percent of the total existing PA cover was rated for seed head flowering, and also, (2) percent flower control was calculated using the respective NTC value. *This was done to investigate all aspects/response of the products in this test at the peak time of flowering.* On April 3, the percent of the total existing PA cover that was in flower was highly significant (Table 6). Treated turfs averaged 1 to 55% of the PA in flower at this time. Velocity at 30 + 60 gm ai/a, 30 + 30 + 30 gm ai/a, and 60 + 30 gm ai/a averaged 1 %, 4% and 5% PA flowering, respectively. The 60 + 60 gram ai/a treatment averaged 28 % plot flower cover. The NTC averaged 55% PA in flower (Table 6).

The Embark alone treatment averaged 55% plot flower cover, which exhibited an explosion in flowering after suppression broke from two applications. Among Velocity treatments, there was a general trend in flower reduction with increased rates applied from the second application, but the response was inconsistent in that the high combination rates of 60 + 60 gm ai/a had 28% PA flowering, while other treatments receiving lesser amounts of product had more flower reduction (Table 6). The addition of iron to the 30 + 30 + 30 gm ai/a treatment had four times as much PA in flower than when the iron was not included (4% and 15% PA in flower, respectively) (Table 6). Proxy/Primo and Proxy/Primo/Embark averaged 17 and 15% in flower.

On April 3 2004, the "percent PA seed head control" (expressed as percentage of untreated control) was significant, as with values ranging from – 49%, to 97% seed head control (Table 6, Figure 8). Velocity at 30 + 60 grams ai/a, and at 30 + 30 + 30 grams ai/a and 60 + 30 grams ai/a had 90 % or greater seed head control on this date. Embark flowered profusely, after PGR release from the last (March 18) application (Table 6, Figure 8). Proxy/primo had 6% control, and most likely required a third application to maintain seed head suppression. The seed head suppression index (SHSI) mean scores for treatments generally ranked similar with the percent seed head control and with the percent of total PA that was in flower on that day. Therefore when observing responses across the season, the seed head suppression index values are valid for interpretation.

<u>April 7, 2004.</u> (47 DAT/1 : 232 DAT/2 : 18 DAT/3).
The last set of data was collected on April 7, 2004. Seed head suppression index scores were significant and ranged from 11 to 90 among treated turfs (Table 3). The Embark treated turf had very low suppression again (11), while the NTC plots were still flowering quite heavily (7). Proxy/Primo was now having slight to moderate seed head suppression (30), which needed another application (from empirical experience). The greatest seed head suppression occurred for the 30 + 60 gm ai/a Velocity treatment (90). The 60 + 60 gm ai/a treatment produced a mean seed head suppression index of 60, which should have been greater than the 30 + 60 gm ai/a treatment (Table 3). Thus again, there was not always a biological response to cumulative product amounts and/or absolute amount of active ingredient applied from sequential applications among Velocity treatments. After April 9, the golf course terminated irrigation as part of a major irrigation system upgrade, after which the turf was subjected to extreme drought.

Velocity did have an affect on the seed head suppression of PA. Velocity did not decrease the vegetative cover of highly infested PA turf in a ¾ " cut turf. Proxy/Primo, Embark and the 3 way tank mix of these products did not effectively decrease the vegetative plot cover of PA either. Velocity caused the PA to appear chlorotic, while Proxy/Primo tended to darken the PA. Thus Velocity treated turf "highlighted" the amount of PA, which may indirectly inflate PA visual ratings, and decrease whole plot quality scores as well. Still in this test, plots were relatively uniform in infestation of PA, and "percent control" data did include the response of non-treated controls. In this test, each plot had it's own non-treated control which maximizes observable field conditions and provides the best statistical precision as (s) / ($N^{½}$). The response of Velocity was not always linear with the active ingredient rate, or sum total of active ingredient when Velocity was applied in sequential applications. Treatments were applied in either 2 or three sequential timings, starting on Feb 19, 2003. Earlier applications were not made (January) based on Valent knowledge that Velocity can injure ryegrass overseed in cool (cold) temperatures, have diminished affect of PA, or both. The application timings in this test were only 2 ½ weeks apart, and it is not known if early applications of Velocity (at initial low ai/a amounts) coupled with higher rates afterwards would increase efficacy. Proxy/Primo applications usually start in January. In this test, the Proxy/Primo tank mix reached a maximum seed head suppression index value of 65 on March 19, which was not as high as anticipated based on previous experience. Note that the PA pressure was severe and uniform in this test. As the spring progressed with warmer temperatures, Velocity increased in its activity to suppress seed head emergence, but was inconsistent with total rate and/or second application amount. Embark lost its ability to suppress seed heads at rough height by early April when only two applications of product were applied.

Conclusions

1. Velocity herbicide, when applied to perennial ryegrass overseed turf with heavy Poa annua infestations, caused periodic discoloration of the ryegrass and yellowing of the Poa annua.

2. After applications of Velocity, perennial ryegrass leaves lost their sheen (became dull in appearance), accompanied by some leaf twisting. These responses were inconsistent with applications rates and occurred during early March, two weeks after treatments were applied (14 DAT).

3. In general, Velocity causes a distinct and highly noticeable yellowing/bronzing of Poa annua.

4. The leaf yellowing of PA caused by Velocity is in contrast to color enhancement of PA from Proxy/Primo tank mixes.

5. Seed head suppression of Poa annua on March 5 from Velocity ranged from 35% to 75% among Velocity treatments applied at 30, 45 and 60 gm ai/a.

6. Structured sequentially applied treatments which had the same amounts of active ingredients applied (at the first application date) did not always produce similar results in Poa control, or seed head suppression.

7. Velocity did not control vegetative Poa annua in highly infested plots. Negative percent weed control values resulted from Velocity treatments, as more Poa annua was visible in Velocity treated plots then their untreated ½ plot counterparts. The fact that Velocity changes the color of PAo drastically, may affect the visual estimation of Poa amounts between treated and non-treated turfs severely infested with PA.

8. Seed head suppression of PA from Velocity was slightly greater in early April, than in early March. The level of seed head suppression in March did allow for moderate flowering of PA.

9. As cumulative treatment amounts of active ingredient of Velocity increased, the seed head suppression increased for treatments beyond the 30 + 30 gm ai/a rate. Above this rate, seed head suppression was increased, but not consistently with the applied active ingredient rate.

10. Embark alone had fair seed head suppression from early to mid-March, but decreased dramatically afterwards.

11. Collectively, Velocity caused visible injury to Poa annua and also to the perennial ryegrass. The injury to ryegrass included some stunting, leaf twisting, and loss of leaf sheen. Velocity did produce seed head suppression, similar to or greater than Proxy/Primo/Embark, Embark alone, on the Proxy/Primo tank mix.

12. There was no benefit of the 30 + 60 gm ai/a treatment, over the 60 + 60 gm ai/a treatment for seed head suppression of PA.

13. Biological response in terms of absolute rate of ai/a applied and response to cumulative amounts of total Velocity were not consistent for PA seed head suppression or vegetative control.

14. No product affectively reduced vegetative control of PA in a uniformity infested stand of perennial ryegrass/PA, which was 40-50% PA.

15. If Velocity is to be competitive against other seed head reducing products, rate structures may have to be amended for more multiple applications.

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TABLE 1. Percent plot vegetative cover① of overseed perennial rye and Poa annua. University of Arizona, 2004.

Treatment②	*% POA* 19-Feb	*% POA* 5-Mar	*% POA* 19-Mar	*% POA* 3-Apr	*% RYE* 19-Feb	*% RYE* 5-Mar	*% RYE* 19-Mar	*% RYE* 3-Apr
NTC	46.4	34.4	56.3	70.6	50.6	65.6	43.8	29.4
Velocity@30(2/19)+30(3/4)	48.8	31.3	51.3	62.5	48.0	68.8	48.8	37.5
Velocity@45(2/19)+45(3/18)	46.3	30.0	45.0	60.0	49.3	70.0	55.0	40.0
Velocity@60(2/19)+30(3/18)	50.0	33.8	52.5	65.0	46.5	66.3	47.5	35.0
Velocity@30(2/19)+60(3/18)	38.8	31.3	38.8	61.3	60.0	68.8	61.3	38.8
Velocity@60(2/19)+60(3/18)	48.8	42.5	43.8	75.0	45.5	57.5	56.3	25.0
Velocity@30(2/19)+30(3/4)+30(3/18)	48.8	37.5	53.8	61.3	48.0	62.5	46.3	38.8
Velocity@30+Fe(2/19)+30+Fe(3/4)+30+Fe(3/18)	51.3	30.0	50.0	72.5	46.3	70.0	50.0	27.5
Proxy/Primo(2/19)+(3/18)	45.0	26.3	33.8	65.0	53.5	73.8	66.3	35.0
Embark(2/19)+(3/18)	41.3	42.5	38.8	61.3	55.0	57.5	61.3	38.8
Proxy/Primo/Embark(2/19)+(3/18)	47.5	35.0	27.5	57.5	50.0	65.0	72.5	42.5
Test Mean③	46.6	34.0	44.7	64.7	50.2	66.0	55.3	35.3
LSD value④	ns	12.1	18.6	ns	12.0	12.1	18.6	ns

① The mean of percent plot cover canopy composition (0-100%).

② Treatments are grams ai/A for velocity. Proxy applied at 5 ounces product/ 1000 ft^2. Primo applied at 0.25 ounces product/ 1000 ft^2. Embark applied at 1/16th lb. ai/A.

③ Test mean of all treatments and non-treated control on that date.

④ LSD value = Least significant difference value = treatment mean separation statistic.

TABLE 2. Percent vegetative control[1] of Poa annua on overseeded Bermudagrass.   University of Arizona, 2004.

Treatment[2]	*19-Feb*	*5-Mar*	*19-Mar*	*3-Apr*
Velocity@30(2/19)+30(3/4)	-43.4	-16.0	-11.1	3.6
Velocity@45(2/19)+45(3/18)	9.6	11.3	33.2	23.4
Velocity@60(2/19)+30(3/18)	4.8	17.9	15.6	9.4
Velocity@30(2/19)+60(3/18)	-11.8	-4.2	25.6	4.5
Velocity@60(2/19)+60(3/18)	-20.8	-65.0	3.6	-14.5
Velocity@30(2/19)+30(3/4)+30(3/18)	-3.3	-13.7	-9.3	6.2
Velocity@30+Fe(2/19)+30+Fe(3/4)+30+Fe(3/18)	-18.1	1.4	-5.3	-14.6
Proxy/Primo(2/19)+(3/18)	11.5	30.2	45.3	16.0
Embark(2/19)+(3/18)	6.9	-18.8	37.2	16.9
Proxy/Primo/Embark(2/19)+(3/18)	-3.3	-0.4	50.7	25.0
Test Mean[3]	-6.8	-5.7	18.6	7.6
LSD value[4]	ns	66.27	37.09	33.59

① Percent control (0-100%) calculated as (1-(treatment/non-treated control)) x 100. Values are the mean of four observations.

② Treatments are grams ai/A for velocity. Proxy applied at 5 ounces product/ 1000 ft^2. Primo applied at 0.25 ounces product/ 1000 ft^2. Embark applied at 1/16th lb. ai/A.

③ Test mean of all treatments and non-treated control on that date.

④ LSD value = Least significant difference value = treatment mean separation statistic.

TABLE 3. Seed head suppression index value① of Poa annua after select herbicide treatments. University of Arizona, 2004.

Treatment②	*5-Mar*	*19-Mar*	*30-Mar*	*3-Apr*	*7-Apr*
NTC	16.4	14.4	3.5	4.5	6.5
Velocity@30(2/19)+30(3/4)	50.2	10.5	20.4	30.3	25.3
Velocity@45(2/19)+45(3/18)	55.1	40.2	55.1	60.1	45.2
Velocity@60(2/19)+30(3/18)	75.0	35.3	55.1	50.2	40.2
Velocity@30(2/19)+60(3/18)	45.2	45.2	45.2	80.0	89.9
Velocity@60(2/19)+60(3/18)	50.2	50.2	50.2	45.2	60.1
Velocity@30(2/19)+30(3/4)+30(3/18)	35.3	20.4	60.1	60.1	65.1
Velocity@30+Fe(2/19)+30+Fe(3/4)+30+Fe(3/18)	50.2	25.3	45.2	40.2	40.2
Proxy/Primo(2/19)+(3/18)	25.3	65.1	30.3	30.3	30.3
Embark(2/19)+(3/18)	55.1	65.1	20.4	5.5	10.5
Proxy/Primo/Embark(2/19)+(3/18)	25.3	45.2	50.2	40.2	55.1
Test Mean③	43.9	37.9	39.6	40.6	42.6
LSD value④	37.3	38.6	28.7	27.0	30.2

① Seed head control index 0-100, 0-20 = none/minimal, 21-40 = marginal, 41-60 = fair, 61-80 = moderate, 81-90 = good, 90+ = excellent. Values are the mean of four observations.

② Treatments are grams ai/A for velocity. Proxy applied at 5 ounces product/ 1000 ft^2. Primo applied at 0.25 ounces product/ 1000 ft^2. Embark applied at 1/16th lb. ai/A.

③ Test mean of all treatments and non-treated control on that date.

④ LSD value = Least significant difference value = treatment mean separation statistic.

TABLE 4. Degree[①] and percent[②] injury to either perennial ryegrass overseed or to Poa annua on select dates after application of select herbicides for Poa annua control/suppression. University of Arizona, 2004.

	3/5/04		3/19/04	
Treatment[③]	Degree Injury (rye)	%-Injury (rye)	Degree Injury (poa)	%-Injury (poa)
NTC	1.4	9.0	1.3	6.5
Velocity@30(2/19)+30(3/4)	1.3	5.5	3.8	55.1
Velocity@45(2/19)+45(3/18)	2.5	30.3	1.3	5.5
Velocity@60(2/19)+30(3/18)	3.0	40.2	1.3	5.5
Velocity@30(2/19)+60(3/18)	2.0	20.4	1.0	0.5
Velocity@60(2/19)+60(3/18)	3.0	40.2	1.5	10.5
Velocity@30(2/19)+30(3/4)+30(3/18)	2.0	20.4	4.8	75.0
Velocity@30+Fe(2/19)+30+Fe(3/4)+30+Fe(3/18)	2.0	20.4	3.8	55.1
Proxy/Primo(2/19)+(3/18)	1.8	15.4	1.0	0.5
Embark(2/19)+(3/18)	4.0	60.1	1.0	0.5
Proxy/Primo/Embark(2/19)+(3/18)	2.5	30.3	1.0	0.5
Test Mean[④]	2.3	26.6	2.0	19.6
LSD value[⑤]	1.5	30.8	0.5	10.5

① Degree injury; 1-6, 1= none, 2= slight, 3= slight/moderate, 4= moderate, 5= moderate/severe, 6= severe. Values are the mean of four observations.

② Percent plot injury; 0-100, Percent of entire plot showing any/all injury.

③Treatments are grams ai/A for velocity. Proxy applied at 5 ounces product/ 1000 ft^2. Primo applied at 0.25 ounces product/ 1000 ft^2. Embark applied at 1/16[th] lb. ai/A.

④ Test mean of all treatments and non-treated control on that date.

⑤ LSD value = Least significant difference value = treatment mean separation statistic.

TABLE 5. Turfgrass quality ① of overseeded turf after application of select herbicides. University of Arizona, 2004.

Treatment ②	*19-Mar*	*30-Mar*
NTC	5.2	3.4
Velocity@30(2/19)+30(3/4)	5.0	6.0
Velocity@45(2/19)+45(3/18)	6.3	4.0
Velocity@60(2/19)+30(3/18)	7.5	5.8
Velocity@30(2/19)+60(3/18)	6.3	3.8
Velocity@60(2/19)+60(3/18)	6.0	4.0
Velocity@30(2/19)+30(3/4)+30(3/18)	5.0	5.0
Velocity@30+Fe(2/19)+30+Fe(3/4)+30+Fe(3/18)	4.5	4.8
Proxy/Primo(2/19)+(3/18)	7.8	6.8
Embark(2/19)+(3/18)	7.5	5.3
Proxy/Primo/Embark(2/19)+(3/18)	7.8	6.5
Test Mean ③	6.2	5.0
LSD ④	1.6	1.5

① Quality 1-9; 1= dead, 5= marginal, 6= acceptable, 9= best possible. Values are the mean of four observations. Plots average 40-60% Poa annua cover, 40-60% perennial ryegrass overseed.

② Treatments are grams ai/A for velocity. Proxy applied at 5 ounces product/ 1000 ft^2. Primo applied at 0.25 ounces product/ 1000 ft^2. Embark applied at 1/16th lb. ai/A.

③ Test mean of all treatments and non-treated control on that date.

④ LSD value = Least significant difference value = treatment mean separation statistic.

TABLE 6. Percent Poa annua in flower ① and percent flower seed head control ② after applications of select herbicides. University of Arizona, 2004.

Treatment ③	3-Apr % FLW	FLW con
NTC	54.8	-
Velocity@30(2/19)+30(3/4)	15.8	74.5
Velocity@45(2/19)+45(3/18)	9.8	83.1
Velocity@60(2/19)+30(3/18)	5.3	90.2
Velocity@30(2/19)+60(3/18)	1.3	96.5
Velocity@60(2/19)+60(3/18)	28.0	65.9
Velocity@30(2/19)+30(3/4)+30(3/18)	3.8	93.8
Velocity@30+Fe(2/19)+30+Fe(3/4)+30+Fe(3/18)	15.0	65.9
Proxy/Primo(2/19)+(3/18)	17.0	5.7
Embark(2/19)+(3/18)	55.0	-48.5
Proxy/Primo/Embark(2/19)+(3/18)	15.0	64.8
Test Mean ④	20.0	59.2
LSD ⑤	22.8	73.03

① Percent Poa annua in flower; Percentage of the entire Poa annua canopy which is covered with seed heads (0-100%). Value is independent of the actual amount of plot Poa annua coverage. Values are the mean of four observations.

② Percent flower seed head control; Herbicide induced seed head control. Calculated as (1-(treatment/non-treated control)) x 100. Values are the mean of four observations.

③Treatments are grams ai/A for velocity. Proxy applied at 5 ounces product/ 1000 ft^2. Primo applied at 0.25 ounces product/ 1000 ft^2. Embark applied at 1/16th lb. ai/A.

④ Test mean of all treatments and non-treated control on that date.

⑤ LSD value = Least significant difference value = treatment mean separation statistic.

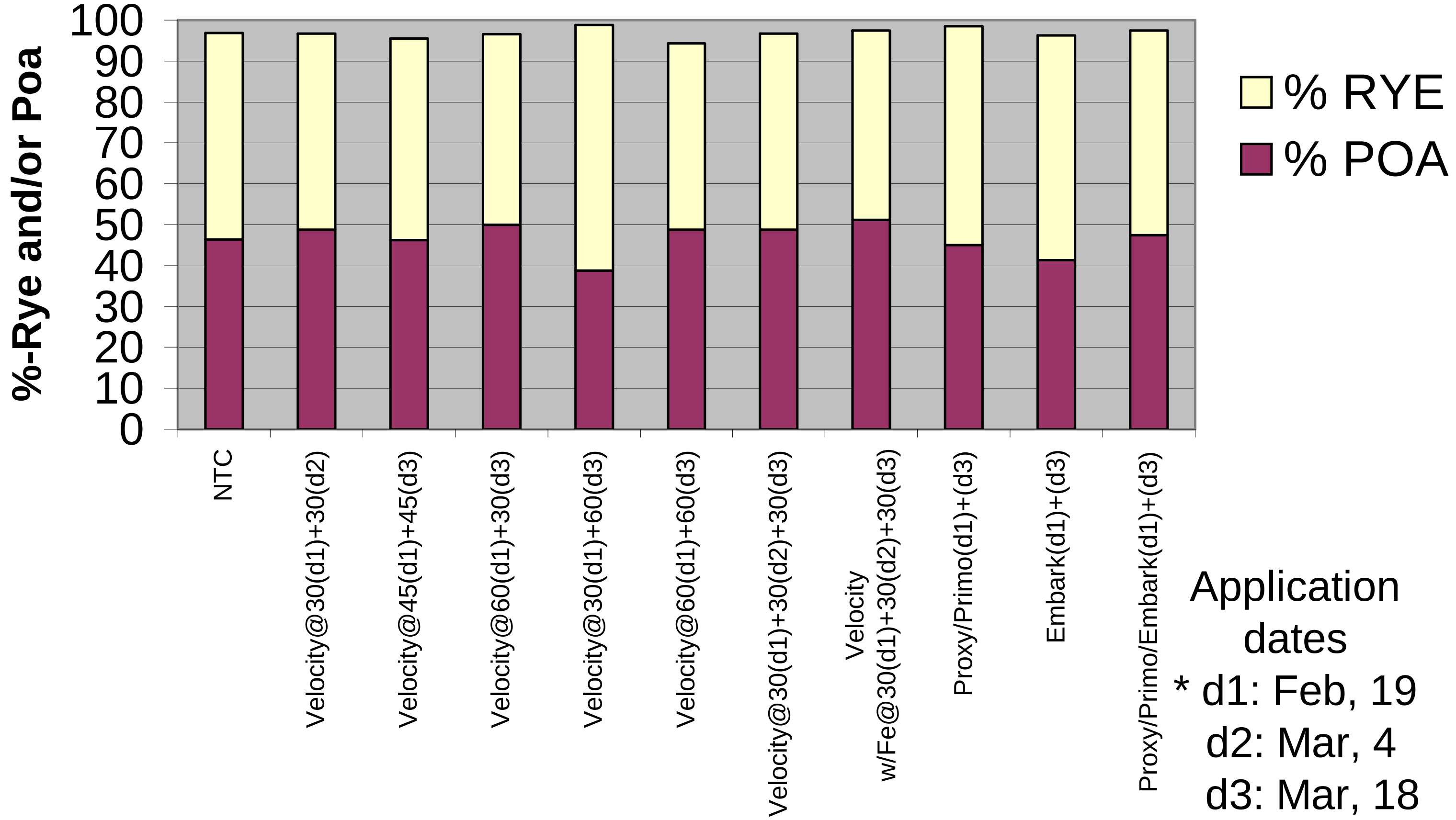
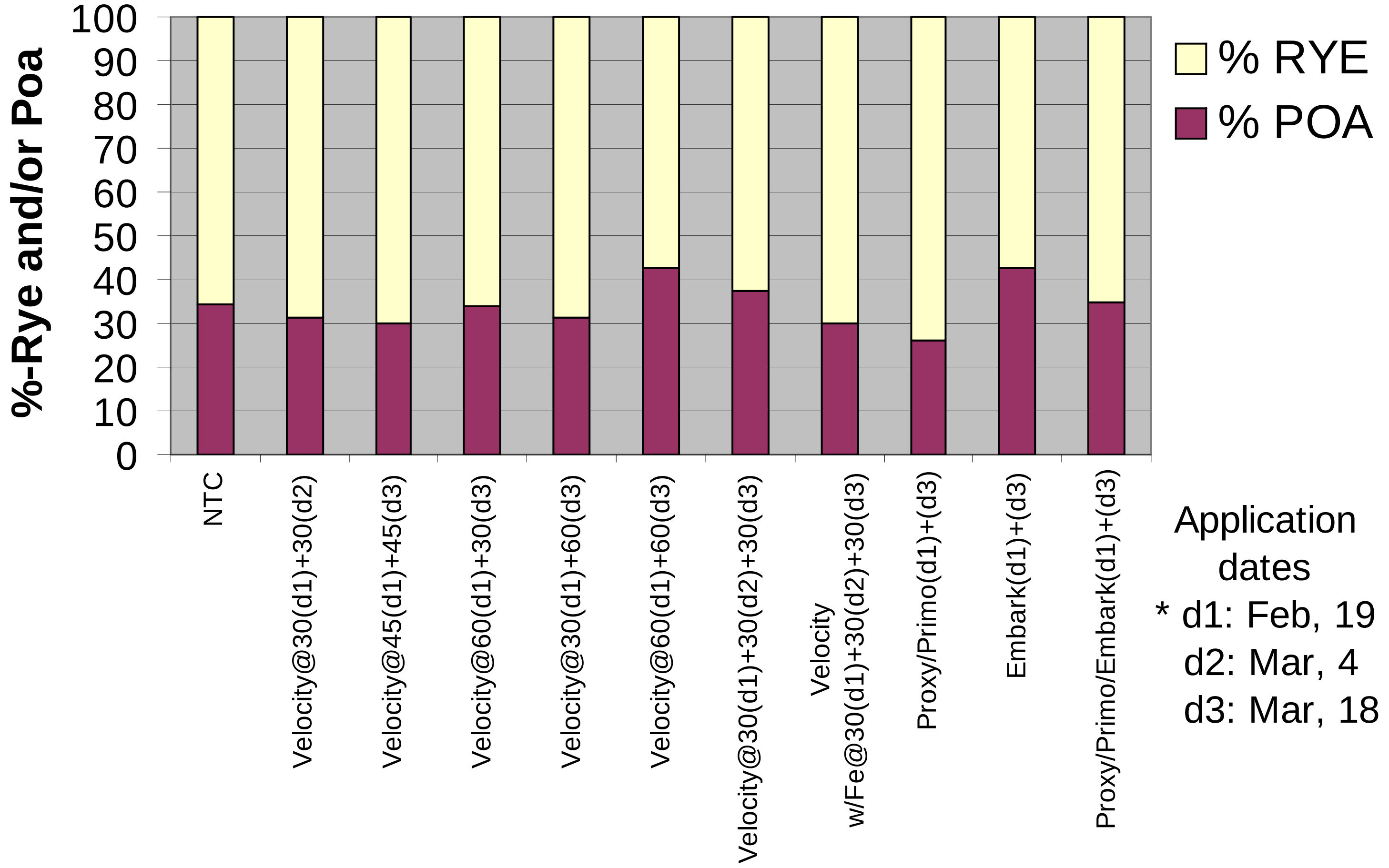


Figure 1. Canopy Composition on 2/19 as affected by Select post-emergent herbicides

Figure 2. Canopy Composition on 3/5 as affected by Select post-emergent herbicides



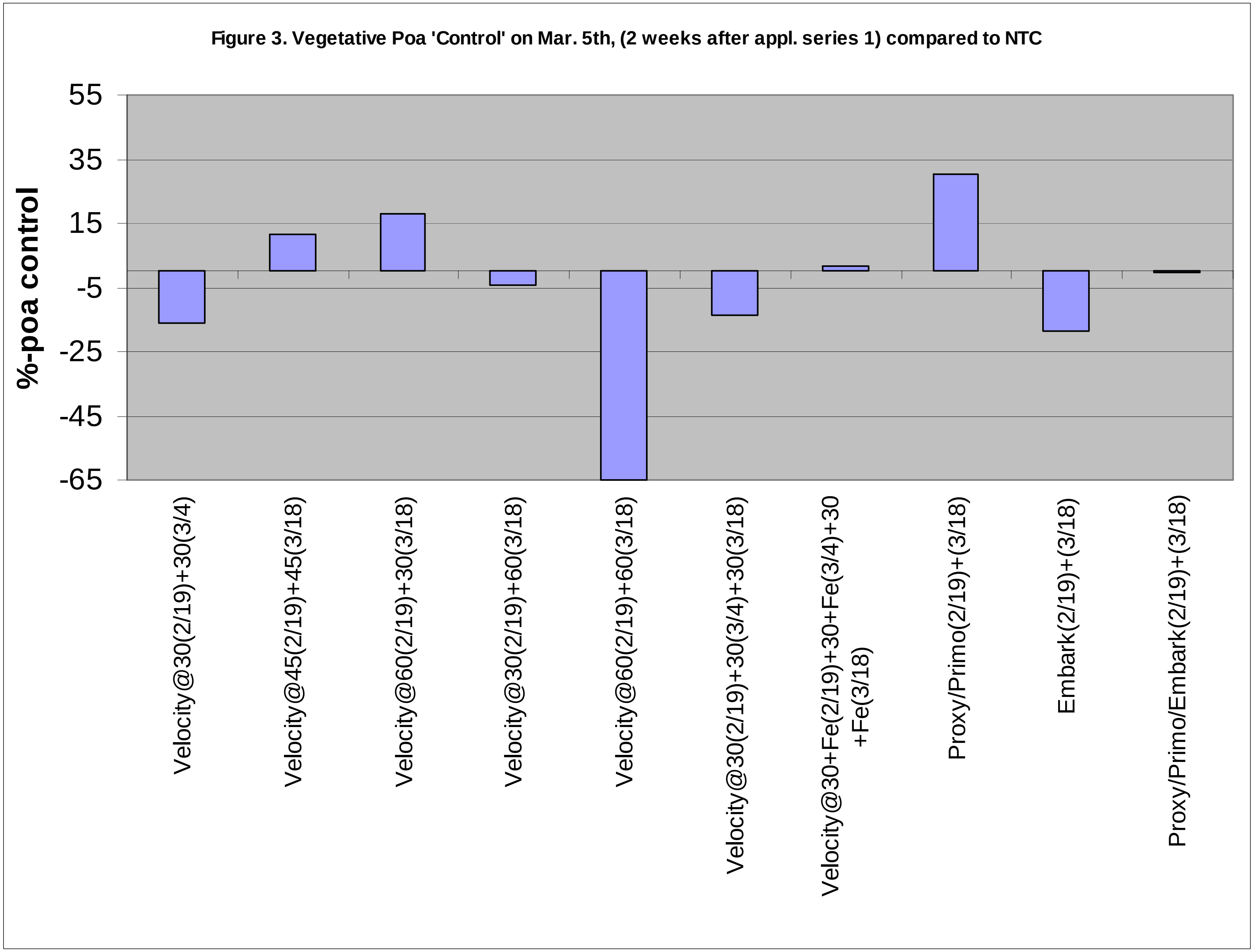


Figure 3. Vegetative Poa 'Control' on Mar. 5th, (2 weeks after appl. series 1) compared to NTC
%-poa control
55
35
15
-5
-25
-45
-65
Velocity@30(2/19)+30(3/4)
Velocity@45(2/19)+45(3/18)
Velocity@60(2/19)+30(3/18)
Velocity@30(2/19)+60(3/18)
Velocity@60(2/19)+60(3/18)
Velocity@30(2/19)+30(3/4)+30(3/18)
Velocity@30+Fe(2/19)+30+Fe(3/4)+30 +Fe(3/18)
Proxy/Primo(2/19)+(3/18)
Embark(2/19)+(3/18)
Proxy/Primo/Embark(2/19)+(3/18)

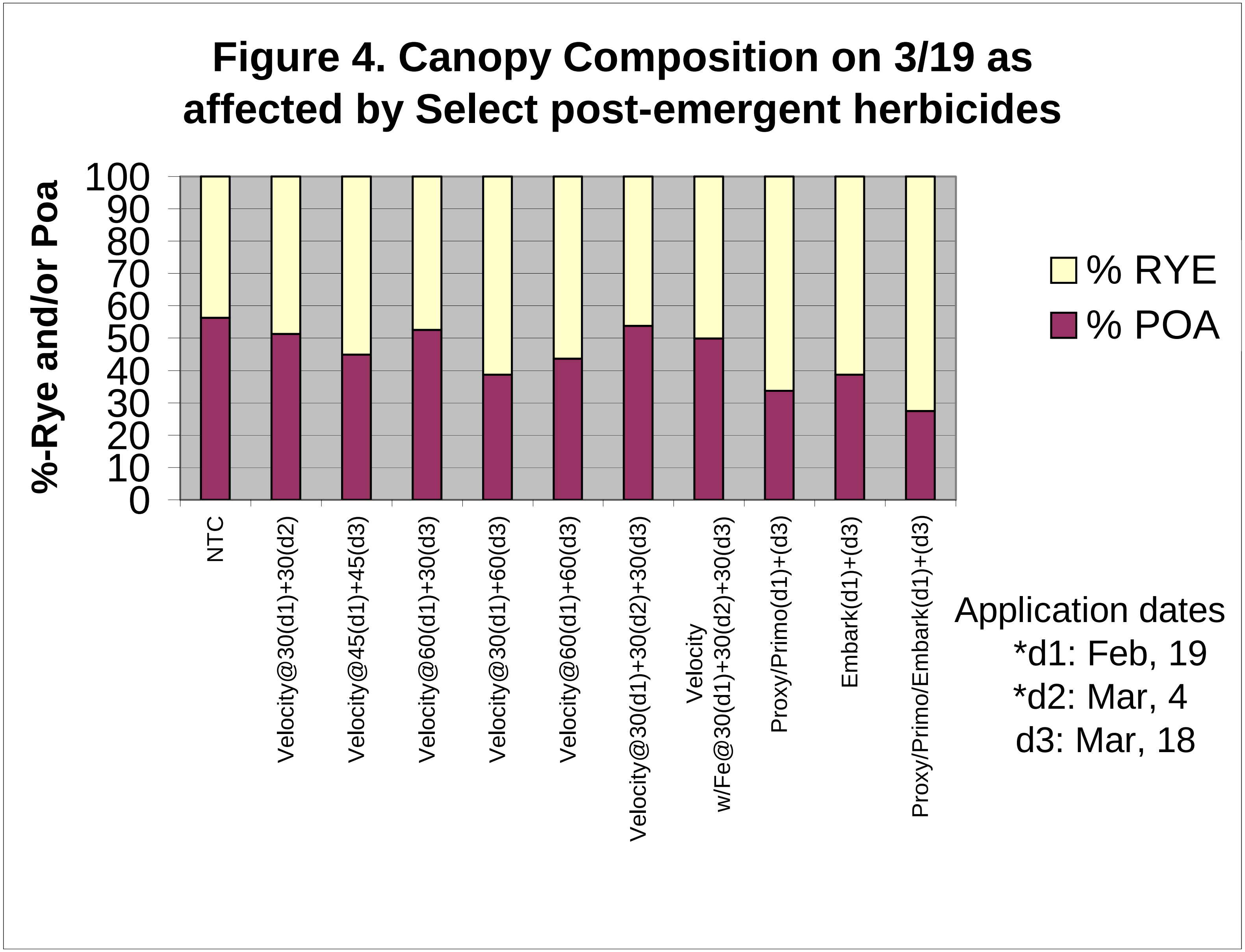


Figure 4. Canopy Composition on 3/19 as affected by Select post-emergent herbicides
%-Rye and/or Poa
100
90
80
70
60
50
40
30
20
10
0
NTC
Velocity@30(d1)+30(d2)
Velocity@45(d1)+45(d3)
Velocity@60(d1)+30(d3)
Velocity@30(d1)+60(d3)
Velocity@60(d1)+60(d3)
Velocity@30(d1)+30(d2)+30(d3)
Velocity w/Fe@30(d1)+30(d2)+30(d3)
Proxy/Primo(d1)+(d3)
Embark(d1)+(d3)
Proxy/Primo/Embark(d1)+(d3)
% RYE
% POA
Application dates
*d1: Feb, 19
*d2: Mar, 4
d3: Mar, 18

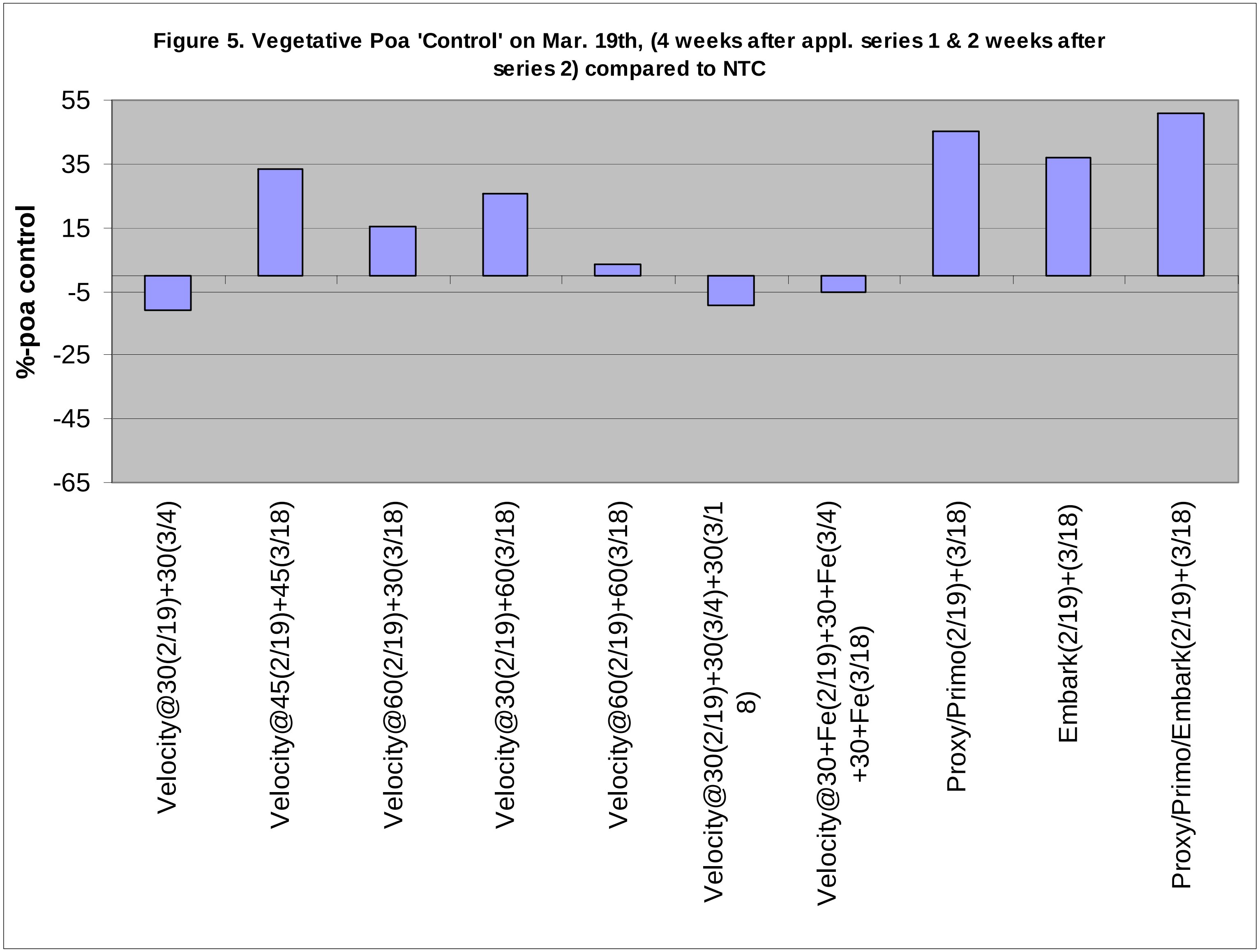


Figure 5. Vegetative Poa 'Control' on Mar. 19th, (4 weeks after appl. series 1 & 2 weeks after series 2) compared to NTC
%-poa control
55
35
15
-5
-25
-45
-65
Velocity@30(2/19)+30(3/4)
Velocity@45(2/19)+45(3/18)
Velocity@60(2/19)+30(3/18)
Velocity@30(2/19)+60(3/18)
Velocity@60(2/19)+60(3/18)
Velocity@30(2/19)+30(3/4)+30(3/18)
Velocity@30+Fe(2/19)+30+Fe(3/4)+30+Fe(3/18)
Proxy/Primo(2/19)+(3/18)
Embark(2/19)+(3/18)
Proxy/Primo/Embark(2/19)+(3/18)

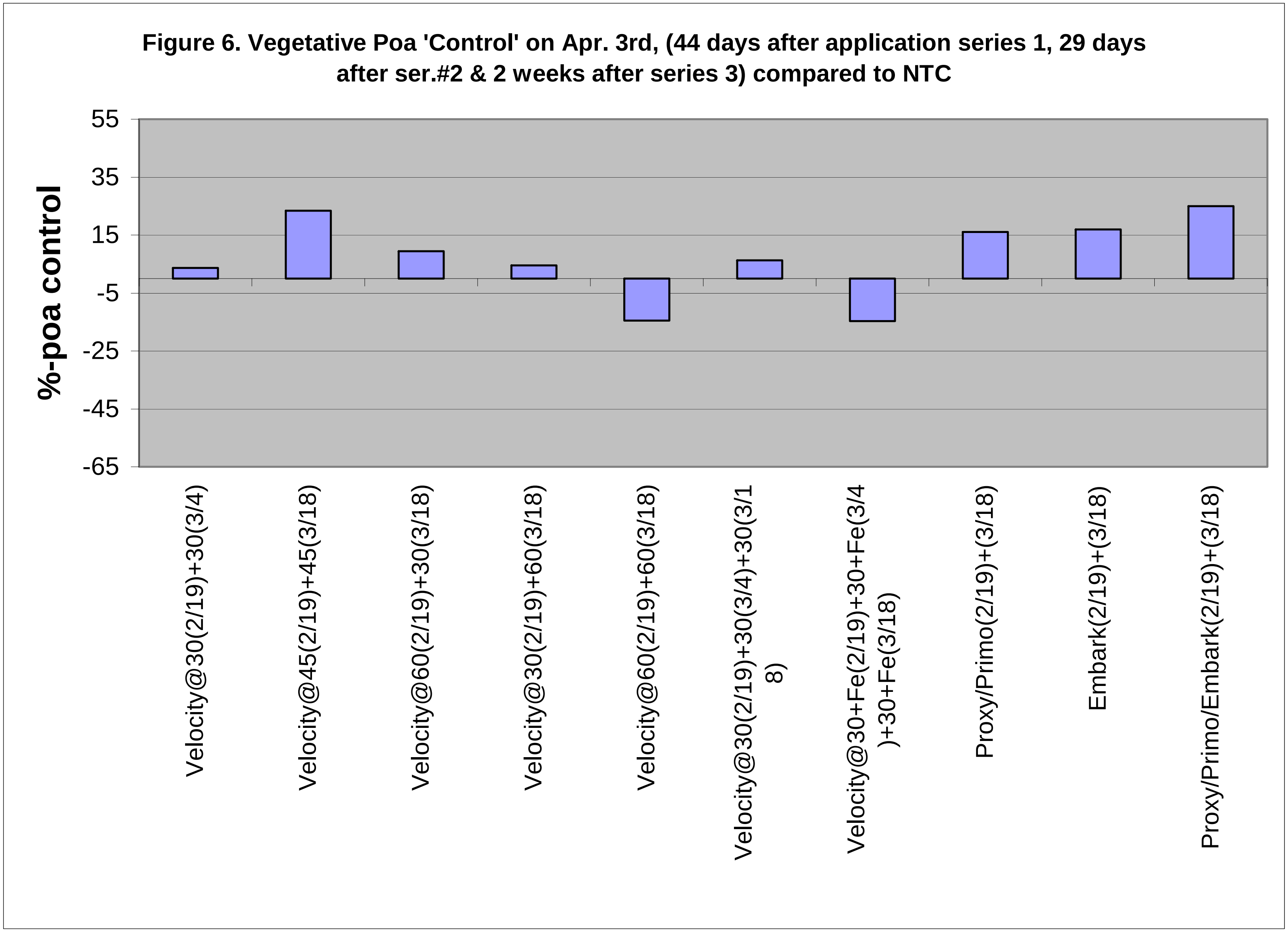


Figure 6. Vegetative Poa 'Control' on Apr. 3rd, (44 days after application series 1, 29 days after ser.#2 & 2 weeks after series 3) compared to NTC
%-poa control
55
35
15
-5
-25
-45
-65
Velocity@30(2/19)+30(3/4)
Velocity@45(2/19)+45(3/18)
Velocity@60(2/19)+30(3/18)
Velocity@30(2/19)+60(3/18)
Velocity@60(2/19)+60(3/18)
Velocity@30(2/19)+30(3/4)+30(3/18)
Velocity@30+Fe(2/19)+30+Fe(3/4)+30+Fe(3/18)
Proxy/Primo(2/19)+(3/18)
Embark(2/19)+(3/18)
Proxy/Primo/Embark(2/19)+(3/18)

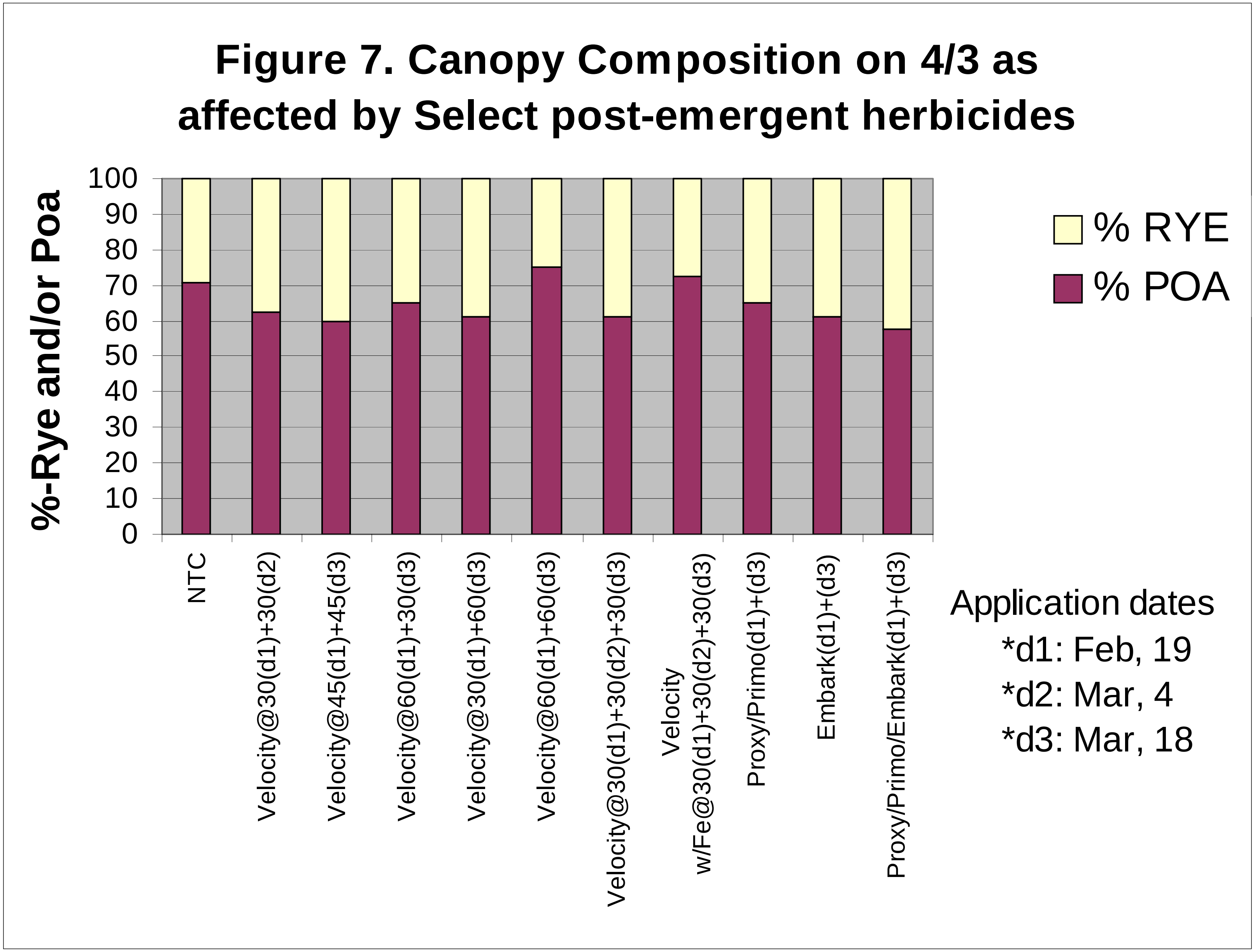


Figure 7. Canopy Composition on 4/3 as affected by Select post-emergent herbicides
%-Rye and/or Poa
100
90
80
70
60
50
40
30
20
10
0
NTC
Velocity@30(d1)+30(d2)
Velocity@45(d1)+45(d3)
Velocity@60(d1)+30(d3)
Velocity@30(d1)+60(d3)
Velocity@60(d1)+60(d3)
Velocity@30(d1)+30(d2)+30(d3)
Velocity w/Fe@30(d1)+30(d2)+30(d3)
Proxy/Primo(d1)+(d3)
Embark(d1)+(d3)
Proxy/Primo/Embark(d1)+(d3)
% RYE
% POA
Application dates
*d1: Feb, 19
*d2: Mar, 4
*d3: Mar, 18

Figure 8. %-Flower Head 'Control' on Apr. 3rd (44 days after application ser.# 1, 29 days after ser.#2 & 2 weeks after ser.# 3) compared to NTC.