What's Cropping Up?

A NEWSLETTER FOR NEW YORK FIELD CROPS & SOILS *VOLUME 21, NUMBER 1, JANUARY-FEBRUARY, 2011*

Kixor – A New Herbicide for Corn and Soybeans

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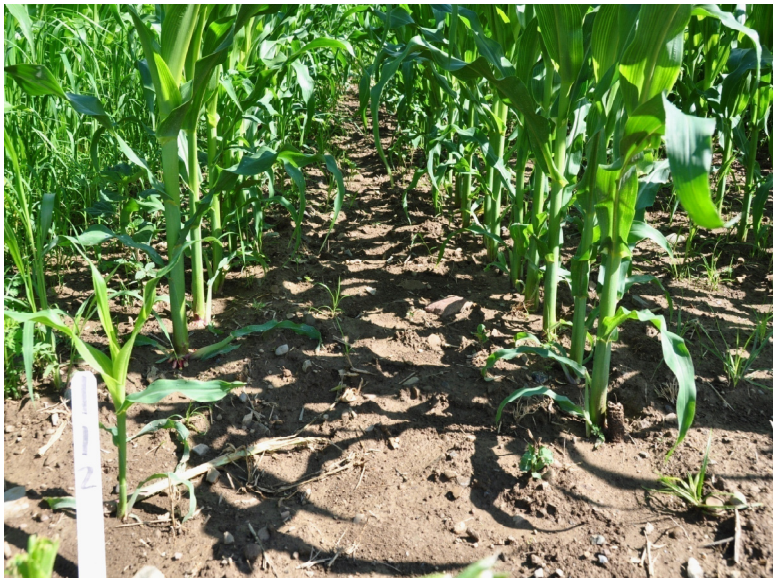
Three new herbicide products, Sharpen, Verdict, and OpTill, were recently registered for use in NY State. Each contains a new active ingredient, Kixor (saflufenacil). Kixor is a PPO inhibitor or Group 14 herbicide. PPO (an enzyme) inhibition results in lipids and proteins being attacked and oxidized. The resulting loss of plant pigments and leaky membranes allows cells to dry and rapidly disintegrate. PPO inhibitors are also known as cell membrane disrupters. Other Group 14 herbicides include Reflex, Cobra, Resource, Valor SX, and Aim. Worldwide, only four weeds have developed resistance to this site of action. Two of these, tall waterhemp (a pigweed) and common ragweed, have been confirmed in the U.S.

Kixor is rapidly absorbed by roots, shoots, and leaves depending on application timing, and is translocated upward in plants. It provides rapid burndown and has residual activity on a variety of broadleaf weeds including velvetleaf, redroot/smooth pigweed, common ragweed, common lambsquarters, wild buckwheat, wild mustard, and numerous others. Kixor does not control grasses. Kixor will be marketed alone as **Sharpen** for field corn and soybeans. Premix products powered by Kixor include **Verdict**, a mixture of Kixor and Outlook, for field corn and soybeans; and **OpTill**, a mixture of Kixor and Pursuit, for soybeans only. These premix products, Verdict and OpTill, provide residual control of many weedy grasses as well as the broadleaf weeds controlled by Kixor. Because of their burndown activity, these products can only be applied preplant (PP) or preemergence (PRE) before corn or soybeans emerge. Severe crop injury will occur if they are applied after crop emergence. They are positioned in the marketplace for burndown and/or residual control or suppression of labeled weeds in planned sequential (two-pass) control programs for corn or soybeans. When used for no-tillage burndown, the preferred adjuvants for these products are methylated seed oil (MSO) plus ammonium sulfate (AMS) or urea ammonium nitrate (UAN).

Preemergence Corn Trials

Corn trials in NY State the past three seasons have focused on PRE residual activity of Verdict alone and of Sharpen plus Prowl H2O tank-mix combinations. The main PRE comparison has been between Verdict (Kixor and Outlook) and Lumax (Callisto, Dual, and AAtrex). One experiment was conducted on a sandy gravelly loam soil with 2.4% organic matter near Valatie in 2008. Corn was planted and PRE herbicides applied May 15 and 16, respectively. Rainfall during the week after treatment (WAT) was 0.81 inch, with 0.41 inch recorded on May 18. Common ragweed and giant foxtail were the dominant weeds along with some velvetleaf and common lambsquarters. Verdict at 13 fl oz/A and Lumax at 2.5 qt/A each provided good to excellent control of all three broadleaf species 4 WAT. Common ragweed control with Verdict was slightly better (99%) than with Lumax (93%), and giant foxtail was similar with these products 16



Weed control with preemergence application of 13 fl oz/A of Verdict plus 1 pt/A of AAtrex 4L at Aurora in 2010.

Weed Management

WAT (Table 1). When applied alone, 2 fl oz/A of Sharpen controlled more than 95% of velvetleaf, ragweed, and lambsquarters 4 WAT. By 16 WAT, ragweed control with Sharpen was still 100% but there was no foxtail control (Table 1). A tank-mix of 2 fl oz/A of Sharpen plus 3 pt/A of Prowl H2O controlled 98 and 88% of the ragweed and foxtail 16 WAT respectively. This was similar to control with the tank-mix of 1 qt/A of AAtrex plus 3 pt/A of Prowl H2O (Table 1). Grain yields for Verdict and Lumax were similar with an average of 143 bu/A. The lack of foxtail control with Sharpen alone resulted in a yield of only 64 bu/A while the tank-mix of Sharpen plus Prowl H2O yielded 141 bu/A which was similar to the yield with the AAtrex plus Prowl H2O combination. The untreated check yielded 44 bu/A.

Table 1. Common ragweed and giant foxtail control ratings 16 weeks after treatment (WAT), and grain corn yields following preemergence herbicide applications at Valatie, NY in 2008.

Herbicides	Rate Amt/A	% Control – 16 WAT		Yield bu/A
		Ragweed	Foxtail	
Verdict	13 fl oz	99	97	144
Lumax	2.5 qt	93	96	141
Sharpen	2 fl oz	100	0	64
Sharpen + Prowl H2O	2 fl oz 3 pt	98	88	141
AAtrex 4L + Prowl H2O	1 qt 3 pt	93	85	147
Untreated Check	-	0	0	44

Unfortunately, suggested Sharpen and Verdict rates used in 2008 and 2009 corn trials at Aurora were significantly higher than those that are now labeled. As a result, only Aurora results from 2010 will be discussed here. The soil at Aurora is a silt loam with about 3% organic matter. Corn was planted and PRE herbicides applied May 20 and 25, respectively. Rainfall during the first WAT was only 0.24 inch, but 2.11 inches was recorded during the second WAT. Common ragweed and giant foxtail were the dominant weeds. Ratings made 3 WAT showed 85 and 98% ragweed control with 13 fl oz/A of Verdict alone or in combination with 1 pt/A of AAtrex respectively. The PRE standard of 2.5 qt/A of Lumax plus 1 pt/A of AAtrex had 96% ragweed control 3 WAT. By 10 WAT, ragweed and foxtail control had declined to 58 and 60% with Verdict alone (Table 2). When Verdict was applied with1 pt/A of AAtrex, ragweed control was 95% 10 WAT. This was similar to ragweed control with 2.5 qt/A of Lumax plus 1 pt/A of AAtrex (90%). Foxtail control with 13 fl oz/A of Verdict alone dropped from 98 to 60% between 3 and 10 WAT, but foxtail control with the Verdict plus 1 pt/A of AAtrex or with Lumax plus 1 pt/A of AAtrex averaged 89% 10 WAT (Table 2). With only 0.24 inch of rain the first WAT, performance of Prowl H2O with Sharpen or with AAtrex was not acceptable. The addition of 1 pt/A of AAtrex to the Prowl H2O plus Sharpen mixture controlled 96% of the ragweed 10 WAT but only 48% of the foxtail (Table 2). The lack of foxtail control was likely due to inadequate rainfall activation of Prowl H2O. Grain corn yields with Verdict plus AAtrex and with Lumax plus AAtrex treatments were both 176 bu/A (Table 2). Although late season weed control with Verdict alone was poor, good

Untreated check in foreground and weed control with preemergence application of 13 fl oz/A of Verdict alone immediately behind at Valatie in 2008

Table 2. Common ragweed and giant foxtail control ratings 10 weeks after treatment (WAT), and grain corn yields following preemergence herbicide applications at Aurora, NY in 2010.

Herbicides	Rate Amt/A	% Control – 16 WAT		Yield bu/A
		Ragweed	Foxtail	
Verdict	13 fl oz	58	60	173
Verdict + AAtrex 4L	13 fl oz 1 pt	95	89	176
Lumax + AAtrex 4L	2.5 qt 1 pt	90	88	176
Sharpen + Prowl H2O	2.5 fl oz 3 pt	63	25	143
Sharpen + Prowl H2O + AAtrex 4L	2.5 fl oz 3 pt 1 pt	96	48	163
AAtrex 4L + Prowl H2O	1 qt 3 pt	68	20	158
Untreated Check	-	0	0	70
LSD (0.10)		8	11	17

to excellent early season control resulted in a yield (173 bu/A) similar to the standard Lumax plus AAtrex treatment. The Prowl H2O tank mix treatments with Sharpen or AAtrex yielded less than the Verdict plus AAtrex and Lumax plus AAtrex treatments.

Summary

These results demonstrate the strengths and weaknesses of Verdict and Sharpen in providing PRE residual control of some annual weeds in corn. While the residual activity of Verdict, the pre-mix of Kixor and Outlook, compared favorably with Lumax in these trials, growers are reminded that labeled rates of Verdict and Sharpen are intended for use in planned sequential weed control programs where PP or PRE Verdict or Sharpen applications would be followed by a postemergence (POST) application of glyphosate or other POST herbicides for full-season weed control. This kind of program would be most attractive in zone/no-tillage systems where growers could take advantage of the burndown capability of Kixor plus its residual activity through early to mid-season before making the sequential POST application. Burndown for zone-tillage will be discussed in a future article. Rotational crop planting intervals for Sharpen and Verdict are quite favorable. Fall seeded small grains may be planted 3 to 4 months after applying these herbicides, and there are no rotational crop restrictions the spring following their use the previous year.

Crop Management

Planting Rates for Grain Corn

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Assuming soil conditions are conducive to a 90% emergence rate, we currently recommend seeding rates of 30,000 kernels/acre for grain corn on silt loam soils in New York, based on studies at the Aurora Research Farm from 2003 to 2005 (Table 1). Recent hybrid releases, however, have been selected at higher plant populations and lodge less because of the Bt trait so there is a general belief that seeding rates should exceed recommended rates, based on hybrid releases from the early 2000s. On the other hand, most corn seed is now treated with soil-applied insecticide/fungicide, which results in greater stand establishment today than hybrids planted in the early 2000s. Consequently, the higher emergence rate may offset the need to plant the new hybrid releases at higher seeding rates. We have been conducting field-scale studies at the Aurora Research Farm since 2006 on fields following soybean and planted in early May under strip tillage to validate our small plot research. When averaged across years (2006 to 2010), optimum yields occurred at seeding rates of 29,600 kernels/acre (Table 2), close to our recommended seeding rate. We initiated another field-scale study in Cayuga County as well as a small-plot hybrid by seeding rate by N rate study in 2010 to further evaluate seeding rates for grain corn.

Two hybrids were planted at four seeding rates ranging from 30,000 to 38,000 kernels/acre with four replications at

Table 1. Plant populations at the six leaf stage (V6) and grain yield of a DEKALB and a Pioneer hybrid at four seeding rates in 2003, 2004, and 2005 and pooled across years at the Aurora Research Farm in Cayuga Co., NY (bold values represent optimum values based on regression analyses).

RATE	DKC53-34				37F16			
k/acre	2003	2004	2005	Avg.	2003	2004	2005	Avg.
	----------plants/acre----------							
25,000	24700	20310	20870	21960	18420	27700	20000	22040
30,000	28600	25125	26631	26785	21580	33125	25870	26858
35,000	33160	28000	31305	30822	25090	34875	29565	29260
40,000	37020	30440	34457	33972	27370	39000	37066	34479
	----------bu/acre----------							
25,000	**187**	178	148	171	165	186	143	165
30,000	188	**197**	**152**	**179**	171	**189**	**150**	**170**
35,000	187	189	142	173	180	180	134	165
40,000	175	188	142	168	**186**	180	138	168

Table 2. Plant populations at the six leaf stage (V6) and grain yield of a different hybrid at four seeding rates in field-scale studies at the Aurora Research Farm in Cayuga Co., NY from 2006 to 2010 (bold values represent optimum values based on regression analyses).

RATE	GRAIN YIELD					
	2006	2007	2008	2009	2010	Avg.
k/acre		----------bu/acre----------				
27,500	139	130	187	173	158	157
29,600	**150**	**134**	189	**173**	**166**	**163**
32,100	148	132	188	170	**168**	161
34,200	153	133	**197**	172	170	165
	---------- plants/acre----------					
27,500	23874	23700	24820	25055	22445	23979
29,000	25888	25825	26631	26187	26000	26106
32,100	28904	28480	29378	28500	26235	28299
34,200	31691	29830	31698	30500	29330	30610

Table 3. Grain yield and plant populations at the 8th leaf stage (V8) of a DEKALB and Pioneer hybrid planted on the Du Mond Farm (Cayuga Co.) in 2010 (bold values represent optimum values based on regression analyses).

	GRAIN YIELD		PLANTS/ACRE	
RATE	DKC46-40	P9512XR	DKC46-40	P9512XR
kernels/acre	--------bu/acre-------		------plants/acre------	
30,000	**211**	**208**	28,005	27,805
32,500	208	213	30,005	30,200
35,000	213	213	32,000	32,800
38,000	214	211	34,500	34,750

the Du Mond Farm in Cayuga Co. on 18 May. Each subplot averaged 0.9 acres so the entire study represented about 28 acres of research. Plant populations at the 8th leaf stage (V8) in late June ranged from about 28,000 to 34,500 plants/acre (Table 3). Neither hybrid responded to seeding rates in this study, possibly because the mid-May planting date resulted in emergence rates of 92%, so optimum seeding rates at this site was also at the recommended rate.

There is also a general belief that hybrids will not respond to seeding rates unless the N rate is high so we also tested two hybrids at four seeding rates (25,000 to 40,000 kernels/acre) with two N rates (the recommended 125 lbs/acre of total N for corn following soybeans and a high N rate of 175 lbs/acre of total N) in small plot research at the Aurora Research Farm. The planting date was 30 April and the emergence rate was 87% for the DEKALB hybrid and 79% for the Pioneer hybrid. Despite the differences in emergence rates between the hybrids, both showed similar responses to seeding rate, especially at the high N rate (Table 4). As in all previous studies, 30,000 kernels/acre was the optimum seeding rate, regardless of N rates. Such high yields in this study indicate that seeding rates or N rates do not have to be above recommended rates to achieve such high yields.

Conclusion

We have repeatedly seen that seeding rates of about 30,000 kernels/acre result in optimum yields on silt loam soils in Cayuga Co. Nevertheless, there is enough information out there to make us question whether this response is consistent across different soil types and farming operations in NY. Consequently, we will initiate field-scale studies on four to six farms across NY State at different row spacing for the next two years to further validate our current seeding rate recommendations for grain corn in New York.

Table 4. Plant populations at the 6th leaf stage (V6) and grain yield of a DeKalb and a Pioneer hybrid at four seeding rates and two N rates in a field following soybeans at the Aurora Research Farm in Cayuga Co., NY (bold values represent optimum values based on regression analyses).

RATE	**DKC51-84**			**P0125XRR**			
	125N	**175N**	**AVG.**	**125N**	**175N**	**AVG.**	**MEAN**
k/acre	----------plants/acre----------						
25,000	21200	20325	20763	18480	17390	17935	19349
30,000	26090	27065	26578	23260	25000	24130	25354
35,000	31850	33370	32610	28045	29565	28805	28805
40,000	33045	34130	33588	32390	30870	31630	31630
	----------bu/acre----------						
25,000	256	272	264	267	280	274	264
30,000	299	296	**298**	288	296	**293**	**295**
35,000	300	302	301	300	296	**298**	299
40,000	296	303	300	309	300	304	302
Mean	**288**	**293**		**291**	**293**		
LSD 0.05		**NS**			**NS**		

Crop Management

A Broad Optimum Planting Date for Corn?

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Corn planting dates have moved up earlier in the spring across the USA because of warmer spring temperatures, improved cold tolerance of modern corn hybrids, and improved seed protection from early-season soil-borne insects and pathogens via seed treatments. For example, at the Aurora Research Farm, the average number of growing degree days (GDD, 86/50 ^{0}F system) have increased by 22 GDD in April and 31 GDD in May during the 1981-2010 period compared with the 1951-1980 period (Table 1). Also, corn hybrids now begin the germination process at about 46 ^{0}F compared with 50 ^{0}F for the hybrids of yesteryear. Finally, seed-applied insecticides that protect corn kernels in cool soils from soil-borne insects and pathogens were commercialized during this past decade. Consequently, there is much less risk involved with early planting of corn compared to 30 years ago. Nevertheless, only 55% of the corn is planted by 15 May on average in New York (New York Ag Statistics). We initiated a study at the Aurora Research Farm (Cayuga Co.) and Sparta Farms (Livingston Co.) to evaluate the response of six corn hybrids when planted from April 20-25 compared with planting from May 15-20.

April and May had above-average growing degree days in 2009 and 2010 (Table 1) so April-planted corn had minimum overall cold stress during emergence in both years of the study. Consequently, emergence averaged 92% for the April-planted corn and 95% for the May-planted corn in both growing season, negating any effect of stand establishment on yields in this study. Temperatures did go down to 28 degrees, however at the Sparta Farm site on 12 May in 2010, which thoroughly singed off all corn leaves at the 3-leaf (V3) stage of development. All hybrids, however, recovered quickly and new leaves emerged from the below-ground growing point a few days after the frost event.

Grain yield had a strong year by location by planting date interaction so we will present data for each year and site. When averaged across hybrids, the late April-planted corn had a 3.7% yield advantage over the mid-May planted corn at the Aurora Research Farm in 2009 (Table 2), a cool and moist growing season that was stress-free throughout. Of equal importance, especially in the 2009 growing season when dry-down was quite slow because of cool conditions, grain moisture at harvest averaged 2.2 percentage units lower, which would greatly decrease drying costs (Table 3). At Sparta Farms, however, corn yield averaged the same between the two planting dates when averaged across hybrids (Table 2). As at Aurora, grain moisture at harvest averaged 2.6 percentage units dryer at the April-planting date, which would make that the more profitable planting date at Sparta Farms in 2009 (Table 3). Because the 2009 growing season was stress-free and frost did not occur until mid-October, we believe that the 2009 results clearly show the planting date effect with no confounding weather interactions.

When averaged across hybrids, the April-planted corn yielded 7.3% lower at Aurora and a stunning 19.6% lower at Sparta Farms when compared with mid-May planted corn in 2010 (Table 2). The April-planted hybrids at Aurora were at the silking stage from 9-11 July, when temperatures averaged 93 ^{0}F during the 7-day period preceding silking. In contrast, the May-planted hybrids were at the silking stage from 18-20 July when temperatures averaged about 82 degrees for the 10 day period before and after silking. Corn is most vulnerable to drought or heat stress in the 10-day period before and after silking. We believe that the lower yield at Aurora for the April-planted corn was associated with the timing of heat stress, which is a random event, rather than a planting date effect. Grain moisture at harvest averaged 2.1 percentage units lower at harvest for the April compared with the mid-May planted corn, mitigating somewhat the loss of profit with the early planting date at this site.

Explanation of the 19.6% yield decrease for the April-planted corn at Sparta Farms is more problematic. The 12 May frost delayed development so silking

Table 1. Average number of growing degree days (GDD, 86/50 system) at the Aurora Research Farm during the main spring months in the 2009 and 2010 compared with long-term averages.

	GDD					
Month	2009	2010	1951-80 Avg.	1961-90 Avg.	1971-2000 Avg	1981-2010 Avg.
	---------- ^{o}F ----------					
April	173	202	117	120	124	139
May	330	414	285	295	315	316
April 20-30	112	46	62	63	65	71

Table 2. Grain yield of six corn hybrids planted on two dates at the Aurora Research Farm (Cayuga Co.) and Sparta Farms (Livingston Co.) in 2009 and 2010.

	PLANTING DATE			
	AURORA		SPARTA FARMS	
HYBRID	4/25/09	5/18/09	4/27/09	5/20/09
DKC48-40	275	248	282	261
DKC50-44	262	253	270	273
DKC52-43	263	301	265	266
DKC52-59	298	268	273	270
DKC54-16	286	284	232	244
36V53	304	269	218	247
Mean	**281**	**271**	**257**	**260**
LSD 0.05	**9**		**NS**	
	4/22/10	5/17/10	4/23/10	5/18/10
DKC48-40	190	235	175	271
DKC50-44	227	237	241	286
DKC52-43	209	217	214	249
DKC52-59	210	235	234	274
DKC54-16	237	238	235	276
36V53	224	237	235	285
Mean	**216**	**233**	**222**	**273**
LSD 0.05	**7**		**9**	

†LSD 0.05 compares means between planting dates.

did not occur for the April-planted corn until 14-15 July compared with 20-21 July for the May-planted corn. Consequently, there was only a 1.1 instead of the typical 2 percentage unit difference in grain moisture at harvest between planting dates because of the delayed development for April-planted corn after the frost. Temperatures averaged 89 ^{0}F in the 10-day period before silking for the April-planted corn compared with 85 ^{0}F for the 10-day before and after silking for the May-planted corn. The temperature difference should not have resulted in a 19.6% yield difference because there was no moisture stress at this site. We believe that the frost stress followed by moderate heat stress resulted in multiple stresses for the April-planted corn, which contributed to the significant yield hit. There is a much greater probability that a significant frost event will occur after corn emergence for April-planted compared to mid-May planted corn. Consequently, we believe that the results at Sparta Farms in 2010 are indicative of the risk of planting corn in April for valley locations, such as the Sparta Farms site.

Conclusion

Spring conditions have warmed considerably over the last 30 years and corn growers in the USA have taken advantage by planting corn earlier. In New York, especially on dairy farms where manure is spread in the spring, corn planting frequently does not occur until May so only 55% of the corn is planted in New York by mid-May. An April-planting date for locations near the Lakes, such as Aurora, will probably result in a small but significant yield advantage because there is limited danger of killing frost (<28 ^{0}F) during the month of May. Of equal importance is that grain moisture at harvest will average 2 percentage units lower for April compared with mid-May planted corn, which will greatly reduce drying costs, especially in years with high LPG prices. In locations where there is a danger of killing frost in mid-May, April-planted corn may be vulnerable to some yield damage, especially in years when it is warm in late April and the first half of May. The growing point of corn will still be below the ground so the stand will probably recover but development could be delayed and yield may be impacted. Nevertheless, we recommend planting corn anytime after 20 April in central/western NY if soil conditions are dry enough in all locations because weather conditions are random and heat and drought stress can occur at silking for corn planted on any date. If soil conditions are wet in late April or early May, there is no need to mud it in because there is very limited yield loss, if any, for corn planted from 15-20 May compared with corn planted from 20-25 April. Grain moisture will be 2 percentage units higher at harvest, however, so planting earlier hybrids is a consideration if planting drags on until late May or early June.

Table 3. Grain moisture at harvest of six corn hybrids planted on two dates at the Aurora Research Farm (Cayuga Co.) and Sparta Farms (Livingston Co.) in 2009 and 2010.

	PLANTING DATE			
	AURORA		SPARTA FARMS	
HYBRID	4/25/09	5/18/09	4/27/09	5/20/09
DKC48-40	17.5	20.0	21.3	23.7
DKC50-44	18.7	21.5	20.9	23.7
DKC52-43	19.7	19.9	21.2	23.0
DKC52-59	18.5	21.3	21.0	23.1
DKC54-16	19.5	21.5	22.6	26.2
36V53	19.3	22.3	23.1	25.9
Mean	**18.9**	**21.1**	**21.7**	**24.3**
LSD 0.05	**0.2**		**0.7**	
	4/22/10	5/17/10	4/23/10	5/18/10
DKC48-40	19.2	21.3	20.3	21.5
DKC50-44	19.1	21.1	21.7	22.3
DKC52-43	19.8	21.1	20.7	21.7
DKC52-59	19.9	22.1	21.5	22.6
DKC54-16	21.3	23.3	22.5	23.7
36V53	20.1	22.8	21.2	22.3
Mean	**19.9**	**22.0**	**21.3**	**22.4**
LSD 0.05	**0.3**		**0.6**	

†LSD 0.05 compares means between planting dates.

Calendar of Events

March 23, 2011	**Adaptive N Management and Soil Health Management Workshops, Ithaca, NY**
June 2, 2011	**Small Grains Management Field Day, Musgrave Farm, 1256 Poplar Ridge Rd, Aurora, NY**

What's Cropping Up? is a bimonthly newsletter distributed by the Crop and Soil Sciences Department at Cornell University. The purpose of the newsletter is to provide timely information on field crop production and environmental issues as it relates to New York agriculture. Articles are regularly contributed by the following Departments at Cornell University: Crop and Soil Sciences, Plant Breeding, Plant Pathology, and Entomology. **To get on the mailing list, send your name and address to Larissa Smith, 237 Emerson Hall, Cornell University, Ithaca, NY 14853 or lls14@cornell.edu.**

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