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Fertilizer and Fluazifop-P Inputs for Winter Bentgrass- (*Agrostis hyemalis*) Infested Lowbush Blueberry Fields

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Winter bentgrass is a common, shallow-rooted perennial weed of lowbush blueberry fields. This unique production system is typically managed on a biannual cycle with blueberry shoot growth and floral bud development occurring in the first year (vegetative year) and berries harvested in the second year (crop year). An experiment was conducted in two commercial blueberry fields to determine the impact of 0, 143, or 286 kg ha^{-1} of 14–18–10 fertilizer applied in the vegetative year, and fluazifop-P applications in the vegetative, crop, or both years of the biannual production cycle, on winter bentgrass and blueberry growth and yield. Fluazifop-P tended to reduce winter bentgrass biomass at both sites and the vegetative year-herbicide applications had a greater impact on winter bentgrass ground cover than crop-year applications. Total weed biomass following fluazifop-P applications was reduced in the vegetative year but not the crop year due to an increase in broadleaf weed biomass. Grass biomass tended to increase with fertility inputs in the vegetative year. In all years and sites, the application of fertilizers without herbicides increased grass biomass compared to the use of fertilizers combined with herbicides. Blueberry floral bud numbers per stem, flowers per stem, and berry yield tended to increase with vegetative year applications of fluazifop-P, although differences were not significant. These data indicate that winter bentgrass management is best achieved with herbicide applications in the vegetative year and this might result in yield increases, especially if broadleaf weeds also are adequately controlled.
Nomenclature: Fluazifop-P; winter bentgrass, *Agrostis hyemalis* (Walt.); lowbush blueberry, *Vaccinium angustifolium* Ait.
Key words: Perennial crops, postemergence herbicides, weed management.

Agrostis hyemalis es una maleza perenne de raíces superficiales común en campos de arándano de porte bajo. Este sistema de producción es manejado típicamente en un ciclo bienal, con el crecimiento de la parte aérea del arándano y el desarrollo de las yemas florales ocurriendo en el primer año (año vegetativo) y con la cosecha de bayas en el segundo año (año de cosecha). Se realizó un experimento en dos campos comerciales de arándano para determinar el impacto de aplicaciones de fertilizante 14-18-10 a 0, 143, ó 286 kg ha^{-1} en el año vegetativo, y de aplicaciones de fluazifop-P en los años vegetativo, cosecha y ambos del ciclo bienal de producción, sobre el crecimiento de *A. hyemalis* y el crecimiento y rendimiento del arándano. Fluazifop-P tendió a reducir la biomasa de *A. hyemalis* en ambos sitios y las aplicaciones de herbicida en el año vegetativo tuvieron un mayor impacto en la cobertura del suelo de *A. hyemalis* que las aplicaciones en el año de cosecha. La biomasa total de las malezas después de las aplicaciones de fluazifop-P se redujo en el año vegetativo pero no en el año de cosecha debido al aumento en la biomasa de malezas de hoja ancha. En todos los años y sitios, la aplicación de fertilizantes sin herbicidas incrementó la biomasa de malezas gramíneas al compararse con el uso de fertilizantes en combinación con herbicidas. El número de yemas florales del arándano, las flores por tallo, y el rendimiento de bayas tendió a incrementar con las aplicaciones de fluazifop-P en el año vegetativo, aunque las diferencias no fueron significativas. Estos datos indican que el manejo de *A. hyemalis* se alcanza mejor con aplicaciones de herbicidas en el año vegetativo y esto podría resultar en aumentos en el rendimiento, especialmente si las malezas de hoja ancha son adecuadamente controladas.

The lowbush blueberry is a native, perennial berry species in Nova Scotia, Canada. Commercial fields are developed on abandoned farmland or cleared woodland where native blueberry stands already exist (Anonymous 2005). These stands are composed of distinct and variable clones that spread by underground rhizomes (Glass and Percival 2000). Commercial fields are managed on a 2-yr cycle. Fields are pruned at the soil surface with flail

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mowers or burning in the first year (vegetative year) to stimulate shoot emergence and the formation of flower buds (Barker and Collins 1963; Eaton et al. 2004). Flowering, fruit development, and harvest occur in the second, or crop year (Wood 2004). Pesticides and low levels of fertilizers are applied to control pests and encourage berry production (Eaton 1994). Weed management options are limited because crop rotation and cultivation are not viable options due to the perennial nature of the crop. As a result, weeds are the primary yield-limiting factor in lowbush blueberry (Jensen 1985; McCully et al. 1991).

The number of perennial grass species in lowbush blueberry fields in Nova Scotia nearly doubled between 1985 and 2001 (Jensen and Sampson, unpublished data; McCully et al. 1991) with many species now serious weeds in blueberry fields throughout the province. Rough hair, or winter bentgrass is one of two native species of perennial *Agrostis* that have become increasingly common over this period. Winter bentgrass was not identified in weed surveys conducted in the early 1980s (McCully et al. 1991), but was found in 36% of fields sampled during a similar survey in 2001 (Jensen and Sampson, unpublished data). The plant is a short-lived, tussock-forming perennial grass that forms dense stands in infested blueberry fields (Jensen and Hainstock 2000; Jensen and Yarborough 2004). It has a very shallow fibrous root system (Jensen et al. 2003) and plants spread primarily by seed, with individual plants producing up to 16,000 seeds (Stevens 1932). Seeds are produced on large, fine-stalked open panicles (Jensen and Hainstock 2000) that readily break free from the mother plant at maturity and are dispersed by wind. Winter bentgrass seed is also a common contaminant of mechanical blueberry harvesters (Boyd and White 2009), a factor likely contributing to the increased frequency of this species in recent weed surveys.

Knowledge of competitive interactions between winter bentgrass and lowbush blueberry is limited. Winter bentgrass is a concern to growers because it spreads rapidly, appears to reduce yields, interferes with harvest operations, and is tolerant to hexazinone, the primary herbicide used in commercial lowbush blueberry production. It is currently managed with PRE applications of terbacil in the nonbearing year or POST applications of fluazifop-P or sethoxydim in the spring of either production year (Anonymous 2012; Jensen et al. 2003). The impact of POST vs. PRE herbicide applications on competitive interactions between lowbush blueberry and grasses has not been studied. However, POST applications are desirable because the dying tussocks provide needed ground cover between spreading blueberry clones that inhibits soil erosion and enhances blueberry rhizome growth (Burgess 2002; Jensen and Yarborough 2004). It is unclear if POST applications are required in both years of the blueberry production cycle to adequately manage winter bentgrass and maintain satisfactory yields. It is also unclear how fertility inputs impact the competitive relationship between winter bentgrass and blueberry in the presence or absence of herbicides.

Blueberry yields can increase, decrease, or remain unchanged following fertilizer applications (Penney and McRae 2000; Percival and Sanderson 2004; Rayment 1965; Yarborough et al. 1986). Weed growth, on the other hand, consistently increases with increased nitrogen inputs (Eaton 1994; Yarborough et al. 1986). This is particularly true for grassy weeds that have a fibrous root system and tend to be more competitive for nutrients such as nitrogen (Evans 1977; Sullivan et al. 2000). Fertilizers applied in conjunction with herbicides therefore tend to have positive impacts on the growth and yield of lowbush blueberries (Eaton 1994; Ismail 1974; Penney and McRae 2000). It is widely accepted that a maintenance level of nitrogen fertilizer is needed to maintain adequate blueberry yields (Trevett 1972). Fertilizers are therefore routinely applied by growers but need to be combined with judicious use of herbicides in weedy fields.

The objectives of this research were to determine the impact of fertilizer inputs on the competitive relationship between winter bentgrass and lowbush blueberry, determine if winter bentgrass reduces berry yields, and determine which year of the 2-yr production-cycle POST herbicides should be applied to maximize winter bentgrass control and berry yield.

Materials and Methods

Experimental Setup. An experiment was conducted to test the impact of year of application of fluazifop-P (Venture® L; Syngenta Canada Inc., Guelph, Ontario, Canada) on winter bentgrass control over a range of fertilizer levels. The experiment occurred in two commercial blueberry fields located in East River St. Marys (East River), (45°34′N, 62°38′W) and Folly Mountain (45°39′N, 63°32′W), Nova Scotia. The East River site was established in the spring of 2007 and the Folly Mountain site was established in early spring of 2008. Both experiments were set up in the vegetative year with 2- by 6-m plots separated by a 1-m buffer. Hexazinone (Velpar 75DF; E. I. DuPont Company, Mississauga, Ontario, Canada) was applied at 1,920 g ai ha^{-1} to the entire experimental area in early May of the vegetative year at each site for general broadleaf weed control. Mesotrione (Callisto 480 SC; Syngenta Canada Inc., Guelph, ON) at 101 g ai ha^{-1} was applied to the entire experimental area at East River on June 15 of the vegetative year for additional broadleaf weed control. The experimental design was a 3 by 4 factorial design with four blocks. Factor one was 0, 143, or 286 kg ha^{-1} of 14–18–10 fertilizer applied in early May of the vegetative year. Factor two was herbicide application timing with fluazifop-P applied in the vegetative year, the crop year, the vegetative and the crop year, or not at all. Fluazifop-P was applied when winter bentgrass was 5 to 10 cm tall. This occurred between June 15 and June 28 at each site in both production years. Fluazifop-P was applied at 250 g ai ha^{-1}. Hexazinone, mesotrione, and fluazifop-P were all applied using a CO_2 pressurized sprayer (R&D Sprayer, Opelousas, LA) equipped with Teejet (Teejet Technologies, Wheaton, IL) 8002VS nozzles calibrated to deliver 200 L water ha^{-1} at a pressure of 276 kPa.

Data Collection. Blueberry and winter bentgrass damage was rated 7 to 14, 21 to 35, and 42 to 56 d after spraying (DAS) in each production year using a 0 to 10 scale where 0 is no damage and 10 is complete plant death. Aboveground weed and blueberry biomass was collected in each production year from two 25 by 25 cm quadrats randomly placed in each plot. Vegetative year biomass was collected on July 16 and August 8 at East River and Folly Mountain, respectively. Crop year biomass was collected mid-summer at each site. Harvested biomass was separated into blueberry, winter bentgrass, and other weeds, placed in paper bags, and dried at 50 C for 48 hr and then weighed. The number of blueberry stems was counted in each quadrat to estimate blueberry stem density in each treatment at each site. Blueberry and winter bentgrass ground cover were visually estimated in each plot using a 0 to 100 scale at both sites in each production year. Ground cover in the vegetative year was estimated on July 3 and August 8 at East River and Folly Mountain, respectively. Ground cover was estimated in late June at each site in the crop year.

Yield potential at the end of the vegetative year was assessed by measuring the stem length and number of flower buds on 15 blueberry stems collected at 50-cm intervals along a diagonal transect in each plot in late October at each site. Stems were clipped at the soil surface and brought back to the lab for measurements. Crop-year yield potential was determined by counting the number of flowers on 15 randomly selected blueberry stems in each plot in early June at East River, but not Folly Mountain. Blueberry yield was determined by harvesting all fruit in a randomly placed 0.9 m^2 quadrat in each plot using a hand-held rake. Lightweight debris such as leaves were removed from harvested fruit by pouring the berries across moving air currents, and the fresh berry weight was determined directly in the field with a portable scale.

Statistical Analysis. All data were tested for normality and constant variance in SAS (SAS® Version 9.3, SAS Institute, Inc., Cary, NC) using the Proc Univariate procedure. Normality was based on the P value associated with the Shapiro–Wilk test statistic. Data were analyzed in SAS using the PROC MIXED procedure with block as a random variable. Means comparisons were made using the LSMEANS statement and orthogonal contrasts with the contrast statement in SAS.

Results and Discussion

Weed Biomass and Grass Cover. There were significant herbicide by year by site and fertilizer by year by site interactions on winter bentgrass biomass and ground cover, and a significant fertilizer by year by site interaction on total weed biomass (Table 1). Given the interactions and known differences between sites, all data were analyzed separately for each site. When averaged across fertility levels and application timings, fluazifop-P significantly de-

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Table 1. Test of fixed effects included in the model with blueberry biomass, winter bentgrass biomass, red sorrel biomass, total biomass, and winter bentgrass cover as dependent variables.

	Blueberry biomass	Winter bentgrass biomass	Red sorrel biomass	Total weed biomass	Winter bentgrass cover
Site	NS[a]	***	—	NS	NS
Year	**	NS	***	***	***
Year by site	NS	***	—	***	*
Herbicide	NS	***	NS	NS	***
Herbicide by site	NS	NS	—	NS	NS
Herbicide by year	NS	***	NS	**	**
Herbicide by year by site	NS	***	—	NS	**
Fertilizer	NS	*	*	***	NS
Fertilizer by site	NS	NS	—	**	NS
Fertilizer by year	NS	**	NS	**	NS
Fertilizer by year by site	NS	**	—	***	**
Herbicide by fertilizer	NS	NS	NS	NS	NS
Herbicide by fertilizer by site	NS	NS	—	NS	NS
Herbicide by fertilizer by year	NS	NS	NS	NS	NS

[a] Abbreviation: NS, nonsignificant.

*$P < 0.05$, **$P < 0.01$, and ***$P < 0.001$ level of significance obtained with PROC MIXED.

creased winter bentgrass biomass compared to plots where no herbicide was applied in all sites and years except the vegetative year at East River where the same trend was observed (Table 2). Neither the production year when fluazifop-P was applied nor the number of applications consistently had a significant impact on winter bentgrass biomass at either site (Table 2). Winter bentgrass biomass at East River decreased from the vegetative to the crop year but this trend was not observed in Folly Mountain (Table 2).

Fluazifop-P applications reduced total weed biomass in the vegetative year but not the crop year at both sites (Table 2). The reduction in total weed biomass observed in the vegetative year occurred because winter bentgrass was the predominant weed species and is susceptible to fluazifop-P. The removal of the predominant grass species resulted in an increase in broadleaf weed populations as has been observed by other authors (Smagula and Ismail 1981; Yarborough and Ismail 1985). At East River, the broadleaf weed population was composed primarily of red sorrel (*Rumex acetossella* L.), whereas there was greater diversity at Folly Mountain. Unfortunately, there are very few broadleaf herbicides that can be applied POST in lowbush blueberry, and the emerged broadleaf weeds were not adequately controlled. As a result, no significant reduction in total weed biomass was observed with fluazifop-P applications in the crop year at either site (Table 2). In fact, total weed biomass increased by 8 and 529% between the vegetative and crop year where herbicides were applied in the vegetative year, compared to a 24% reduction and a 114% increase where herbicides were not applied at East River and Folly Mountain, respectively (Table 2). Management of grasses must be combined with broadleaf weed management, especially in sites where hard-to-control species (such as red sorrel) are present, to prevent overall increases in weed density.

Winter bentgrass and total weed biomass tended to increase with fertility inputs in both years at both sites, although the difference was not always significant (Table 2). Fertility rate had no consistent impact on winter bentgrass or total weed biomass (Table 2), indicating similar stimulation in weed growth from both fertilizer rates used in this study. In all years and sites, the application of fertilizers without herbicides significantly increased winter bentgrass biomass compared to the use of fertilizers combined with herbicides (Table 2). Total weed biomass tended to decrease where fertilizers were combined with herbicides vs. fertility alone in the vegetative year (Table 2), but this difference did not occur in the crop year due to the increase in broadleaf weeds. This assumption is supported by the increase in red sorrel biomass with fertility inputs that was observed at East River in the vegetative year (data not shown), an observation

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Table 2. Impact of fertilizer (14–18–10) rates and fluazifop-P application timing on winter bentgrass and total weed biomass in the vegetative and crop year of the production cycle at East River and Folly Mountain, Nova Scotia, Canada.

	East River				Folly Mountain			
	Winter bentgrass biomass		Total weed biomass		Winter bentgrass biomass		Total weed biomass	
	Vegetative	Crop	Vegetative	Crop	Vegetative	Crop	Vegetative	Crop
	$g\ m^{-2}$							
Fertilizer rates ($kg\ ha^{-1}$)								
0	25 bc[a]	15 c	69 c	147 b	26 b	46 a	52 b	197 a
143	70 ab	17 c	177 b	177 b	36 b	57 a	70 b	228 a
286	80 a	3 d	220 a	166 b	32 b	55 a	69 b	218 a
Herbicide timing								
Nontreated	82 ab	21 cd	200 a	152 b	58 ab	47 ab	98 b	210 a
Vegetative year	43 abc	5 e	150 b	162 ab	60 ab	69 a	35 c	220 a
Crop year	85 a	11 de	158 ab	163 ab	2 d	37 b	85 b	209 a
Vegetative & crop year	25 bc	9 de	114 b	176 ab	5 c	58 ab	37 c	216 a
Contrasts								
herbicide vs. no herbicide[b]	*0.0481*	*0.0003*	*0.0333*	*0.3669*	< *0.0001*	*0.0040*	*0.0011*	*0.6418*
fertility vs. no fertility[c]	*0.0011*	*0.2784*	< *0.0001*	*0.1074*	*0.4819*	*0.1190*	*0.1627*	*0.1338*
fertility vs. herbicide + fertility[d]	*0.0251*	*0.0109*	*0.0218*	*0.5529*	< *0.0001*	*0.0077*	*0.0086*	*0.9382*

[a] Sites were analyzed separately and there was no significant interaction between fertilizer rates and herbicide timing. Tukey adjusted means comparisons within sites and fertility or herbicide rates but across years with different letters are significantly different at $P < 0.05$.

[b] This contrast compares no fluazifop-P application vs. the mean of fluazifop-P applied at 250 g ai ha^{-1} in the vegetative year, crop year, or both years, averaged across all fertility levels.

[c] This contrast compares the no fertility treatments vs. the mean of all fertility rates averaged across herbicide treatments.

[d] This contrast compares the mean of all treatments with fertility but no herbicide vs. the mean of all treatments that received fertility and fluazifop-P inputs.

consistent with previous reports of fertility impacts on red sorrel growth in lowbush blueberry (Kennedy et al. 2010, 2011). Although the contrasts only show a significant difference in the vegetative year at East River, grass and total weed biomass tended to be higher where fertilizers were applied with the herbicide compared to herbicides alone at both sites (Table 2). Fertilizer applications aid in the recovery of some perennial grasses from herbicide injury (McCarty and Scifres 1968), and this likely occurred in this study as well. This is in contrast to studies that report larger reductions in annual weed biomass from some POST herbicides under high rather than low fertility conditions (Cathcart et al 2004; Mithila et al. 2008).

Trends observed with winter bentgrass ground cover were very similar to biomass measurements. Winter bentgrass ground cover tended to be lower where fluazifop-P was applied in all sites and years (Table 3). Grass cover in the crop year was lower where fluazifop-P was applied in the vegetative year vs. the crop year in East River (Table 3). The same trend, although not statistically significant, was also observed at Folly Mountain. Fertility inputs only increased winter bentgrass ground cover in the vegetative year at East River (Table 3). This difference reversed in the crop year (Table 3). Winter bentgrass ground cover tended to be greater in all sites and years at the high fertility level but the trend is not significant (Table 3). However, winter bentgrass ground cover was significantly lower in all sites and years except the crop year at Folly Mountain where herbicides and fertilizers were combined vs. fertility inputs alone (Table 3).

Blueberry Growth, Reproduction, and Yield. Blueberry biomass was 82 and 147 g m^{-2} in the vegetative and crop year, respectively. Blueberry biomass did not differ significantly across sites or among treatments (Table 1). Average blueberry stem density across all treatments and sites was 232 stems m^{-2}. Neither herbicide treatment ($P = 0.8648$) nor fertility inputs ($P = 0.8526$) had a

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Table 3. The impact of fertilizer (14–18–10) rates and fluazifop-P application timing on winter bentgrass ground cover in the vegetative and crop year at East River and Folly Mountain, Nova Scotia, Canada.

	East River		Folly Mountain	
	Vegetative	Crop	Vegetative	Crop
	% ground cover			
Fertilizer rates (kg ha^{-1})				
0	24 bc[a]	25 bc	37	26
143	31 ab	10 c	27	27
286	42 a	14 c	39	32
Herbicide timing				
Nontreated	57 a	37 b	53 a	56 a
Vegetative year	3 d	4 d	20 cd	21 cd
Crop year	64 a	22 c	43 ab	33 bc
Vegetative & crop year	5 d	3 d	20 c	8 d
Contrasts				
herbicide vs. no herbicide[b]	*< 0.0001*	*< 0.0001*	*0.0018*	*0.3365*
fertility vs. no fertility[c]	*0.0329*	*0.0026*	*0.5498*	*0.9809*
fertility vs. herbicide + fertility[d]	*< 0.0001*	*0.0009*	*0.0270*	*0.8498*

[a] Sites were analyzed separately and there was no significant interaction between fertilizer rates and herbicide timing. Tukey adjusted means comparisons within sites and fertility or herbicide rates but across years with different letters are significantly different at $P < 0.05$.

[b] This contrast compares no fluazifop-P application vs. the mean of fluazifop-P applied at 250 g ai ha^{-1} in the vegetative year, crop year, or both years, averaged across all fertility levels.

[c] This contrast compares the no fertility treatments vs. the mean of all fertility rates averaged across herbicide treatments.

[d] This contrast compares the mean of all treatments with fertility but no herbicide vs. the mean of all treatments that received fertility and fluazifop-P inputs.

significant impact on stem density. This is contrary to previous research that observed a reduction in stem density when blueberry competes with broadleaf weeds (Hughes 2012). Blueberry floral bud numbers per stem and yield differed between sites. Fluazifop-P applications had a marginal impact on floral bud numbers ($P = 0.0974$) as did fertility inputs ($P = 0.0697$) at East River. The number of floral buds per stem increased with vegetative year applications of fluazifop-P and tended to increase with fertilizer inputs. The same trend was observed at Folly Mountain. The number of flowers per stem also increased at East River following fluazifop-P applications. The herbicide by fertilizer by site interaction was also marginally significant ($P = 0.0622$).

Some interesting trends emerged with the contrasts statements. Floral bud numbers, flowers per stem, and yield consistently increased at East River where fluazifop-P was applied vs. no herbicide application when averaged over fertility inputs; however, only the increase in floral bud numbers was significant (Table 4). Floral bud numbers and berry yield also tended to be higher when fluazifop-P was applied in the vegetative year vs. the crop year (Table 4), although the difference was only significant with floral bud counts in East River. The number of applications did not have a significant impact on yield (Table 4), nor did the addition of fertilizers (Table 4). The number of flower buds per stem following fertilizer applications tended to increase at Folly Mountain, but this resulted in a yield decrease (Table 4). This is similar to results reported by Penney and McRae (2000), who found increased flower buds from vegetative year nitrogen applications, but lower final yields due to suspected increased fruit abortion caused by nutrient deficiency in the crop year. When both fluazifop-P and fertilizer were applied, there was a consistent increase in blueberry floral buds, flowers, and berry yields, although differences were not always significant (Table 4). This is consistent with results reported by other authors. For example, Ismail (1974) found that fertilizer applications without the application of herbicides caused excessive weed growth, but fertilizers applied in combination with herbicides doubled yields compared to the no-herbicide plots. Penney and McRae

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Table 4. Impact of fertilizer (14–18–10) rates and herbicide application timing on lowbush blueberry floral bud numbers, flowers, and blueberry yields in East River and Folly Mountain, Nova Scotia, Canada. Values given are means with standard error (SE) in parentheses.

	East River			Folly Mountain	
	Floral buds	Flowers	Yield	Floral buds	Yield
	No. stem^{-1}	No. stem^{-1}	kg ha^{-1}	No. stem^{-1}	kg ha^{-1}
Fertilizer rates (kg ha^{-1})					
0	1.9 (0.24) a[a]	24 (1.7)	1,416 (175) a	3.3 (0.35) a	4,273 (599)
143	1.5 (0.18) a	21 (1.8)	1,029 (152) b	4.4 (0.44) b	4,573 (560)
286	2.0 (0.39) a	23 (2.2)	1,048 (129) b	4.5 (0.44) b	3,909 (519)
Herbicide timing					
Nontreated	1.2 (0.25) b	21 (2.1)	1,130 (151)	3.9 (0.50)	3,911 (469)
Vegetative year	2.2 (0.40) a	22 (2.1)	1,172 (113)	4.4 (0.63)	4,919 (466)
Crop year	1.5 (0.22) b	24 (2.4)	1,077 (207)	3.9 (0.45)	4,190 (829)
Vegetative & crop year	2.3 (0.35) a	24 (2.3)	1,279 (244)	4.5 (0.46)	4,135 (645)
Contrasts					
herbicide vs. no herbicide[b]	*0.010*	*0.069*	*0.816*	*0.539*	*0.501*
fertility vs. no fertility[c]	*0.620*	*0.089*	*0.040*	*0.011*	*0.950*
fertility vs. herbicide + fertility[d]	*0.028*	*0.185*	*0.985*	*0.252*	*0.820*

[a] Sites were analyzed separately and there was no significant interaction between fertilizer rates and herbicide timing. Tukey adjusted means comparisons within sites and fertility or herbicide rates but across years with different letters are significantly different at $P < 0.05$.

[b] This contrast compares no fluazifop-P application vs. the mean of fluazifop-P applied at 250 g ai ha^{-1} in the vegetative year, crop year, or both years, averaged across all fertility levels.

[c] This contrast compares the no fertility treatments vs. the mean of all fertility rates averaged across herbicide treatments.

[d] This contrast compares the mean of all treatments with fertility but no herbicide vs. the mean of all treatments that received fertility and fluazifop-P inputs.

(2000) applied nitrogen, phosphorus, and potassium in the vegetative and crop year with or without hexazinone and found that crop year nitrogen only increased yield when combined with effective weed control. Fertility inputs, when combined with ineffective weed control, stimulated weed growth and decreased flower numbers.

The results of this paper demonstrate that fluazifop-P applications reduce winter bentgrass biomass and ground cover. Grass ground-cover measurements, as well as blueberry floral bud and flower numbers, all suggest that an application during the vegetative year provides the greatest benefit; this timing is preferred by growers because it minimizes travel in the field during blueberry flowering and pollination. A second application of fluazifop-P in the crop year appears to provide no added benefit in terms of a reduction in winter bentgrass biomass, but should be recommended when grass populations might interfere with pollination or harvest operations. In addition, the use of grass herbicides without a broadleaf herbicide opens new microsites for broadleaf weed establishment. As a result, broadleaf weed density can increase and negate any potential yield increase from the grass herbicide application. The decision to use fertilizers when trying to manage perennial grasses with POST herbicides in lowbush blueberry should be based on blueberry tissue nutrient content, yield potential, and management costs. Fertilizer applications in the absence of herbicides are not recommended due to the resulting increased weed growth.

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