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Comparison of Roundup Ready and Conventional Soybean (Glycine Max L.) Weed Control Systems for Optimizing Yield and Economic Profitability

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To the Graduate Council:

I am submitting herewith a thesis written by Brittany Lee Gaban entitled "Comparison of Roundup Ready and Conventional Soybean (Glycine Max L.) Weed Control Systems for Optimizing Yield and Economic Profitability." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Plant Sciences.

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Comparison of Roundup Ready and Conventional Soybean (*Glycine Max L.*) Weed Control Systems for Optimizing Yield and Economic Profitability

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Abstract

Research was conducted in 2010, 2011 and 2012 at the East Tennessee Research and Education Center in Knoxville, TN, in order to compare differences in soybean yield among differing levels of weed control within Roundup Ready® [Glyphosate-resistant] (RR)and conventional soybean cultivars to gain a better understanding of the impact different intensities of weed control have on RR and conventional cropping systems. Results determined that after applying the weed control regimens, there was no significant difference ($p<0.05$) in yield (kg ha^{-1}) [kilograms per hectare] between soybean cultivars at any level of weed control at any date or environment. Additionally, no significant difference in yield was found between the two highest levels of weed control used.

Glyphosate resistant weeds introduce new challenges and create a more costly weed control regimen, especially when using a RR based soybean cultivation operation. Therefore, calculated economic returns of RR and conventional weed management technologies used in this study were contrasted to determine profitability of each system. In a glyphosate resistant-free environment, the conventional soybean cultivar had a net return of only 0.4% greater than that of the RR cultivar. The comparison of cultivar net return and yield indicates conventional soybean production is competitive to RR productions, however the tremendous use of RR technologies leaves conventional crops vulnerable to potential damage or death due to drift. If glyphosate resistant weeds are present in an environment, RR production and hand hoeing may be the best choice for weed control.

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Introduction

Soybean

Soybean [*Glycine max* (L.) Merr.] is a bushy, annual herbaceous legume that produces seed, which can be used for a variety of products (Duke 1983). Soybean is the second largest crop by planted area in the United States after corn (*Zea mays* L.) (Reddy 2001). The U.S. is the current global leader in soybean production, growing 35% of all soybeans in 2010 (ASA 2012). In 2011, 30 million hectares of soybeans were planted, producing 83 million metric tons of seed (USDA 2011a). Vital to the United States' economy, 45% of soybeans produced in the U.S. were exported and farm cash receipts for soybean production in 2011 were $40.2 billion dollars at about $1140.61/metric ton (USDA 2011b).

Glyphosate-resistant Weeds

Weed shifts occur due to selection pressures or disturbances, which favor a particular species. Herbicide use is one of the most important selective forces on a weed community in an agricultural ecosystem (Owen, Zelaya 2005). Continuous use of a single herbicide applied to a given site over time selects for increased resistance in weed species that had once been susceptible to that herbicide (LeBaron, Gressel 1982). Resistance occurs due to the selection in favor of naturally-occurring mutations of resistant plants, as herbicides do not cause mutations (Duke et al. 1991). According to Warwick (1991), herbicide resistance may be defined as the state in which a plant is able to survive the "normal field dose of a herbicide, as a result of selection and genetic response to repeated exposure."

Glyphosate has largely replaced many selective herbicides. In the U.S. 90%+ soybean, 91%+ cotton, and 60%+ corn crops are glyphosate-resistant (Powles 2008). Most growers of RR

crops utilize glyphosate alone or as the primary herbicide in their weed control regimens. After only 3 years of using only glyphosate in RR soybeans, reduced levels of control of horseweed (*Conyza canadensis*) populations were documented in Delaware (VanGessel 2001). The elimination of herbicide susceptible individuals, allows resistant individuals to fill open ecological niches. Currently, there are 23 glyphosate resistant (GR) species of weeds worldwide (Weed Science 2012). Currently GR horseweed and GR palmer pigweed (*Amarathus palmeri*) pose a major threat to the productivity of RR soybeans in Tennessee.

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Part I

Soybean Yield and Profitability in Response to Cultivar and Level of Weed Control

Abstract

A 2 by 4 factorial study was conducted in 2010, 2011 and 2012 at the East Tennessee Research and Education Center in Knoxville, TN to contrast the yields of 2 near isogenic lines of soybean, the Roundup Ready® (RR) 'Allen' and the conventional 5601T, over 4 levels of weed control (i.e. untreated, low, medium and high). The conventional line received herbicides that range in mode of action, including pendimenthalin, imazaquin, clethodim, and imazethapyr. The RR line received only POST glyphosate. The high level of weed control for both conventional and RR soybean lines also received hand hoeing to maintain a weed-free check. A partial budget analysis was used to determine financial differences between RR technology and conventional technology in soybean production systems. 5601T at the medium level of weed control did not show significantly different yield from the Allen at the medium level of weed control or the 5601T at the high level of weed control; however it did yield significantly less than Allen at the high level of weed control. Allen at the medium level of weed control did not yield differently from wither the 5601T at the medium level or either of the cultivars at the high level of weed control, indicating that there is not a difference between medium and high levels of weed control when analyzed using Tukey HSD. Results from this study suggest that utilizing a herbicide treatment which provides adequate weed control will produce high yields and will have the greatest net benefit for both RR and conventional technologies.

Nomenclature: Soybean (*Glycine max* L.)

Key words: *soybean (Glycine max L.), near isogenic lines, glyphosate-resistant, weed control, partial budget analysis, Roundup Ready®*

Introduction

It is well known that the presence of weeds is a major yield-limiting factor when compared to other crop pests, and some form of weed management is generally utilized to reduce competition for resources between crops and weeds. In the last century, a chemical revolution has introduced synthetic herbicides to the agricultural industry and has influenced the way growers handle weed problems. Herbicides provide crop protection simplicity, are cost efficient and have proven to be economically viable for crop production (Reddy 2001).

Glyphosate

Prior to the release of RR crops, glyphosate use was limited to no-till situations prior to crop emergence or in perennial cropping systems (Powles 2008). More recently, RR weed control technology has revolutionized the agricultural industry in the U.S. (Paarlberg 2000). Glyphosate can be applied post-emergence in RR crops to control a broad spectrum of weeds without crop phytotoxicity. Glyphosate will be more than adequate on small weeds as well as large weeds and does not normally require tank mixes or sequential herbicides that other weed management systems might (Powles 2008). The widespread use of glyphosate in RR systems is attributed to simplicity, cost efficiency, favorable environmental profile, and low mammalian toxicology (Powles 2008). However, continuous exposure of large tracts of farmland to glyphosate has selected for glyphosate resistant plants of various weed species. Thus modern agriculture is demanding different, yet just as efficient, weed management practices.

Glyphosate inhibits the 5-Enolypyruvylshikimate-3-phosphate synthase (EPSPS) enzyme of the shikimate pathway by means of competing with the phosphoenolpyruvate (PEP) binding site on EPSPS (Duke and Powles 2008). EPSPS is the catalyst for the transfer of the enolpyruvyl moiety of PEP to shikimate-3-phosphate (S3P), forming EPSP and phosphate; this is a key step

in the synthesis of aromatic amino acids (Dill 2005). Without the aromatic amino acids phenylalanine, tyrosine and tryptophan, the plant is unable to make proteins causing the prevention of secondary products necessary for life (Reddy 2001). The enzyme EPSPS is present in all plants, bacteria and fungi but not in animals (Reddy 2001).

Glyphosate offers a large window of opportunity to make an application that will provide adequate weed control in soybeans. Glyphosate can be applied at any point from soybean emergence to flowering (Reddy 2001). To get the best weed control, glyphosate is applied after most weeds have emerged. Application rate and timing relative to weed growth stage will determine the effectiveness of the glyphosate application (Reddy 2001). It was found that full control of a given species can be achieved despite a difference in plant size by increasing the rate of glyphosate (Jordan et al. 1997).

Glyphosate-resistant Soybean

RR is a seed trait technology which provides weed management programs that utilize POST glyphosate for weed control in glyphosate resistant (GR) crops (Hurley at al. 2009; Powles 2008). After the commercial release of transgenic soybean in 1996, U.S. farmers embraced and exponentially adopted the use of RR soybean (USDA 2011; Reddy 2001). The adoption of RR technologies has created a strong selection pressure on weed species that possess GR genes, thus introducing new challenges for U.S. growers who rely on RR technologies.

Commercialized RR soybeans were developed through the insertion of the CP4 gene into the crop's genome (Duke and Powles 2008). CP4 is a bacterial EPSPS enzyme isolated from *Agrobacterium* sp. that has a herbicide binding site identical to that of EPSPS (Dill 2005). RR crops will contain both EPSPS and CP4-EPSPS. When treated with glyphosate, the glyphosate will bind with EPSPS, PEP will be able to by-pass EPSPS and bind with CP4-EPSPS resulting in

a shikimate pathway that will function normally and the plant will maintain aromatic amino acid levels (Dill 2005; Reedy 2001). Yield drag was originally observed with RR soybean production (Elmore et al. 2001). In some field studies, it has been noted that RR lines yielded 5% less than the conventional lines (Elmore et al. 2000).

Soybean Near Isogenic Lines (NIL): Allen and 5601T

Soybean cultivar 5601T is a conventional cultivar developed by the Tennessee Agricultural Experiment Station (Pantalone et al. 2003). 5601T was released in 2001 for its high yielding abilities in the southern United States, and was the highest yielding line in USDA Maturity Group V Regional test for Tennessee and Kentucky in 2005, 2006, and 2007 (Landau-Ellis and Pantalone 2009). 5601T has been used as a USDA check cultivar in the southern region and is frequently used as a check cultivar in many research experiments.

Through marker-assisted backcrossing, the soybean cultivar 'Allen' (originally designated as line 501TRR-292) is the BC3F2-derived RR progeny of the conventional cultivar and recurrent parent, 5601T and the donor line TN93-99RR (Pantalone et al. 2010). Due to high yield capabilities, 5601T was an optimal soybean line to be used as a recurrent parent of RR progeny for the southern region. TN93-99RR was chosen as a donor line as it shared a common parent with 5601T, 'Hutcheson', in addition to its high yield throughout the southern U.S. (Buss et al. 1988, Pantalone et al. 2003). Marker-assisted selection (MAS) allows plant breeders to select superior individual based on DNA. One application of MAS is to identify plants during backcrossing that are more genetically similar to the recurrent parent than to the donor parent. Utilizing 93 simple sequence repeat markers, DNA profiles of specific BC1F1, BC2F1, and BC3F1 plants containing a genome most in common with 5601T were identified (Pantalone et al. 2010). With the ability to choose and backcross lines that are most genetically similar to the

recurrent parent, MAS hastens the time needed to incorporate genes into the favorable line. As a result, the rapid MAS development of the Allen cultivar was expected to have similar genetic characteristics, including yield as 5601T. The present study was conducted to compare yield and economics of RR vs. conventional weed management technologies by using the NIL 5601T and Allen, thus reducing possible variations commonly associated with different soybean cultivars.

Economic Impacts

Reduced yields due to weed pressure is of financial significance in soybean cultivation, even more so when GR weeds are present. Conventional soybean farming systems, without RR technologies, can cost between $109.49-$173.12/ha (Reddy and Whiting. 2000). RR technologies will cost approximately $127.85/ha for optimum weed control utilizing a two time application program of glyphosate, if GR weeds are not present (Reddy and Whiting 2000). Both soybean weed control programs take into account costs for seed, herbicide, adjuvant, and application (Reddy and Whiting 2000). The presence of GR weeds such as horseweed in RR soybeans programs will have a cost increase of $28.42/ha (Mueller et al. 2005).

It is important for soybean producers to accommodate and adapt to new production issues. Changes that are made to current programs will have consequences. To compare benefits and costs of these adjustments, partial budgets are used as a tool for farm planning (Roth and Hyde 2002). A partial budget will only include resources that will be adjusted, focusing on changes on income and expenses. It will have four parts: additional income, reduced costs, reduced income and additional costs (Lessley et al. 1991). Additional income will include means of generating new revenue or increasing existing enterprises. Reduced costs include expenses no longer incurred due to the change. Reduced income includes possible reduction in revenue due to the proposed change. Lastly, the additional costs section will consist of new costs associated

with the proposed change (Roth and Hyde 2002). Net income is calculated by comparing the sum of additional income and reduced costs with the sum of reduced income and additional costs (Lessley et al. 1991).

The increasing presence of GR weeds in soybean fields has much to do with the grower's crop management decision (Green and Owen 2011). GR weed best management practices include using different herbicides with different MOA and preventing weeds from setting seed (Monsanto 2012). In a study published by Johnson and others (2009), less than half of all growers surveyed believed that it was a priority to have a tank mix with glyphosate for GR weed management, and less than one third believed tillage was a GR weed management tool. Furthermore, these growers believed that following glyphosate label rates was 'the most effective strategy for reducing or preventing GR weeds' (Johnson et al. 2009). In a more recent survey, only 52% of growers who use continuous RR soybean seed were aware of GR weeds at a county level, only 45% of southern growers surveyed believed that GR weeds are a 'very serious' problem, and, alarmingly enough, 54% of farmers who use a continuous RR soybean system have found on-farm GR weeds (Prince et al. 2012). Although awareness of GR weeds has increased, most growers act to focus on weed control issues at hand rather than to be proactive to prevent the onset of GR weeds (Mueller et al. 2005). With the loss of weed control in RR systems, cost for adequate weed management will increase. Additionally, in a Delaware soybean grower survey, 48% of growers reported a $5-$17/ha increase for GR horseweed management, with another 28% of growers experiencing a $17+/ha increase (Scott and VanGessel 2007).

It is indicated that greatest control of GR weeds will be in soybeans that utilize a diversity of herbicides. Greater than 80% control of GR palmer amaranth (*Amaranthus palmeri*) was achieved 90 days after POST herbicide application by using a PRE s-metolachlor and PRE

fomesafen in combination with POST fomesafen, while POST glyphosate controlled 23% of GR palmer amaranth population (Whitaker et al. 2010). In the study mentioned above, only a RR soybean cultivar was used in both the RR and conventional herbicide systems. Technology fees are associated with the RR seed trait and are avoided in conventional herbicide systems, suggesting that utilization of conventional seed and herbicide systems may be the most cost-effective option.

Previous similar research examined RR and conventional cultivars. Reddy and Whiting (2000) reported lower net returns in non-RR compared to other cultivars. They reported that major factors to consider would be yield potential, seed cost (including any technology fee), since herbicide costs were comparable among the different systems. Shaw et al (2001) also published a report related to this topic. They used 3 RR and 3 conventional soybean cultivars at 4 levels, ranging from untreated (none) to low to medium to high levels (which represented reduced rates to full rates to full rates + additional POST application). The reported results were mixed with respect to maximum net returns as affected by the examined variables.

The objectives for this study were 1) to compare differences in yield among different levels of weed control within RR and conventional soybean NIL cultivars and 2) to contrast the economic return of RR and conventional weed management technologies. A major difference in our research approach compared to previous reports is the use of a NIL soybean to eliminate the potential yield difference between the 2 cultivars. Previous reports (Reddy and Whiting 2000, Shaw et al. 2001) used disparate soybeans with varying levels of yield potential, disease tolerance, etc. Our methods also included a complete range of weed control levels from an untreated weedy control to a hand-weeded, weed-free check plot; whereas other approaches were used by the previously mentioned reports.

Materials and Methods

Field research to examine the effects of cultivar and level of weed control on soybean yield and profitability was conducted at two environments within the East Tennessee Research and Education Center in Knoxville, TN: the Plant Science Unit (PSU) and the Holston Unit (HU). This experiment was repeated over a three year period (2010, 2011, 2012). Soybean seed was planted into tilled ground using a conventional till system at PSU in 2010 and 2011 and no-till system at HU in all years and PSU in 2012. Both sites had similar soil (Sequatchie loam) and good to excellent fertility levels. No supplemental irrigation was added to any trial, and no PRE herbicides were activated by irrigation. The entire plot area was fertilized with 750 kg ha^{-1} of 12-12-12 fertilizer ~ 7 d before planting. A different plot area was used for the subsequent studies in later years. The PSU in 2011 was not harvested due to extended wet weather that precluded harvest of the plots, and the plants lost their seeds due to shattering.

This experiment is a 2 by 4 factorial study, which utilized a randomized complete block, split-plot design with 4 replications at each environment. Soybean cultivar (Allen and 5601T) was the whole plot treatment, while level of weed control (untreated, low, medium and high) was the sub-plot treatment in our design model. Sub-plots were four 76 cm rows wide by 12.2 m in length, and main plots were 16 rows wide by 12.2 m. A minimum of 4 soybean rows or 4 meters was allowed between main plots to provide a buffer zone to avoid glyphosate drift onto 5601T plots. The cultivars are a maturity group V, which is well-adapted to the climate.

The 5601T cultivar's levels of weed control consisted of four levels of weed control utilizing selective herbicides. The untreated received no herbicide application or hand hoeing. The low level received a PRE herbicide application of a mixed formulation of pendimenthalin and imazaquin (Squadron®, BASF, Research Triangle Park, NC). The medium level received

the PRE as well as an EPOST application of clethodim (Select Max®, Valent U.S.A Corp., Walnut Creek, CA) and imazethapyr (Pursuit®, BASF, Research Triangle Park, NC). The high level received both the PRE and EPOST treatments as well as supplemental hand hoeing to maintain a weed-free plot.

The Allen cultivar's herbicide treatments that define the four levels of weed control are historically consistent with RR technologies, utilizing only glyphosate (Roundup WeatherMax®, Monsanto Co., St. Louis, MO). The untreated level received no herbicide applications and no hand hoeing. The low level received an EPOST application of glyphosate at 0.84 kg ae ha^{-1} (all glyphosate applications used the same dosage). The medium level received an EPOST and a LPOST application of glyphosate. The high level received both EPOST and LPOST treatments as well as supplemental hand hoeing to maintain a weed-free plot.

Herbicides were applied using small plot equipment of 8002 flat fan nozzles delivering 225 l ha^{-1}. Extreme care was taken not to drift glyphosate onto 5601T plots, or to have any drift from adjacent field studies. Mix size was 3 liters, and PRE applications were made the day of planting each year. EPOST applications were made to V3-V4 soybeans, and LPOST applications were made 3 to 4 weeks later.

The primary weeds present at PSU were ivyleaf morningglory (*Ipomoea hederacea L.*), johnsongrass *(Sorghum halepense L.*) and horseweed *(Conyza canadensis L.*). The primary weeds present at HU were pitted morningglory *(Ipomoea lacunosa L.*), johnsongrass *(Sorghum halepense L.*) and common cocklebur *(Xanthium strumarium L.*). Only in the PSU 2012 environment was GR horseweed present. No other GR weeds were present at any time in this study. Although clear differences were apparent in the levels of weed control, the exact amount

of weed in each plot were not determined. The objective data collected in this study were soybean yield in each plot, the various input costs, and the duration of hand hoeing for each plot.

The timing of herbicide application was determined by the growth stage of crop (PRE/POST) and by the size and growth of the weeds present. Additional hand hoeing was implemented throughout the growing season to maintain weed free plots. Yield data was collected via an on-board weigh scale and data logger in the combine on the day of harvest. Additionally, time spent hoeing high level plots were recorded at each hoeing event.

Data were analyzed using SAS 9.3 and the PROC MIXED procedure it offered. The random effects used were replication within environment and variety by replication within environment. Means were separated using Tukey's HSD at the 0.05 significance level. The relative increase in soybean yield for each increase in weed control level was calculated by the formula:

(Yield 2 – Yield 1)/ (Yield 1) *100.

This was done to illustrate how the NIL responded to more complete weed control.

Utilizing a partial budget analysis equation, the net benefit of each soybean production system was determined. Resources under financial consideration included yield revenue, herbicide costs, labor for hoeing costs, and seed costs. Resources not included were labor & equipment to plant seed, labor & equipment to harvest crop, labor in herbicide application, tillage (when used), or additional inputs such as land cost or fertilization.

Results and Discussion

Effects of Soybean Weed Control System on Yield

Within the 2010, 2011 and 2012 dates and environments, similar patterns observed in the soybean yield data (Table 1). No yield difference was observed between medium and high weed control levels at any environment or between cultivars (statistical analysis not shown). Lowest

yields were observed in untreated and low weed control levels in both cultivars at all environments. When comparing yield at the various weed control levels, there was no statistical difference between Allen and 5601T within a environment.

Averaged across all five environments (PSU 2010, HU 2010, HU 2011, PSU 2012, HU 2012) there was no significant difference ($p<0.05$) between cultivars at any weed control level. High and medium weed control levels produced yields that were significantly higher ($p<0.01$) than that of the untreated and low weed control levels. Untreated weed control levels also yielded significantly less than low treatment levels. The high weed control level was not significantly different from the medium weed control levels, despite the incorporation of hand hoeing into the high weed control treatment.

The relative yield response of the NIL to improved weed control was similar. As the weed control level went from none to low an increase of ~100% in both Allen and 5601T. Drastically lower increases were observed when weed control level went from medium to high in both cultivars (Table 4). These results indicate several aspects of this research. The NIL respond the same way as weed population densities are reduced by successive improvements in weed control. Greatest yield increase was noted at the first levels of weed control improvement (from none to low). Only a slight improvement in yield (less than 12%) was noted as weed control was maximized (from medium to high). The data also reinforce the need for weed control to maximize yields. Although only based on conjecture, the slightly greater effect of adding hand-hoeing in 5601T might indicate slightly less complete weed control in these plots compared to Allen. To reduce artifacts due to plot disturbance, the authors at the onset of the study decided to not take any subjective visual evaluations of weed control nor any destructive harvests of weed biomass (data not reported).

The three years of the study's course had widely divergent weather patterns, and resulting yields were highly variable (Table 1). Over all treatments, the lowest yield was 331 kg ha^{-1} and the highest yield was 4795 kg ha^{-1}. Within a given weed control level, variability was reduced, but there was still substantial variation. In general however, the NIL produced similar yields at the various levels. At the HU 2011 location there was an infestation of grasshoppers, which was controlled with the application of acephate. There appeared to be no difference in feeding preference of the insects for either cultivar.

The two NIL appeared to be quite similar in many ways, however in the course of the study one apparent difference was noted. The Allen cultivar was approximately 5 days later to full maturity than the 5601T. This was consistent in all environments in the study, and is consistent with previous observations of the developer of these NIL (personal communication, Pantalone). One reason the authors mention this observation is to remind the readers that the introgression of a given trait is never completely perfect from a genetic standpoint, in that it is essentially impossible not to insert additional ancillary genetic material is inherited along with the desired gene.

Whenever a cost analysis is conducted, a variety of input parameters is essential. A common source of error is estimating input values for the various input costs. This analysis is not unique from that perspective. The estimates for various parameters are listed in Table 2. Our cost estimates were based on local conditions and information available to the authors at the time of this writing. As seed, herbicide and labor costs change over time it would be relatively simple to reconstruct this table for a possible follow-up analysis.

The partial budget analysis results indicated the two NIL behaved similarly within a weed control level but differed substantially across the diverse levels (Table 3). Lowest returns were

noted in the untreated weed level, with returns less than $500 per hectare. Following the approximately 100% increase in soybean yield from untreated to low, the corresponding net returns were approximately doubled. The highest net returns were at the medium weed control level, with ~ $1800 per hectare net. The addition of hand weeding to remove the very few weeds that were present substantially reduced net income, due to high labor cost of ~ $1000 per hectare. From a short-term biological perspective, the medium level of weed control was the most profitable.

The authors caution that these results may not be applicable in all situations. These field plots did not have extremely problematic GR weeds, such as Palmer amaranth. If GR Palmer amaranth is present, it is advised that in the long-term interest of profitability the highest level of weed control may be the best choice to decrease the GR Palmer weed seed bank. Also important to remember is that the weed population in these plots was exceptionally high and that the hand weeding cost of a large, broad acre production field may be substantially lower for the entire field. It is common for the hand weeding efforts to be focused on a small portion of the entire field. This focusing of effort would reduce the total hand weeding cost per a given area. As such, the hand weeding cost estimates from this study represent an absolute worst-case scenario that may not be applicable in real-world situations.

Extreme care was taken not to drift glyphosate onto the 5601T plots, both from treatments inside the study and outside the study. One aspect of using RR soybean cultivars over the last 15 years in the United States is that since everybody has RR cultivars, the chance of crop injury from glyphosate drift onto soybeans is low. As weed control systems become more complex due to the diversity of traits that will soon be entering the market, drift may become a more common problem. New developments of soybeans that are tolerant of dicamba, 2,4-D and

HPPD- herbicides are expected soon and could be added to the already available glufosinate resistant soybean cultivars. The use of a conventional soybean cultivar such as 5601T, would be the most vulnerable soybean field from a drift potential perspective.

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Abbreviations Used

EPOST, early post-emergence; GR, glyphosate-resistant; HU, Holston Unit; LPOST, late post-emergence; MAS, Marker Assisted Selection; MOA, mode of action; PRE, pre-emergence; PSU, Plant Science; RR, Roundup Ready.

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Appendix A

Table 1. Soybean yield in 5 field environments in Tennessee as affected by soybean cultivar and weed control level.

Location/ Year	cultivar	Weed Control level			
		None	Low	Medium	High
		---------- kg ha $^{-1}$ ----------			
HU 10	Allen	331	2142	4427	4795
HU 10	5601T	461	1977	4201	4364
PSU 10	Allen	1221	2218	3848	3963
PSU 10	5601T	1128	2671	3272	3399
HU 11	Allen	940	1735	2811	2824
HU 11	5601T	1088	1822	2912	3288
HU 12	Allen	1022	1200	3786	3779
HU 12	5601T	649	1207	2956	3636
PSU 12	Allen	1474	2567	3695	3995
PSU 12	5601T	1557	2070	3463	4153
Average	Allen	998	1972	3713	3871
Average	5601T	976	1949	3361	3768

Table 2. Variables associated with using RR or conventional weed control technologies

	Price(US$)/Unit	Use Rate	US$/ha
1. Seed			
Allen	55.00/bag	2.72 bags/ha	149.48
5601T	24.00/bag	2.72 bags/ha	65.21
2. Herbicide			
Glyphosate (Roundup WeatherMax)	76 per 2.5gal	23 fl oz/a	13.52
Pendimethalin+imazaqin (Squadron)	92.25 per 2.5gal	3 pts/a	34.25
clethodim (Select Max)	265 per 2.5gal	12 fl oz/a	24.60
imazethapyr (Pursuit)	436 per gal	4 oz/a	33.73
3. Labor*			
1st Hand Hoe Allen	7.25/hour	78.36 hours/ha	568.11
2nd Hand Hoe Allen	7.25/hour	49.41 hours/ha	358.22
1st Hand Hoe 5601T	7.25/hour	108.67 hours/ha	787.86
2nd Hand Hoe 5601T	7.25/hour	68.86 hours/ha	499.24

*Labor prices based off of current minimum wage and by using timed trials in plots that were 40' long with a row spacing of 30".

Table 3. Net benefit calculations for Allen and 5601T soybeans over all five study environments (US$/ha)

	Untreated		Low		Medium		High	
	Allen	5601T	Allen	5601T	Allen	5601T	Allen	5601T
Revenue	547.11	535.49	1081.67	1069.13	2036.48	1843.05	2122.96	2066.53
Seed Costs	149.48	65.21	149.18	65.21	149.18	65.21	149.18	65.21
Herbicide Costs	0	0	13.52	34.25	27.04	58.84	27.04	58.84
Labor Costs (Hand weeding only)	0	0	0	0	0	0	926.33	1287.48
Net Benefit	397.93	470.28	918.97	969.67	1860.26	1719.00	1020.41	655.00

Table 4. Yield increase observed from change in weed control level within soybean cultivar.

Change in Weed Control Level	**Yield Increase (%)**	
	Allen	**5601T**
None to Low	98	99.7
Low to Medium	88	72
Medium to High	4	12

Appendix B

Table 5. PSU 10 Field Trail Protocol

Plots: 10 by 35 feet

Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	Amt Product to Measure	Rep 1	2	3	4
6	VAR	Allen-LOW												101	204	303	403
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
7	VAR	Allen-MEDIUM												102	202	304	404
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	26.95 ml/mx				
5	VAR	Allen-UTC												103	203	301	402
	CHK	untreated															
8	VAR	Allen-HIGH												104	201	302	401
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	26.95 ml/mx				
	CULT	PLUS HANDWEED															
3	VAR	5601T-MEDIUM												105	208	306	406
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	14.06 ml/mx				
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters	7.499 ml/mx				
2	VAR	5601T-LOW												106	206	305	405
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
1	VAR	5601T-UTC												107	207	308	407
	CHK	untreated															
4	VAR	5601T-HIGH												108	205	307	408
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	14.06 ml/mx				
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters	7.499 ml/mx				
	CULT	PLUS HANDWEED															

Table 6. PSU 10 Field Trial Location Information

General Trial Information

Study Director: Tom Mueller
Investigator: Tom Mueller

Discipline: H herbicide

Trial Status: F one-year/final
Initiation Date: 4/23/2010 **Planned Completion Date:** 12/15/2010

Personnel

Study Director: Tom Mueller
Investigator: Tom Mueller

Crop Description

Crop 1: GLXMA Glycine max Soybean
Variety: Allen and 5601T **Description:** RR and conventional
BBCH Scale: BSOY **Planting Date:** 4/23/2010
Planting Method: PLANTD planted **Rate, Unit:** 45 LB/A
Depth, Unit: 1.5 in
Row Spacing, Unit: 30 in **Spacing Within Row, Unit:** 3 in
Seed Bed: MEDIUM medium
Harvest Date: 11/11/2010 **Harvest Equipment:** plot combine
Harvested Width, Unit: 5 ft **Harvested Length, Unit:** 35 ft
% Standard Moisture: 13.5 **Moisture Meter:** plot combine
Weighing Equipment: plot combine

Site and Design

Plot Width, Unit: 10 FT **Site Type:** FIELD field
Plot Length, Unit: 35 FT **Experimental Unit:** 1 PLOT plot
Plot Area, Unit: 350 FT2 **Tillage Type:** NOTILL no-till
Replications: 4 **Study Design:** SPLPLO Split-Plot

Soil Description

Description Name: Sequatchie
% Sand: 36 **% OM:** 1.4 **Texture:** L loam
% Silt: 46 **pH:** 6.3 **Soil Name:** Sequatchie
% Clay: 18 **CEC:** 9 **Fert. Level:** G good
Soil Drainage: G good

Table 7. PSU 10 Application Description

	A	B	C
Application Date:	4/23/2010	5/11/2010	6/4/2010
Time of Day:	10:00 AM	9:00 AM	7:45 AM
Application Method:	SPRAY	SPRAY	SPRAY
Application Timing:	PREMCR	POEMCR	POEMCR
Application Placement:	BROSOI	BROADC	BROADC
Applied By:	TCM	TCM	TCM

Table 8. PSU 10 Application Equipment

	A	B	C
Appl. Equipment:	TCM-6 Nozzle	TCM-6 Nozzle	TCM-6 Nozzle
Equipment Type:	BACMAN	BACMAN	BACMAN
Operation Pressure, Unit:	40 PSI	40 PSI	40 PSI
Nozzle Type:	flat fan	flat fan	flat fan
Nozzle Size:	8002	8002	8002
Nozzle Spacing, Unit:	19 in	19 in	19 in
Nozzles/Row:	2	2	2
% Coverage:	100	100	100
Boom Length, Unit:	10 ft	10 ft	10 ft
Boom Height, Unit:	20 in	20 in	20 in
Ground Speed, Unit:	3 MPH	3 MPH	3 MPH
Carrier:	WATER	WATER	WATER
Spray Volume, Unit:	20 gal/ac	20 gal/ac	20 gal/ac
Mix Size, Unit:	3 liters	3 liters	3 liters
Propellant:	COMCO2	COMCO2	COMCO2

Table 9. PSU 10 Yield in Bushel/Acre of Replication 1

Crop Code													GLXMA
BBCH Scale													BSOY
Crop Scientific Name													Glycine max
Crop Name													Soybean
Part Rated													YIELD C
Rating Date													11/11/2010
Rating Type													YIELD
Rating Unit													bu/ac
Number of Subsamples													1
Days After First/Last Applic.													202 160
Trt-Eval Interval													202 DA-A
Plant-Eval Interval													202 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	1
6	VAR	Allen-LOW											32.98 c
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
7	VAR	Allen-MEDIUM											57.23 a
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	
5	VAR	Allen-UTC											18.15 d
	CHK	untreated											
8	VAR	Allen-HIGH											58.93 a
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	
	CULT	PLUS HANDWEED											
3	VAR	5601T-MEDIUM											48.65 b
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters	
2	VAR	5601T-LOW											39.73 c
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
1	VAR	5601T-UTC											16.78 d
	CHK	untreated											

Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	1
4	VAR	5601T-HIGH											50.55 ab
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters	
	CULT	PLUS HANDWEED											
LSD (P=.05)													8.386
Standard Deviation													5.645
CV													13.98
Bartlett's X2													14.424
P(Bartlett's X2)													0.044*
Replicate F													0.525
Replicate Prob(F)													0.6707
Treatment F													34.186
Treatment Prob(F)													0.0001

Table 10. PSU Yield in Bushel/Acre of Replication 2

Crop Code														GLXMA
BBCH Scale														BSOY
Crop Scientific Name														Glycine max
Crop Name														Soybean
Part Rated														YIELD C
Rating Date														11/11/2010
Rating Type														YIELD
Rating Unit														bu/ac
Number of Subsamples														1
Days After First/Last Applic.														202 160
Trt-Eval Interval														202 DA-A
Plant-Eval Interval														202 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	Plot	1
6	VAR	Allen-LOW											101	23.80
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	204	41.40
													303	37.40
													403	29.30
													Mean =	32.98
7	VAR	Allen-MEDIUM											102	56.00
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	202	57.80
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	304	60.10
													404	55.00
													Mean =	57.23
5	VAR	Allen-UTC											103	13.10
	CHK	untreated											203	17.60
													301	19.70
													402	22.20
													Mean =	18.15
8	VAR	Allen-HIGH											104	56.30
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	201	61.40
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	302	57.40
	CULT	PLUS HANDWEED											401	60.60
													Mean =	58.93
3	VAR	5601T-MEDIUM											105	54.70
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	208	38.40
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	306	54.10
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	406	47.40
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters		
													Mean =	48.65
2	VAR	5601T-LOW											106	34.30
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	206	29.00
													305	47.30
													405	48.30
													Mean =	39.73
1	VAR	5601T-UTC											107	18.20
	CHK	untreated											207	15.40
													308	17.60
													407	15.90
													Mean =	16.78
4	VAR	5601T-HIGH											108	55.40
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	205	53.80
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	307	42.40
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	408	50.60
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters		
	CULT	PLUS HANDWEED												
													Mean =	50.55

Table 11. HU 10 Field Trial Protocol

Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	Amt Product to Measure	Rep 1	2	3	4
3	VAR	5601T-MEDIUM												101	208	306	406
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	14.06 ml/mx				
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters	7.499 ml/mx				
2	VAR	5601T-LOW												102	206	305	405
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
1	VAR	5601T-UTC												103	207	308	407
	CHK	untreated															
4	VAR	5601T-HIGH												104	205	307	408
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	14.06 ml/mx				
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters	7.499 ml/mx				
	CULT	PLUS HANDWEED															
8	VAR	Allen-HIGH												105	201	302	401
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	26.95 ml/mx				
	CULT	PLUS HANDWEED															
7	VAR	Allen-MEDIUM												106	202	304	404
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	26.95 ml/mx				
5	VAR	Allen-UTC												107	203	301	402
	CHK	untreated															
6	VAR	Allen-LOW												108	204	303	403
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				

Table 12. HU 10 Field Trial Location Information

General Trial Information

Study Director: Tom Mueller
Investigator: Tom Mueller

Personnel

Study Director: Tom Mueller
Investigator: Tom Mueller

Crop Description

Crop 1: GLXMA Glycine max Soybean
Variety: Allen and 5601T
Description: RR and conventional
BBCH Scale: BSOY
Planting Date: 4/30/2010
Planting Method: PLANTD planted
Rate, Unit: 45 LB/A
Depth, Unit: 1.5 in
Row Spacing, Unit: 30 in
Spacing Within Row, Unit: 3 in
Seed Bed: MEDIUM medium
Harvest Date: 11/2/2010
Harvest Equipment: plot combine
Harvested Width, Unit: 5 ft
Harvested Length, Unit: 35 ft
% Standard Moisture: 13.5
Moisture Meter: plot combine
Weighing Equipment: plot combine

Site and Design

Plot Width, Unit: 10 FT
Site Type: FIELD field
Plot Length, Unit: 35 FT
Experimental Unit: 1 PLOT plot
Plot Area, Unit: 350 FT2
Tillage Type: NOTILL no-till
Replications: 4
Study Design: SPLPLO Split-Plot

Field Prep./Maintenance:

on september 2, 20110 (9-2-10) sprayed Warrior on all plots for grasshopper control. loaded 40 mL of Warrior product into a 3 gallon Stainless Steel tank and sprayed with tractor boom over-hanging plots. used 8002 nozzles on boom.

Soil Description

Description Name: Sequatchie
% Sand: 36
% OM: 1.4
Texture: L loam
% Silt: 46
pH: 6.3
Soil Name: Sequatchie
% Clay: 18
CEC: 9
Fert. Level: G good
Soil Drainage: G good

Table 13. HU 10 Application Description

	A	B	C
Application Date:	4/30/2010	5/28/2010	6/9/2010
Time of Day:	1:30 pm	11:45 AM	9:15 am
Application Method:	SPRAY	SPRAY	SPRAY
Application Timing:	PREMCR	POEMCR	POEMCR
Application Placement:	BROSOI	BROADC	BROADC
Applied By:	TCM	TCM	TCM

Table 14. HU 10 Application Equipment

	A	B	C
Appl. Equipment:	TCM-6 Nozzle	TCM-6 Nozzle	TCM-6 Nozzle
Equipment Type:	BACMAN	BACMAN	BACMAN
Operation Pressure, Unit:	40 PSI	40 PSI	40 PSI
Nozzle Type:	flat fan	flat fan	flat fan
Nozzle Size:	8002	8002	8002
Nozzle Spacing, Unit:	19 in	19 in	19 in
Nozzles/Row:	2	2	2
% Coverage:	100	100	100
Boom Length, Unit:	10 ft	10 ft	10 ft
Boom Height, Unit:	20 in	20 in	20 in
Ground Speed, Unit:	3 MPH	3 MPH	3 MPH
Carrier:	WATER	WATER	WATER
Spray Volume, Unit:	20 gal/ac	20 gal/ac	20 gal/ac
Mix Size, Unit:	3 liters	3 liters	3 liters
Propellant:	COMCO2	COMCO2	COMCO2

Table 15. HU 10 Yield in Bushel/Acre Replication 1

Crop Code												GLXMA
BBCH Scale												BSOY
Crop Scientific Name												Glycine max
Crop Name												Soybean
Part Rated												YIELD C
Rating Date												11/2/2010
Rating Type												YIELD
Rating Unit												bu/ac
Number of Subsamples												1
Days After First/Last Applic.												186 146
Plant-Eval Interval												186 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	1
3	VAR	5601T-MEDIUM											62.48 a
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters	
2	VAR	5601T-LOW											29.40 b
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
1	VAR	5601T-UTC											6.85 c
	CHK	untreated											
4	VAR	5601T-HIGH											64.90 a
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters	
	CULT	PLUS HANDWEED											
8	VAR	Allen-HIGH											71.30 a
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	
	CULT	PLUS HANDWEED											
7	VAR	Allen-MEDIUM											65.83 a
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	
5	VAR	Allen-UTC											4.93 c
	CHK	untreated											
6	VAR	Allen-LOW											31.85 b
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
LSD (P=.05)													11.997
Standard Deviation													8.076
CV													19.14
Bartlett's X2													35.405
P(Bartlett's X2)													0.001*
Replicate F													2.104
Replicate Prob(F)													0.1355
Treatment F													45.925
Treatment Prob(F)													0.0001

Table 16. HU 10 Yield in Bushel/Acre Replication 2

Crop Code													GLXMA
BBCH Scale													BSOY
Crop Scientific Name													Glycine max
Crop Name													Soybean
Part Rated													YIELD C
Rating Date													11/2/2010
Rating Type													YIELD
Rating Unit													bu/ac
Number of Subsamples													1
Days After First/Last Applic.													186 146
Plant-Eval Interval													186 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	Plot	1
3	VAR	5601T-MEDIUM											101	65.90
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	208	58.30
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	306	73.70
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	406	52.00
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters		
													Mean =	62.48
2	VAR	5601T-LOW											102	15.20
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	206	39.30
													305	50.00
													405	13.10
													Mean =	29.40
1	VAR	5601T-UTC											103	6.70
	CHK	untreated											207	4.90
													308	8.60
													407	7.20
													Mean =	6.85
4	VAR	5601T-HIGH											104	63.80
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	205	65.10
	HERB	Select Max	0.97	LBA/GAL	EC	12	fl oz/a	B	20	GAL/AC	3	Liters	307	65.70
	HERB	Pursuit 70 dg	70	%	DF	1.44	oz wt/a	B	20	GAL/AC	3	Liters	408	65.00
	ADJ	NIS	100	%	SL	0.25	% v/v	B	20	GAL/AC	3	Liters		
	CULT	PLUS HANDWEED												
													Mean =	64.90
8	VAR	Allen-HIGH											105	65.00
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	201	67.90
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	302	80.00
	CULT	PLUS HANDWEED											401	72.30
													Mean =	71.30
7	VAR	Allen-MEDIUM											106	53.20
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	202	65.40
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	304	73.40
													404	71.30
													Mean =	65.83
5	VAR	Allen-UTC											107	5.40
	CHK	untreated											203	4.50
													301	5.30
													402	4.50
													Mean =	4.93
6	VAR	Allen-LOW											108	36.70
	HERB	Roundup WeatherMax	5.5	LB/GAL	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	204	19.70
													303	29.50
													403	41.50
													Mean =	31.85

Table 17. HU 11 Field Trial Protocol

Plots: 10 by 40 feet

Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	Amt Product to Measure	Rep 1	2	3	4
1		Conventional 5601T												101	206	302	401
	CHK	Untreated Check															
2		Conventional 5601T												102	207	304	402
	CHK	Handweeded Check															
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	14.06 ml/mx				
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters	7.499 ml/mx				
3		Conventional 5601T low weed control												103	208	303	404
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
4		Conventional 5601T medium weed control												104	205	301	403
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	14.06 ml/mx				
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters	7.499 ml/mx				
5		RoundupReady Allen												105	204	306	406
	CHK	Untreated Check															
6		RoundupReady Allen												106	202	308	407
	CHK	Handweeded Check															
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	26.95 ml/mx				
7		RoundupReady Allen low weed control												107	201	305	408
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
8		RoundupReady Allen medium weed control												108	203	307	405
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	26.95 ml/mx				

Table 18. HU 11 Field Trial Location Information

General Trial Information

Study Director: Tom Mueller
Investigator: Tom Mueller

Personnel

Study Director: Tom Mueller
Investigator: Tom Mueller

Crop Description

Crop 1: GLXMA Glycine max Soybean
Variety: Allen and 5601T
Description: RR and conventional
BBCH Scale: BSOY
Planting Date: 5/9/2011
Planting Method: PLANTD planted
Rate, Unit: 45 LB/A
Depth, Unit: 1.5 in
Row Spacing, Unit: 30 in
Spacing Within Row, Unit: 3 in
Seed Bed: MEDIUM medium
Harvest Date: 11/2/2011
Harvest Equipment: plot combine
Harvested Width, Unit: 5 ft
Harvested Length, Unit: 35 ft
% Standard Moisture: 13.5
Moisture Meter: plot combine
Weighing Equipment: plot combine

Site and Design

Plot Width, Unit: 10 FT
Site Type: FIELD field
Plot Length, Unit: 40 FT
Experimental Unit: 1 PLOT plot
Plot Area, Unit: 400 FT2
Tillage Type: NOTILL no-till
Replications: 4
Study Design: SPLPLO Split-Plot

Soil Description

Description Name: Sequatchie
% Sand: 36
% OM: 1.4
Texture: L loam
% Silt: 46
pH: 6.3
Soil Name: Sequatchie
% Clay: 18
CEC: 9
Fert. Level: G good
Soil Drainage: G good

Table 19. HU 11 Application Description

	A	B	C
Application Date:	5/9/2011	5/31/2011	7/6/2011
Time of Day:	1:30 PM	5:00 PM	8:30 AM
Application Method:	SPRAY	SPRAY	SPRAY
Application Timing:	PREMCR	POEMCR	POEMCR
Application Placement:	BROSOI	BROADC	BROADC
Applied By:	TCM	TCM	TCM

Table 20. HU 11 Application Equipment

	A	B	C
Appl. Equipment:	TCM-6 Nozzle	TCM-6 Nozzle	TCM-6 Nozzle
Equipment Type:	BACMAN	BACMAN	BACMAN
Operation Pressure, Unit:	40 PSI	40 PSI	40 PSI
Nozzle Type:	flat fan	flat fan	flat fan
Nozzle Size:	8002	8002	8002
Nozzle Spacing, Unit:	19 in	19 in	19 in
Nozzles/Row:	2	2	2
% Coverage:	100	100	100
Boom Length, Unit:	10 ft	10 ft	10 ft
Boom Height, Unit:	20 in	20 in	20 in
Ground Speed, Unit:	3 MPH	3 MPH	3 MPH
Carrier:	WATER	WATER	WATER
Spray Volume, Unit:	20 gal/ac	20 gal/ac	20 gal/ac
Mix Size, Unit:	3 liters	3 liters	3 liters
Propellant:	COMCO2	COMCO2	COMCO2

Table 21. HU 11 Yield in Bushel/Acre of Replication 1

Crop Code												GLXMA
BBCH Scale												BSOY
Crop Scientific Name												Glycine max
Crop Name												Soybean
Description												yield
Part Rated												SEED C
Rating Date												11/2/2011
Rating Type												YIELD
Rating Unit												bu/ac
Number of Subsamples												1
Days After First/Last Applic.												177 119
Plant-Eval Interval												177 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	1
1		Conventional 5601T											16.15 c
	CHK	Untreated Check											
2		Conventional 5601T											48.90 a
	CHK	Handweeded Check											
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters	
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters	
3		Conventional 5601T low weed control											27.10 b
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
4		Conventional 5601T medium weed control											43.30 a
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters	
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters	
5		RoundupReady Allen											13.98 c
	CHK	Untreated Check											
6		RoundupReady Allen											42.00 a
	CHK	Handweeded Check											
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	
7		RoundupReady Allen low weed control											25.80 b
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
8		RoundupReady Allen medium weed control											41.80 a
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	
LSD (P=.05)													7.185
Standard Deviation													4.836
CV													14.94
Bartlett's X2													6.85
P(Bartlett's X2)													0.445
Replicate F													4.693
Replicate Prob(F)													0.0137
Treatment F													30.462
Treatment Prob(F)													0.0001

Table 22. HU 11 Yield in Bushel/Acre of Replication 2

Crop Code													GLXMA
BBCH Scale													BSOY
Crop Scientific Name													Glycine max
Crop Name													Soybean
Description													yield
Part Rated													SEED C
Rating Date													11/2/2011
Rating Type													YIELD
Rating Unit													bu/ac
Number of Subsamples													1
Days After First/Last Applic.													177 119
Plant-Eval Interval													177 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	Plot	1
1		Conventional 5601T											101	22.40
	CHK	Untreated Check											206	11.40
													302	14.30
													401	16.50
													Mean =	16.15
2		Conventional 5601T											102	48.50
	CHK	Handweeded Check											207	44.10
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	304	53.00
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	402	50.00
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters		
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters		
													Mean =	48.90
3		Conventional 5601T											103	38.60
		low weed control											208	30.00
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	303	22.80
													404	17.00
													Mean =	27.10
4		Conventional 5601T											104	43.90
		medium weed control											205	38.80
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	301	46.20
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	403	44.30
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters		
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters		
													Mean =	43.30
5		RoundupReady Allen											105	14.90
	CHK	Untreated Check											204	23.50
													306	8.60
													406	8.90
													Mean =	13.98
6		RoundupReady Allen											106	39.30
	CHK	Handweeded Check											202	56.00
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	308	31.20
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	407	41.50
													Mean =	42.00
7		RoundupReady Allen											107	29.50
		low weed control											201	38.40
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	305	15.00
													408	20.30
													Mean =	25.80
8		RoundupReady Allen											108	35.60
		medium weed control											203	52.00
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	307	40.60
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	405	39.00
													Mean =	41.80

Table 23. HU 12 Field Trial Protocol

Plots: 10 by 40 feet

Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	Amt Product to Measure	Rep 1	2	3	4
1		Conventional 5601T												101	206	302	401
	CHK	Untreated Check															
2		Conventional 5601T												102	207	304	402
	CHK	Handweeded Check															
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	14.06 ml/mx				
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters	7.499 ml/mx				
3		Conventional 5601T low weed control												103	208	303	404
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
4		Conventional 5601T medium weed control												104	205	301	403
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	56.24 ml/mx				
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	14.06 ml/mx				
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters	7.499 ml/mx				
5		RoundupReady Allen												105	204	306	406
	CHK	Untreated Check															
6		RoundupReady Allen												106	202	308	407
	CHK	Handweeded Check															
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	26.95 ml/mx				
7		RoundupReady Allen low weed control												107	201	305	408
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
8		RoundupReady Allen medium weed control												108	203	307	405
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	26.95 ml/mx				

Table 24. HU 12 Field Trial Location Information

General Trial Information

Study Director: Tom Mueller
Investigator: Tom Mueller

Personnel

Study Director: Tom Mueller
Investigator: Tom Mueller

Crop Description

Crop 1: GLXMA Glycine max Soybean
Variety: Allen and 5601T
Description: RR and conventional
BBCH Scale: BSOY
Planting Date: 4/30/2012
Planting Method: PLANTD planted
Rate, Unit: 45 LB/A
Depth, Unit: 1.5 in
Row Spacing, Unit: 30 in
Spacing Within Row, Unit: 3 in
Seed Bed: MEDIUM medium
Harvest Date: 11/9/2012
Harvest Equipment: plot combine
Harvested Width, Unit: 5 ft
Harvested Length, Unit: 35 ft
% Standard Moisture: 13.5
Moisture Meter: plot combine
Weighing Equipment: plot combine

Site and Design

Plot Width, Unit: 10 FT
Plot Length, Unit: 40 FT
Plot Area, Unit: 400 FT2
Replications: 4
Study Design: SPLPLO Split-Plot

Soil Description

Description Name: Sequatchie
% Sand: 36 **% OM:** 1.4 **Texture:** L loam
% Silt: 46 **pH:** 6.3 **Soil Name:** Sequatchie
% Clay: 18 **CEC:** 9 **Fert. Level:** G good
Soil Drainage: G good

Table 25. HU 12 Application Description

	A	B	C
Application Date:	4/30/2012	5/18/2012	6/7/2012
Application Method:	SPRAY	SPRAY	SPRAY
Application Timing:	PREMCR	POEMCR	POEMCR
Application Placement:	BROSOI	BROADC	BROADC
Applied By:	Gaban	Gaban	Gaban

Table 26. HU 12 Application Equipment

	A	B	C
Appl. Equipment:	TCM-6 Nozzle	TCM-6 Nozzle	TCM-6 Nozzle
Equipment Type:	BACMAN	BACMAN	BACMAN
Operation Pressure, Unit:	40 PSI	40 PSI	40 PSI
Nozzle Type:	flat fan	flat fan	flat fan
Nozzle Size:	8002	8002	8002
Nozzle Spacing, Unit:	19 in	19 in	19 in
Nozzles/Row:	2	2	2
% Coverage:	100	100	100
Boom Length, Unit:	10 ft	10 ft	10 ft
Boom Height, Unit:	20 in	20 in	20 in
Ground Speed, Unit:	3 MPH	3 MPH	3 MPH
Carrier:	WATER	WATER	WATER
Spray Volume, Unit:	20 gal/ac	20 gal/ac	20 gal/ac
Mix Size, Unit:	3 liters	3 liters	3 liters
Propellant:	COMCO2	COMCO2	COMCO2

Table 27. HU 12 Yield in Bushel/Acre of Replication 1

Crop Code												GLXMA
BBCH Scale												BSOY
Crop Scientific Name												Glycine max
Crop Name												Soybean
Description												yield
Part Rated												SEED C
Rating Date												11/9/2012
Rating Type												YIELD
Rating Unit												bu/ac
Number of Subsamples												1
Days After First/Last Applic.												193 193
Trt-Eval Interval												193 DA-A
Plant-Eval Interval												193 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	1
1		Conventional 5601T											9.65 d
	CHK	Untreated Check											
2		Conventional 5601T											54.08 a
	CHK	Handweeded Check											
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters	
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters	
3		Conventional 5601T low weed control											17.95 c
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
4		Conventional 5601T medium weed control											43.95 b
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters	
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters	
5		RoundupReady Allen											15.20 cd
	CHK	Untreated Check											
6		RoundupReady Allen											56.20 a
	CHK	Handweeded Check											
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	
7		RoundupReady Allen low weed control											17.60 c
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
8		RoundupReady Allen medium weed control											56.30 a
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	
LSD (P=.05)													6.391
Standard Deviation													4.302
CV													12.7
Bartlett's X2													13.498
P(Bartlett's X2)													0.061
Replicate F													2.946
Replicate Prob(F)													0.0608
Treatment F													91.549
Treatment Prob(F)													0.0001

Table 28. HU 12 Yield in Bushel/Acre of Replication 2

Crop Code													GLXMA
BBCH Scale													BSOY
Crop Scientific Name													Glycine max
Crop Name													Soybean
Description													yield
Part Rated													SEED C
Rating Date													11/9/2012
Rating Type													YIELD
Rating Unit													bu/ac
Number of Subsamples													1
Days After First/Last Applic.													193 193
Trt-Eval Interval													193 DA-A
Plant-Eval Interval													193 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Spray Volume	Volume Unit	Mix Size	Mix Unit	Plot	1
1		Conventional 5601T											101	8.90
	CHK	Untreated Check											206	9.90
													302	8.30
													401	11.50
													Mean =	9.65
2		Conventional 5601T											102	48.40
	CHK	Handweeded Check											207	53.60
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	304	57.10
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	402	57.20
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters		
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters		
													Mean =	54.08
3		Conventional 5601T low weed control											103	10.20
													208	25.60
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	303	14.70
													404	21.30
													Mean =	17.95
4		Conventional 5601T medium weed control											104	40.00
													205	54.50
	HERB	Squadron	2.3	LBA/GAL	EC	3	pt/a	A	20	GAL/AC	3	Liters	301	33.60
	HERB	Select Max	0.97	LB/GAL	EC	12	fl oz/a	C	20	GAL/AC	3	Liters	403	47.70
	HERB	Pursuit	70	%	DF	1.44	oz wt/a	C	20	GAL/AC	3	Liters		
	ADJ	NIS	100	%	SL	0.25	% v/v	C	20	GAL/AC	3	Liters		
													Mean =	43.95
5		RoundupReady Allen											105	12.80
	CHK	Untreated Check											204	16.60
													306	16.00
													406	15.40
													Mean =	15.20
6		RoundupReady Allen											106	51.50
	CHK	Handweeded Check											202	56.60
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	308	57.50
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	407	59.20
													Mean =	56.20
7		RoundupReady Allen low weed control											107	17.40
													201	11.10
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	305	25.30
													408	16.60
													Mean =	17.60
8		RoundupReady Allen medium weed control											108	54.20
													203	56.60
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	20	GAL/AC	3	Liters	307	53.80
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	20	GAL/AC	3	Liters	405	60.60
													Mean =	56.30

Table 29. PSU 12 Field Trial Protocol

Plots: 10 by 40 feet

Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Amt Product to Measure	Rep 1	2	3	4
1		RoundupReady Allen								101	207	306	405
	CHK	Untreated Check											
2		RoundupReady Allen								102	205	308	406
	CHK	Handweeded Check											
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	26.95 ml/mx				
3		RoundupReady Allen low weed control								103	208	305	407
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	26.95 ml/mx				
4		RoundupReady Allen medium weed control								104	206	307	408
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	26.95 ml/mx				
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	26.95 ml/mx				
5		Conventional 5601T								105	203	301	404
	CHK	Untreated Check											
6		Conventional 5601T								106	202	304	403
	CHK	Handweeded Check											
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	56.24 ml/mx				
	HERB	SelectMax	0.97	LB/GAL	EC	12	fl oz/a	B	14.06 ml/mx				
	HERB	Pursuit	70	%	DG	1.44	oz wt/a	B	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	B	7.499 ml/mx				
7		Conventional 5601T low weed control								107	204	303	401
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	56.24 ml/mx				
8		Conventional 5601T medium weed control								108	201	302	402
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	56.24 ml/mx				
	HERB	SelectMax	0.97	LB/GAL	EC	12	fl oz/a	B	14.06 ml/mx				
	HERB	Pursuit	70	%	DG	1.44	oz wt/a	B	1.618 g/mx				
	ADJ	NIS	100	%	SL	0.25	% v/v	B	7.499 ml/mx				

Table 30. PSU 12 Field Trial Location Information

General Trial Information

Study Director: Tom Mueller
Investigator: Tom Mueller

Objectives:

Compare weed control, soybean yield, and profitability with RR to conventional soybeans. RR line = Allen, and conventional = 5601T

Care should be taken to avoid glyphosate drift onto conventional soybeans.

Due to plot size, will need to mix two (2) 3 liter bottles of each mix for each application to have enough.

Personnel

Study Director: Tom Mueller
Investigator: Tom Mueller

Crop Description

Crop 1: GLXMA Glycine max Soybean
Variety: Allen and 5601T
Description: RR and conventional
BBCH Scale: BSOY
Planting Date: 5/8/2012
Planting Method: PLANTD planted
Rate, Unit: 45 LB/A
Depth, Unit: 1.5 in
Row Spacing, Unit: 30 in
Spacing Within Row, Unit: 3 in
Seed Bed: MEDIUM medium
Harvest Date: 11/12/2012
Harvest Equipment: plot combine
Harvested Width, Unit: 5 ft
Harvested Length, Unit: 35 ft
% Standard Moisture: 13.5
Moisture Meter: plot combine
Weighing Equipment: plot combine

Site and Design

Plot Width, Unit: 10 FT
Site Type: FIELD field
Plot Length, Unit: 40 FT
Experimental Unit: 1 PLOT plot
Plot Area, Unit: 400 FT2
Tillage Type: NOTILL no-till
Replications: 4
Study Design: SPLPLO Split-Plot

Soil Description

Description Name: Sequatchie
% Sand: 36
% OM: 1.4
Texture: L loam
% Silt: 46
pH: 6.3
Soil Name: Sequatchie
% Clay: 18
CEC: 9
Fert. Level: G good
Soil Drainage: G good

Table 31. PSU 12 Application Description

	A	B	C
Application Date:	5/8/2012	5/30/2012	6/13/2012
Application Method:	SPRAY	SPRAY	SPRAY
Application Timing:	PREMCR	POEMCR	POEMCR
Application Placement:	BROSOI	BROADC	BROADC
Applied By:	Gaban	Gaban	Gaban

Table 32. PSU 12 Application Equipment

	A	B	C
Appl. Equipment:	TCM-6 Nozzle	TCM-6 Nozzle	TCM-6 Nozzle
Equipment Type:	BACMAN	BACMAN	BACMAN
Operation Pressure, Unit:	40 PSI	40 PSI	40 PSI
Nozzle Type:	flat fan	flat fan	flat fan
Nozzle Size:	8002	8002	8002
Nozzle Spacing, Unit:	19 in	19 in	19 in
Nozzles/Row:	2	2	2
% Coverage:	100	100	100
Boom Length, Unit:	10 ft	10 ft	10 ft
Boom Height, Unit:	20 in	20 in	20 in
Ground Speed, Unit:	3 MPH	3 MPH	3 MPH
Carrier:	WATER	WATER	WATER
Spray Volume, Unit:	20 gal/ac	20 gal/ac	20 gal/ac
Mix Size, Unit:	3 liters	3 liters	3 liters
Propellant:	COMCO2	COMCO2	COMCO2

Table 33. PSU 12 Yield in Bushel/Acre of Replication 1

Crop Code								GLXMA
BBCH Scale								BSOY
Crop Scientific Name								Glycine max
Crop Name								Soybean
Part Rated								SEED C
Rating Date								11/12/2012
Rating Type								YIELD
Rating Unit								bu/ac
Number of Subsamples								1
Days After First/Last Applic.								188 188
Trt-Eval Interval								188 DA-A
Plant-Eval Interval								188 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	1
1		RoundupReady Allen							21.93 e
	CHK	Untreated Check							
2		RoundupReady Allen							59.40 a
	CHK	Handweeded Check							
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	
3		RoundupReady Allen low weed control							38.18 c
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	
4		RoundupReady Allen medium weed control							54.95 ab
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	
5		Conventional 5601T							23.10 de
	CHK	Untreated Check							
6		Conventional 5601T							61.75 a
	CHK	Handweeded Check							
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	
	HERB	SelectMax	0.97	LB/GAL	EC	12	fl oz/a	B	
	HERB	Pursuit	70	%	DG	1.44	oz wt/a	B	
	ADJ	NIS	100	%	SL	0.25	% v/v	B	
7		Conventional 5601T low weed control							30.78 cd
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	
8		Conventional 5601T medium weed control							51.50 b
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	
	HERB	SelectMax	0.97	LB/GAL	EC	12	fl oz/a	B	
	HERB	Pursuit	70	%	DG	1.44	oz wt/a	B	
	ADJ	NIS	100	%	SL	0.25	% v/v	B	
LSD (P=.05)									7.820
Standard Deviation									5.264
CV									12.33
Bartlett's X2									10.98
P(Bartlett's X2)									0.139
Replicate F									4.251
Replicate Prob(F)									0.0195
Treatment F									38.110
Treatment Prob(F)									0.0001

Table 34. PSU 12 Yield in Bushel/Acre of Replication 2

Crop Code									GLXMA
BBCH Scale									BSOY
Crop Scientific Name									Glycine max
Crop Name									Soybean
Part Rated									SEED C
Rating Date									11/12/2012
Rating Type									YIELD
Rating Unit									bu/ac
Number of Subsamples									1
Days After First/Last Applic.									188 188
Trt-Eval Interval									188 DA-A
Plant-Eval Interval									188 DP-1
Trt No.	Type	Treatment Name	Form Conc	Form Unit	Form Type	Rate	Rate Unit	Appl Code	Plot	1
1		RoundupReady Allen							101	37.50
	CHK	Untreated Check							207	19.20
									306	16.90
									405	14.10
									Mean =	21.93
2		RoundupReady Allen							102	63.10
	CHK	Handweeded Check							205	63.00
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	308	60.20
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	406	51.30
									Mean =	59.40
3		RoundupReady Allen low weed control							103	43.80
									208	38.40
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	305	32.40
									407	38.10
									Mean =	38.18
4		RoundupReady Allen medium weed control							104	52.20
									206	52.10
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	B	307	60.80
	HERB	Roundup WeatherMax	5.5	lba/gal	SL	23	fl oz/a	C	408	54.70
									Mean =	54.95
5		Conventional 5601T							105	29.90
	CHK	Untreated Check							203	32.50
									301	15.00
									404	15.00
									Mean =	23.10
6		Conventional 5601T							106	63.50
	CHK	Handweeded Check							202	64.40
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	304	59.60
	HERB	SelectMax	0.97	LB/GAL	EC	12	fl oz/a	B	403	59.50
	HERB	Pursuit	70	%	DG	1.44	oz wt/a	B		
	ADJ	NIS	100	%	SL	0.25	% v/v	B		
									Mean =	61.75
7		Conventional 5601T low weed control							107	32.00
									204	37.40
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	303	23.30
									401	30.40
									Mean =	30.78
8		Conventional 5601T medium weed control							108	54.40
									201	51.20
	HERB	Squadron	2.33	LBA/GAL	EC	3	pt/a	A	302	50.30
	HERB	SelectMax	0.97	LB/GAL	EC	12	fl oz/a	B	402	50.10
	HERB	Pursuit	70	%	DG	1.44	oz wt/a	B		
	ADJ	NIS	100	%	SL	0.25	% v/v	B		
									Mean =	51.50

Appendix C

Table 35. Weather Data for Holston Locations 2010, 2011, and 2012

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2010	April	14				
2010	April	15	85.5	49.1	0	
2010	April	16	84.8	52.5	0	
2010	April	17	72.9	56.1	0	
2010	April	18	69	39.3	0	
2010	April	19	71.3	39.3	0	
2010	April	20	56.5	49.6	0.33	
2010	April	21	67.1	49	0.01	
2010	April	22	75.3	43.2	0.01	
2010	April	23	83.3	53.6	0.05	
2010	April	24	73.6	59.8	1.04	
2010	April	25	77.8	61.2	0.21	
2010	April	26	63.3	55.6	0	
2010	April	27	56.8	46	0.23	
2010	April	28	65.7	40.4	0.02	
2010	April	29	74.4	40	0	
2010	April	30	86.5	44.9	0	
2010	May	1	79.9	54.4	0.05	
2010	May	2	89.9	62.4	0.42	
2010	May	3	83	62.3	1.68	
2010	May	4	83	57.4	0	
2010	May	5	85.9	52.8	0	
2010	May	6	87.8	57.9	0	
2010	May	7	89.8	57.7	0	
2010	May	8	78.1	56.7	0	
2010	May	9	65.4	43.8	0	
2010	May	10	65.4	41.4	0.03	
2010	May	11	76.8	52.6	0.09	
2010	May	12	82.6	60.7	0	
2010	May	13	87.3	57.9	0	
2010	May	14	89	63.8	0.02	
2010	May	15	85.2	60	0.18	
2010	May	16	79.1	62.6	0.47	
2010	May	17	77	63.7	0.17	
2010	May	18	73.9	59.9	0.01	
2010	May	19	71.1	54.2	0	
2010	May	20	81.9	50.6	0	
2010	May	21	79	62.3	0.03	
2010	May	22	83.5	64.7	0	
2010	May	23	88.2	60.5	0	
2010	May	24	86	60	0	
2010	May	25	86.3	60.5	0	
2010	May	26	85.7	62.5	0.09	
2010	May	27	86.6	62	0.01	
2010	May	28	86.4	63.3	0.18	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2010	May	29	86.4	60.2	0.01	
2010	May	30	84.6	63.9	0.02	
2010	May	31	83.2	66.3	0.29	
2010	June	1	83.1	67.1	0.22	
2010	June	2	87.8	66	0.01	
2010	June	3	89.6	65.3	0	
2010	June	4	84.7	68.2	0.07	
2010	June	5	89.2	67.9	0	
2010	June	6	82.7	70.9	0.14	
2010	June	7	83.6	58	0	
2010	June	8	87.7	59.4	0	
2010	June	9	75.3	66.5	0.53	
2010	June	10	85.1	68.4	0.1	
2010	June	11	90.8	67.4	0	
2010	June	12	90.7	71.2	0.04	
2010	June	13	92.2	72.8	0	
2010	June	14	94	70.8	0	
2010	June	15	94.3	68.3	0.01	
2010	June	16	89	69	0	
2010	June	17	90.5	69.4	0	
2010	June	18	91.1	63.8	0	
2010	June	19	88.3	68.6	0.02	
2010	June	20	93.5	69	0.01	
2010	June	21	96.2	65.7	0	
2010	June	22	96	65	0	
2010	June	23	96.8	70.4	0	
2010	June	24	91.7	70.4	0	
2010	June	25	92.9	68.4	0	
2010	June	26	94.8	67.3	0	
2010	June	27	94.2	71.1	0	
2010	June	28	94.4	72	0.41	
2010	June	29	88.9	70.4	0.01	
2010	June	30	88.9	67.4	0	
2010	July	1	87.3	62.2	0	
2010	July	2	91.1	57.3	0	
2010	July	3	92.2	66.3	0	
2010	July	4	92.3	65	0	
2010	July	5	96	65.6	0	
2010	July	6	96.2	64.6	0	
2010	July	7	97.9	64.1	0	
2010	July	8	99.6	65.7	0	
2010	July	9	92.6	66.9	0.3	
2010	July	10	90.3	69.8	0.01	
2010	July	11	95.6	64.9	0	
2010	July	12	85.2	71.2	0.81	
2010	July	13	87.8	70	0.05	
2010	July	14	91.2	70.9	0.01	
2010	July	15	96.8	65.8	0	
2010	July	16	98.7	67.9	0	
2010	July	17	87.9	72.9	0	
2010	July	18	90.9	71.2	0	
2010	July	19	90.6	71.5	0.39	
2010	July	20	92.7	69.3	0.36	
2010	July	21	90.5	69.5	0.41	
2010	July	22	90	69.4	0.32	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2010	July	23	95.8	70.3	0	
2010	July	24	97.7	70.6	0	
2010	July	25	96.9	76.3	0	
2010	July	26	96.9	71.8	0	
2010	July	27	92.1	73.3	0	
2010	July	28	92.4	71.6	0	
2010	July	29	89.7	73.2	0.51	
2010	July	30	92	71.1	0.16	
2010	July	31	84.8	69.3	0.63	
2010	August	1	92.9	71.8	0.13	
2010	August	2	94	69.7	0	
2010	August	3	95	74.2	0	
2010	August	4	97.4	71	0	
2010	August	5	94.5	71.7	0.24	
2010	August	6	89.9	68.9	0	
2010	August	7	91.9	64.6	0	
2010	August	8	95.7	63.6	0	
2010	August	9	98.7	67.6	0	
2010	August	10	98.1	72	0	
2010	August	11	97.9	73	0	
2010	August	12	93.2	72.7	0.76	
2010	August	13	99	70.1	0	
2010	August	14	96.1	72.4	0.03	
2010	August	15	96.8	71.2	0	
2010	August	16	88.6	71.6	1.01	
2010	August	17	90.5	70.1	0.14	
2010	August	18	89.2	71.9	0.01	
2010	August	19	87.8	72.3	0.48	
2010	August	20	93.5	68.3	0.03	
2010	August	21	83.5	72.7	0.29	
2010	August	22	89.5	70.2	0.07	
2010	August	23	88.2	64.9	0	
2010	August	24	86.3	60.8	0	
2010	August	25	85.7	61.5	0	
2010	August	26	90	61.2	0	
2010	August	27	90.3	61.5	0	
2010	August	28	91.4	63.9	0	
2010	August	29	90	62.6	0	
2010	August	30	91.5	65.7	0	
2010	August	31	92.2	60.5	0	
2010	September	1	94.3	58.6	0	
2010	September	2	94.5	60.7	0	
2010	September	3	88.8	62.8	0.16	
2010	September	4	80.5	53.8	0.01	
2010	September	5	83.7	48.2	0	
2010	September	6	91	50.2	0	
2010	September	7	93.8	55.8	0	
2010	September	8	83.7	68.1	0.45	
2010	September	9	83.6	61.4	0.01	
2010	September	10	76	63.6	0.01	
2010	September	11	87.9	64.1	2.33	
2010	September	12	82.1	57.5	0.01	
2010	September	13	85.6	52.8	0	
2010	September	14	89.7	55.7	0	
2010	September	15	90.3	57.9	0	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2010	September	16	85.8	62.8	0.32	
2010	September	17	85.8	63.1	0.36	
2010	September	18	89.6	58.1	0.01	
2010	September	19	90.7	59.9	0	
2010	September	20	90.5	61.9	0	
2010	September	21	93.9	61.5	0	
2010	September	22	90	65.4	0.38	
2010	September	23	92.5	64.8	0.01	
2010	September	24	90.2	62.2	0	
2010	September	25	81.7	65.4	0	
2010	September	26	66.3	63.2	0.15	
2010	September	27	64.2	58.4	1.03	
2010	September	28	72.3	54.8	0.15	
2010	September	29	80.1	52.7	0	
2010	September	30	77.6	57.1	0.12	
2010	October	1	74.2	52.9	0	
2010	October	2	76.8	46.4	0	
2010	October	3	57.4	47.1	0	
2010	October	4	57.8	41.8	0	
2010	October	5	64.7	39.9	0	
2010	October	6	72.2	38.6	0	
2010	October	7	80.9	43.5	0.01	
2010	October	8	82.2	48.2	0	
2010	October	9	83.3	47.3	0.01	
2010	October	10	84.8	47.5	0	
2010	October	11	84.9	48.9	0.01	
2010	October	12	75	50.1	0.02	
2010	October	13	79.5	55.6	0.01	
2010	October	14	67.4	44.6	0.1	
2010	October	15	70.4	41.7	0	
2010	October	16	71.2	39.4	0	
2010	October	17	76.8	39.3	0	
2010	October	18	78.2	43.1	0	
2010	October	19	78.6	44.6	0.02	
2010	October	20	71.2	46.9	0.16	
2010	October	21	77.2	42.7	0	
2010	October	22	72.4	37.6	0	
2010	October	23	76.4	38.3	0	
2010	October	24	80.8	43.7	0	
2010	October	25	74.2	55.2	1.19	
2010	October	26	84.4	57.6	0.95	
2010	October	27	69.8	56	0.99	
2010	October	28	73.2	54.3	0	
2010	October	29	62.1	39.9	0	
2010	October	30	70.8	33.2	0	
2010	October	31	71.9	42.5	0	
2010	November	1				

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2011	January	7	39.6	34.4	0.06	
2011	January	8	34.1	16	0	
2011	January	9	29.2	9	0	
2011	January	10	30.8	22.9	0	
2011	January	11	34.4	28.5	0.12	
2011	January	12	27.9	21.5	0	
2011	January	13	29.1	17.3	0	
2011	January	14	39	11.3	0	
2011	January	15	45.7	20.3	0	
2011	January	16	49.5	28	0	
2011	January	17	45.1	27.8	0	
2011	January	18	43.6	31.1	0.15	
2011	January	19	44.1	35.9	0.04	
2011	January	20	46	29.5	0.02	
2011	January	21	33.5	21.5	0	
2011	January	22	38.3	21.5	0	
2011	January	23	42	18.6	0	
2011	January	24	54.7	27.6	0	
2011	January	25	44.6	31.4	0.05	
2011	January	26	42.2	31.7	0.49	
2011	January	27	45.1	28.3	0	
2011	January	28	50.7	28.3	0	
2011	January	29	63.3	24	0	
2011	January	30	68.4	28.8	0	
2011	January	31	60.5	38.9	0	2.99
2011	February	1	57.1	45.7	0.35	
2011	February	2	54.1	25.9	0	
2011	February	3	36.3	22.2	0	
2011	February	4	37.7	33.5	0.08	
2011	February	5	47.4	32	0.05	
2011	February	6	49.1	30.4	0	
2011	February	7	50.5	26.8	0.12	
2011	February	8	37.2	23.7	0	
2011	February	9	39.7	20.5	0	
2011	February	10	40.7	22	0	
2011	February	11	43.9	18.4	0	
2011	February	12	51.2	27.5	0	
2011	February	13	60.9	23	0	
2011	February	14	65.9	44.1	0	
2011	February	15	57.4	27.5	0	
2011	February	16	64.4	29.3	0	
2011	February	17	72.2	30.8	0	
2011	February	18	65.8	51.4	0.04	
2011	February	19	61.7	35.4	0.01	
2011	February	20	66.1	33.7	0	
2011	February	21	68.6	46.5	0	
2011	February	22	62.4	39.4	0.15	
2011	February	23	60.2	29.4	0	
2011	February	24	52.1	45.3	0.73	
2011	February	25	64.7	37.4	0.67	
2011	February	26	63.2	29.4	0	
2011	February	27	61.1	38.4	0.33	
2011	February	28	68.4	47	2.63	5.16
2011	March	1	59.1	36.9	0	
2011	March	2	64.9	31	0.01	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2011	March	3	68.2	34.7	0	
2011	March	4	67	36.6	0	
2011	March	5	62.4	49	0.53	
2011	March	6	53.1	35	1.14	
2011	March	7	50.8	32.4	0	
2011	March	8	62.9	35.7	0.25	
2011	March	9	57.7	45.9	0.91	
2011	March	10	51.2	36.9	1.14	
2011	March	11	50	32.4	0.01	
2011	March	12	70.4	30.5	0	
2011	March	13	70.9	40.5	0	
2011	March	14	58.7	43	0	
2011	March	15	60.3	47.8	0.37	
2011	March	16	54.7	37	0	
2011	March	17	73.1	32.6	0.01	
2011	March	18	79.2	43.9	0	
2011	March	19	70.2	52.6	0	
2011	March	20	77	46.9	0	
2011	March	21	75.4	51.3	0	
2011	March	22	79.4	49	0	
2011	March	23	69.7	55	0.42	
2011	March	24	53.8	40	0	
2011	March	25	53	38.4	0.01	
2011	March	26	51.4	45.2	0.39	
2011	March	27	47.5	40.2	0.02	
2011	March	28	48.2	34.9	0.3	
2011	March	29	65.3	34.8	0.03	
2011	March	30	55.5	40.2	0.45	
2011	March	31	41.9	39.7	0.02	6.01
2011	April	1	53.9	33.1	0	
2011	April	2	64.6	38.6	0.06	
2011	April	3	78.5	34.1	0	
2011	April	4	77	59.5	0.72	
2011	April	5	60.1	42.4	1.03	
2011	April	6	71.6	31.1	0	
2011	April	7	75.1	40.3	0	
2011	April	8	78.7	50.3	0	
2011	April	9	84.5	57.8	0	
2011	April	10	86.8	55.5	0	
2011	April	11	82.3	61.9	0	
2011	April	12	66	46.5	0.51	
2011	April	13	69.4	39.9	0.01	
2011	April	14	77.2	38.2	0	
2011	April	15	73.7	45.2	0.82	
2011	April	16	60.1	50.2	1.49	
2011	April	17	70.3	36.2	0	
2011	April	18	77.2	41.6	0	
2011	April	19	84.9	53.8	0	
2011	April	20	77.4	60.7	0.21	
2011	April	21	70.3	53.6	0	
2011	April	22	79.2	51.8	0.03	
2011	April	23	81.6	57.4	0	
2011	April	24	84.9	57	0	
2011	April	25	85.6	53.2	0.02	
2011	April	26	82.2	59.3	0.02	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2011	April	27	84.2	60.5	0.65	
2011	April	28	68.5	48.1	0.01	
2011	April	29	74.4	43.5	0	
2011	April	30	81.3	57.6	0	5.58
2011	May	1	79.2	54.5	0	
2011	May	2	82.1	54.5	0	
2011	May	3	77.8	47.6	0.78	
2011	May	4	56.6	41.2	0.01	
2011	May	5	68.5	35.6	0.01	
2011	May	6	69.5	42.5	0	
2011	May	7	71.8	42.5	0	
2011	May	8	83.3	54.1	0.03	
2011	May	9	86.2	55.5	0	
2011	May	10	88.3	59.5	0	
2011	May	11	88.9	59.8	0	
2011	May	12	89.1	61.7	0	
2011	May	13	85.2	62.6	0.03	
2011	May	14	76.8	60.9	0.06	
2011	May	15	63.2	56.3	0	
2011	May	16	61.1	52.2	0.11	
2011	May	17	51.8	48.1	0.07	
2011	May	18	59.7	47.8	0.01	
2011	May	19	73.8	53.1	0	
2011	May	20	80.6	58.1	0.01	
2011	May	21	88.5	55.2	0	
2011	May	22	91.4	61.1	0.1	
2011	May	23	86.8	60.1	0	
2011	May	24	87.2	65.7	0	
2011	May	25	92.6	61.3	0	
2011	May	26	77.7	62.3	0.41	
2011	May	27	79.8	62.6	0.01	
2011	May	28	87.4	56.9	0	
2011	May	29	93.7	58.7	0	
2011	May	30	95	65	0	
2011	May	31	93.4	66.7	0	1.64
2011	June	1	94.6	67	0	
2011	June	2	93.5	66.5	0	
2011	June	3	92.3	65.6	0	
2011	June	4	94.9	61	0	
2011	June	5	94.3	63.3	0	
2011	June	6	94.3	65.5	0	
2011	June	7	95.1	62.8	0	
2011	June	8	98.1	65.7	0	
2011	June	9	94.8	65.7	0	
2011	June	10	94.4	60.8	0	
2011	June	11	95.5	64.8	0.05	
2011	June	12	91	66.7	0.03	
2011	June	13	86.6	64.5	0.02	
2011	June	14	81.5	57.7	0	
2011	June	15	78.1	57.1	0.27	
2011	June	16	87	62.2	0.19	
2011	June	17	86.1	60.5	0.04	
2011	June	18	80.8	66.7	0.08	
2011	June	19	83.3	66.1	1.05	
2011	June	20	86.2	67.1	0.03	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2011	June	21	93	64.7	0.16	
2011	June	22	81.3	67.3	0.56	
2011	June	23	84.7	66.8	0.12	
2011	June	24	86.1	65.9	1.77	
2011	June	25	86.6	66.2	0	
2011	June	26	86	65.5	0.12	
2011	June	27	90.7	68.5	0	
2011	June	28	82.2	68.7	0	
2011	June	29	87.9	64.6	0	
2011	June	30	89.9	60.9	0	4.49
2011	July	1	92.2	58.7	0	
2011	July	2	94.9	61.4	0	
2011	July	3	96.7	65.4	0	
2011	July	4	90.9	68.5	0.25	
2011	July	5	90.9	68.1	0	
2011	July	6	91.7	66.3	0.3	
2011	July	7	93.4	67.5	1.38	
2011	July	8	89.7	68.1	0.35	
2011	July	9	91.9	72.5	0	
2011	July	10	97.5	70	0	
2011	July	11	97.7	69.7	0	
2011	July	12	88.9	70.6	0.22	
2011	July	13	93.8	69.2	0	
2011	July	14	94.3	69.9	0	
2011	July	15	81.6	69.5	0.43	
2011	July	16	79.9	67.4	0.02	
2011	July	17	91.1	66.2	0	
2011	July	18	94.5	68.4	0	
2011	July	19	92.6	69.5	0.16	
2011	July	20	97.2	74.6	0.01	
2011	July	21	83	72.6	0.37	
2011	July	22	95.7	71.2	0	
2011	July	23	98.4	71.3	0.51	
2011	July	24	94.5	71.6	0.36	
2011	July	25	90.7	73.3	0.11	
2011	July	26	93.4	71.8	0	
2011	July	27	95.9	68.5	0	
2011	July	28	99.5	68.1	0	
2011	July	29	92.8	70.1	0	
2011	July	30	98.5	71.8	0.87	
2011	July	31	92	70.8	0.01	5.35
2011	August	1	95.1	69.9	0	
2011	August	2	98.8	66.9	0	
2011	August	3	98.6	64.5	0	
2011	August	4	93.9	72.3	0.02	
2011	August	5	97.3	69.4	0	
2011	August	6	87.3	73.6	0	
2011	August	7	92.8	69	0	
2011	August	8	92.2	70.9	0.18	
2011	August	9	89.9	69.2	0.01	
2011	August	10	92.3	65.2	0	
2011	August	11	92.2	68.4	0	
2011	August	12	94.4	63.6	0	
2011	August	13	91.8	63.6	0	
2011	August	14	88.8	67.7	0.07	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2011	August	15	83.9	61.4	0	
2011	August	16	88.5	57.8	0	
2011	August	17	94.7	59.1	0	
2011	August	18	94.7	64.7	0.01	
2011	August	19	92.2	65.6	0.83	
2011	August	20	94.4	65.5	0.01	
2011	August	21	91.6	67.7	0	
2011	August	22	89	64.8	0	
2011	August	23	93.5	57.7	0	
2011	August	24	95	58.1	0	
2011	August	25	98.6	64.9	0	
2011	August	26	97.7	68.4	0	
2011	August	27	88.1	63.1	0	
2011	August	28	87.1	58.9	0.01	
2011	August	29	88.6	54	0	
2011	August	30	94.4	56.5	0	
2011	August	31	96.9	62.5	0	1.14
2011	September	1	97.5	63.7	0	
2011	September	2	99.5	64.4	0	
2011	September	3	98.8	67.1	0.52	
2011	September	4	88.8	66.2	0.09	
2011	September	5	70.9	63.1	3.63	
2011	September	6	78.8	62.5	1.24	
2011	September	7	67.8	61.4	0.02	
2011	September	8	72.1	59.5	0.02	
2011	September	9	73.6	57.4	0.01	
2011	September	10	83.8	53.9	0	
2011	September	11	85	54.1	0.12	
2011	September	12	86	58.7	0.01	
2011	September	13	88.1	58	0	
2011	September	14	90.2	58	0	
2011	September	15	68.6	57.7	0.06	
2011	September	16	68.8	52.1	0	
2011	September	17	79.2	56.7	0	
2011	September	18	82.7	56	0	
2011	September	19	75.1	60	0	
2011	September	20	82.9	62.6	0.03	
2011	September	21	84.3	65.8	0.09	
2011	September	22	82	66.3	0	
2011	September	23	75.7	61.5	0.06	
2011	September	24	80.4	55.8	0	
2011	September	25	84.3	52.7	0	
2011	September	26	84.2	60.4	0.14	
2011	September	27	77.4	56.7	0.06	
2011	September	28	80.2	52.3	0	
2011	September	29	81.6	59.1	0	
2011	September	30	70.3	54.7	0	6.1
2011	October	1	56.1	42.2	0	
2011	October	2	63.9	39.4	0	
2011	October	3	71.9	38.2	0	
2011	October	4	77.8	41.7	0	
2011	October	5	82	47.1	0.01	
2011	October	6	83.2	49.6	0	
2011	October	7	82.4	51.5	0.01	
2011	October	8	79.7	49.3	0.01	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2011	October	9	73.1	50.2	0	
2011	October	10	80.2	56.3	0.01	
2011	October	11	72.1	59.2	0.05	
2011	October	12	69.5	58.1	0.02	
2011	October	13	68.9	60	0.02	
2011	October	14	74.1	50.8	0.01	
2011	October	15	71.9	46.4	0.01	
2011	October	16	79.9	41	0.01	
2011	October	17	83.4	51.4	0.01	
2011	October	18	81.9	51.8	0.01	
2011	October	19	64	45.8	0.01	
2011	October	20	52.9	44.6	0.01	
2011	October	21	63	41.4	0.02	
2011	October	22	66.1	35.7	0.01	
2011	October	23	68.6	36.6	0.01	
2011	October	24	73	43.3	0.02	
2011	October	25	78	42.5	0.01	
2011	October	26	76.8	43.8	0.01	
2011	October	27	66.7	50.3	0.01	
2011	October	28	51.2	42	0	
2011	October	29	54.4	35.7	0.01	
2011	October	30	61.5	32.7	0.02	
2011	October	31	61.1	33.6	0	0.32
2011	November	1	66.2	32.7	0.02	
2011	November	2	68.7	34.6	0	
2011	November	3	65.7	35.2	0.01	
2011	November	4	57.1	43.7	0.01	
2011	November	5	65.6	34.8	0	
2011	November	6	64.2	33.2	0.01	
2011	November	7	71.3	35.5	0.01	
2011	November	8	72.1	38.9	0.01	
2011	November	9	66.3	41.2	0	
2011	November	10	56.1	41.9	0.01	
2011	November	11	52.4	27.8	1.12	
2011	November	12	63.8	27.9	0.05	
2011	November	13	68.8	40.4	0	
2011	November	14	71.6	51.1	0	
2011	November	15	72.1	61.2	0.37	
2011	November	16	65.6	52.5	0.04	
2011	November	17	52.2	31.2	0.02	
2011	November	18	55.1	25.2	1.2	
2011	November	19	63.8	29.4	0.08	
2011	November	20	66.1	46.3	0.02	
2011	November	21	63.5	54.8	0.14	
2011	November	22	74	53.3	0.07	
2011	November	23	60.1	40.4	0.03	
2011	November	24	62.5	32.6	0.02	
2011	November	25	63.2	32.5	0.02	
2011	November	26	65.9	34.9	0.01	
2011	November	27	59.4	42.9	0.01	
2011	November	28	66.1	44.3	0.03	
2011	November	29	43.1	38.2	0.03	
2011	November	30	47.1	29.7	0.01	3.35
2011	December	1	54.5	25.6	0.95	
2011	December	2	60	25.5	0.61	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2011	December	3	60.5	29.6	0.01	
2011	December	4	65.7	30.3	0	
2011	December	5	72.9	40.6	0.07	
2011	December	6	60.1	50.6	0.25	
2011	December	7	50	35.6	0.15	
2011	December	8	48.3	27.9	0.95	
2011	December	9	52	26.3	0.31	
2011	December	10	45	27.4	0	
2011	December	11	51.2	23.4	0	
2011	December	12	53.9	29.8	0	
2011	December	13	55.3	42.3	0	
2011	December	14	66.9	41.3	0.01	
2011	December	15	65.4	40.2	0.09	
2011	December	16	57	39.9	0.16	
2011	December	17	47.1	31.3	0.05	
2011	December	18	51	26.5	0.18	
2011	December	19	55.1	27.9	0.01	
2011	December	20	56.9	34.2	0	
2011	December	21	64.4	44.4	0.04	
2011	December	22	62.1	42.3	0.08	
2011	December	23	50.8	45.2	0.11	
2011	December	24	48.1	34.2	0.02	
2011	December	25	52.4	31.7	0.03	
2011	December	26	47.4	27.9	0.12	
2011	December	27	47.2	38.5	0.02	
2011	December	28	46.1	30.6	0.02	
2011	December	29	53.5	26.6	0.4	
2011	December	30	62.1	33.3	0	
2011	December	31	59.5	36	0	4.64
2012	January	1	61.4	31.8	0.07	
2012	January	2	42.1	22.5	0.02	
2012	January	3	31.7	20	0	
2012	January	4	46.9	16.5	0	
2012	January	5	53.9	27.1	0	
2012	January	6	61.8	25.6	0	
2012	January	7	60.1	41.9	0.11	
2012	January	8	50.8	43.9	0.05	
2012	January	9	50.7	44.8	0.04	
2012	January	10	52.7	39.5	0.02	
2012	January	11	59.4	45.3	0.02	
2012	January	12	52.2	28.2	0.02	
2012	January	13	29.7	23.3	0	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2012	January	14	42.9	21	0.04	
2012	January	15	46.3	26.4	0.19	
2012	January	16	47.7	25.9	0.03	
2012	January	17	61.4	40.3	0.34	
2012	January	18	37.5	27.2	0.03	
2012	January	19	41.3	22.6	0	
2012	January	20	49.3	34	0.05	
2012	January	21	53.4	41.9	0.71	
2012	January	22	54.3	42.3	0.13	
2012	January	23	64.6	48.8	0.54	
2012	January	24	60	35.4	0.21	
2012	January	25	62.9	32.7	0.05	
2012	January	26	59.4	41.9	0.04	
2012	January	27	56.5	33.2	0.04	
2012	January	28	51	28.1	0.23	
2012	January	29	50.6	23.3	0	
2012	January	30	59.9	26.5	0	
2012	January	31	63.8	28.9	0	2.98
2012	February	1	52.2	39.2	0.27	
2012	February	2	61.6	40.2	0.13	
2012	February	3	59.1	32.9	0.04	
2012	February	4	49.5	39.9	0.02	
2012	February	5	56.7	46.5	0.04	
2012	February	6	53.5	36.6	0.02	
2012	February	7	55.8	28.1	0.32	
2012	February	8	47.9	33.7	0	
2012	February	9	47.8	32.1	0	
2012	February	10	45.6	27	0	
2012	February	11	38.5	23.4	0.01	
2012	February	12	37.7	17	0	
2012	February	13	43.1	18	0	
2012	February	14	44.9	33.7	0.07	
2012	February	15	55.7	40.2	0	
2012	February	16	60.5	44.7	0.33	
2012	February	17	60.5	39.2	0	
2012	February	18	63.9	36	0	
2012	February	19	51	35.3	0.58	
2012	February	20	51.1	29.2	0.14	
2012	February	21	61.5	29.9	0.01	
2012	February	22	53.7	33.8	0.28	
2012	February	23	77.4	46.6	0.15	
2012	February	24	70.7	41	0.03	
2012	February	25	50.5	32.9	0	
2012	February	26	59.4	25.6	0	
2012	February	27	66.2	32.5	0	
2012	February	28	72.3	33.8	0	
2012	February	29	71.5	52.2	0.16	2.6

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2012	March	1	69.4	44	0.16	
2012	March	2	71.5	40.6	0.16	
2012	March	3	57.3	42.2	0.25	
2012	March	4	46.2	32.5	0	
2012	March	5	48.4	30.1	0	
2012	March	6	64	25.8	0	
2012	March	7	68.3	33.4	0	
2012	March	8	69.2	43.4	0.39	
2012	March	9	57	40.9	0.66	
2012	March	10	63	32.5	0	
2012	March	11	69.1	31.3	0	
2012	March	12	68.2	46.2	0.02	
2012	March	13	77.5	53.1	0.07	
2012	March	14	80.6	46.1	0	
2012	March	15	84	49	0.46	
2012	March	16	76.9	52.6	0.1	
2012	March	17	78.8	51	0.04	
2012	March	18	80.7	57.3	0.47	
2012	March	19	82.7	51.8	0	
2012	March	20	85.9	54.1	0.1	
2012	March	21	84.7	53.1	0.01	
2012	March	22	81.4	53.3	0	
2012	March	23	72.5	57.4	0.21	
2012	March	24	66.6	50.9	0.6	
2012	March	25	69.2	50.1	0.1	
2012	March	26	76.3	50.5	0	
2012	March	27	78.1	47.8	0	
2012	March	28	78.9	50.9	0	
2012	March	29	79.4	59.9	0.08	
2012	March	30	77.7	53.7	0.03	
2012	March	31	73.4	55.6	0.11	4.02
2012	April	2	86.2	54.9	0.37	
2012	April	3	83.7	57.7	0.04	
2012	April	4	81.6	55.1	0.01	
2012	April	5	76.9	55.4	0.64	
2012	April	6	68.3	50	0.06	
2012	April	7	74	37.8	0	
2012	April	8	74.1	42.9	0	
2012	April	9	73.8	39.9	0	
2012	April	10	68.3	42.7	0	
2012	April	11	57.6	34.4	0	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)	
2012	April	12	64.5	30.5	0		
2012	April	13	72	33.6	0		
2012	April	14	79.1	42.9	0		
2012	April	15	82.6	47.8	0		
2012	April	16	81.7	55.3	0		
2012	April	17	70.3	57	0		
2012	April	18	61.2	52.1	0.21		
2012	April	19	76.2	50.6	0		
2012	April	20	76	48.4	0		
2012	April	21	69.1	54.7	0.01		
2012	April	22	54.5	44.3	0		
2012	April	23	58.3	42.8	0		
2012	April	24	63.2	39.6	0.06		
2012	April	25	79.3	49.4	0.07		
2012	April	26	71.8	59.3	0.48		
2012	April	27	75.8	55.2	0		
2012	April	28	83.4	53.6	0		
2012	April	29	87.1	56	0		
2012	April	30	86.4	57.1	0	1.99	
2012	May	1	88.8	58.9	0		
2012	May	2	90.7	62.9	0		
2012	May	3	89.1	61.2	0.01		
2012	May	4	85.4	64.5	0.1		
2012	May	5	83.4	64.5	0.3		
2012	May	6	86.9	60.8	0		
2012	May	7	83.8	60.9	0.8		
2012	May	8	79.6	66.3	0.02		
2012	May	9	70.4	55.7	0.02		
2012	May	10	71.9	47.8	0		
2012	May	11	77.8	45.1	0		
2012	May	12	78.7	53.5	0		
2012	May	13	67.8	61.2	0.39		
2012	May	14	76.2	60.9	1.91		
2012	May	15	77	57.7	0		
2012	May	16	81.7	54.9	0		
2012	May	17	85.1	54.7	0		
2012	May	18	85.7	57.6	0		
2012	May	19	86.6	60.5	0		
2012	May	20	87.3	60.5	0		
2012	May	21	84.2	59.1	0.15		

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2012	May	22	75.6	62.7	0.13	
2012	May	23	78.5	63.3	0.59	
2012	May	24	87.6	62.9	0	
2012	May	25	91.7	60.2	0	
2012	May	26	92.9	64.1	0	
2012	May	27	92.2	66	0	
2012	May	28	93.9	65.7	0	
2012	May	29	89.7	66.6	0	
2012	May	30	90.3	66	0	
2012	May	31	90.3	60.5	0.09	4.51
2012	June	1	72.1	59.5	0.6	
2012	June	2	73.5	51.4	0.01	
2012	June	3	82.9	53.4	0	
2012	June	4	83.1	63.4	0	
2012	June	5	78.5	60.5	0.36	
2012	June	6	79.9	54.2	0	
2012	June	7	83	56.2	0	
2012	June	8	85.2	55.8	0	
2012	June	9	86.7	58	0	
2012	June	10	81.9	66.9	0.03	
2012	June	11	81.8	66.9	0.17	
2012	June	12	82.8	68.4	0.43	
2012	June	13	87.9	64.4	0	
2012	June	14	89.5	61.3	0	
2012	June	15	89.3	64.5	0	
2012	June	16	84.6	66.4	0.19	
2012	June	17	86.6	65.6	0	
2012	June	18	89.9	64	0	
2012	June	19	93.5	63.1	0	
2012	June	20	94.6	66.8	0	
2012	June	21	95.4	66.8	0	
2012	June	22	93.6	70.3	0	
2012	June	23	93.4	66	0	
2012	June	24	97	61.6	0	
2012	June	25	94.7	63.7	0	
2012	June	26	86.9	65.7	0	
2012	June	27	92.7	52.9	0	
2012	June	28	101.7	55.7	0	
2012	June	29	103.8	60.9	0	
2012	June	30	106.4	66.4	0	1.79
2012	July	1	105.4	69.2	0	
2012	July	2	96.7	71.8	0.03	
2012	July	3	96.9	68.6	0	
2012	July	4	97.7	65.8	0	
2012	July	5	101	67.8	0.17	
2012	July	6	96.2	66.6	0	
2012	July	7	101.4	69.2	0	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2012	July	8	100.5	75.7	0	
2012	July	9	89.4	73.4	0.05	
2012	July	10	88	68.5	0.58	
2012	July	11	79.3	69.1	0.31	
2012	July	12	73.8	68.9	0.46	
2012	July	13	87.1	68.9	0.42	
2012	July	14	87.2	72	0.17	
2012	July	15	90.7	68.1	0.01	
2012	July	16	89.7	70.7	0	
2012	July	17	89.3	71.1	0	
2012	July	18	90.2	68.5	0.64	
2012	July	19	92.8	69.5	0	
2012	July	20	86.9	68.8	2.01	
2012	July	21	88.4	69	0	
2012	July	22	92.1	72.3	0.01	
2012	July	23	92	69.8	0	
2012	July	24	95.1	72.7	0	
2012	July	25	95.6	73.6	0	
2012	July	26	94.7	72.5	0	
2012	July	27	93.9	73.6	0	
2012	July	28	92.2	66	0	
2012	July	29	89.5	64.2	0	
2012	July	30	95	66	0	
2012	July	31	91.9	69.4	0.35	5.21
2012	August	1	93.1	64.2	0.03	
2012	August	2	93.8	65.5	0	
2012	August	3	86.1	69.7	0.09	
2012	August	4	90.6	68.6	0.15	
2012	August	5	91.9	69.1	0.42	
2012	August	6	88.5	69	0.03	
2012	August	7	92.1	70.8	0.07	
2012	August	8	93.6	70	0.01	
2012	August	9	88.3	67.7	1.13	
2012	August	10	80.6	65.9	0.5	
2012	August	11	83.2	61.5	0.01	
2012	August	12	85.4	55.9	0	
2012	August	13	84.8	59	0	
2012	August	14	84.8	63.2	0.76	
2012	August	15	85.6	65.6	0.25	
2012	August	16	88.8	61.2	0	
2012	August	17	82.7	64.6	0.01	
2012	August	18	87.9	66.7	0	
2012	August	19	81.4	65.1	0.09	
2012	August	20	84.9	59.9	0.01	
2012	August	21	85.9	55.3	0	
2012	August	22	89.9	56	0	
2012	August	23	90	56.7	0	
2012	August	24	92.1	59.8	0	
2012	August	25	92.5	61	0	
2012	August	26	93.9	61.9	0	
2012	August	27	94.5	62.3	0.01	
2012	August	28	96.3	62.7	0	
2012	August	29	92.8	69.2	0.43	
2012	August	30	87.4	66.8	0	
2012	August	31	89.8	69.2	0	4
					49	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2012	September	1	92.5	68	0	
2012	September	2	92.6	70.5	0.42	
2012	September	3	83.4	69.4	0.29	
2012	September	4	85.6	71.5	0.01	
2012	September	5	89.6	70.1	0	
2012	September	6	90.4	69.6	0.13	
2012	September	7	92.4	65.3	0.01	
2012	September	8	79.9	57.5	0.37	
2012	September	9	80.6	54	0.01	
2012	September	10	82.1	54.7	0	
2012	September	11	85	54.8	0	
2012	September	12	84.7	64.5	0	
2012	September	13	84.1	59.4	0	
2012	September	14	85.4	59.1	0	
2012	September	15	88.1	56.7	0	
2012	September	16	84.7	63.2	0	
2012	September	17	70.1	64.5	1.97	
2012	September	18	73	59.1	3.83	
2012	September	19	75.8	48.8	0	
2012	September	20	80.9	51	0	
2012	September	21	82	54.4	0	
2012	September	22	81.6	54.2	0	
2012	September	23	74.7	47.3	0	
2012	September	24	73.5	41.3	0	
2012	September	25	80.6	44.9	0.01	
2012	September	26	83.8	55	0	
2012	September	27	85	55.9	0	
2012	September	28	81.6	60.7	0.51	
2012	September	29	76.2	61.2	0.01	
2012	September	30	74.3	53.3	0.01	7.58
2012	October	1	73.2	58	0.34	
2012	October	2	77.5	65	0.3	
2012	October	3	76.5	60.5	0	
2012	October	4	79.2	56	0	
2012	October	5	80.8	52.5	0	
2012	October	6	61.9	53.8	0.02	
2012	October	7	57.3	43	0.15	
2012	October	8	51	43.7	0.3	
2012	October	9	60.3	46.5	0	
2012	October	10	63.7	44.7	0.01	
2012	October	11	69.8	39.4	0	
2012	October	12	68.8	52.1	0	
2012	October	13	77.1	47.8	0	
2012	October	14	74.8	51.1	0	
2012	October	15	70.9	49	0.58	
2012	October	16	69.9	44.9	0.01	
2012	October	17	76	44.9	0	
2012	October	18	66.7	48.8	0.11	
2012	October	19	68.7	41.5	0.01	
2012	October	20	64.4	47.9	0	
2012	October	21	72.3	41.3	0	
2012	October	22	79.6	44.2	0.01	
2012	October	23	79.1	48.5	0	
2012	October	24	81.5	47.4	0.01	
2012	October	25	80.6	46.7	0.01	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2012	October	26	80.6	51.8	0	
2012	October	27	58.9	50.6	0	
2012	October	28	50.6	44.9	0.41	
2012	October	29	44.2	42.3	0.01	
2012	October	30	44.7	41	0	
2012	October	31	58.5	42.2	0	2.28
2012	November	1	59.6	33.8	0	
2012	November	2	69	40.1	0	
2012	November	3	70.4	34.4	0.1	
2012	November	4	60.4	39.2	0	
2012	November	5	58.8	32.9	0.01	
2012	November	6	51.1	41.5	0.05	
2012	November	7	48.5	44	0.21	
2012	November	8	59.6	33.9	0.01	
2012	November	9	65	30.7	0	
2012	November	10	71.1	34.7	0	
2012	November	11	72.9	34.9	0.01	
2012	November	12	70.2	41.5	0.28	
2012	November	13	51.7	30.6	0	
2012	November	14	52.3	28.1	0	
2012	November	15	60.6	33.1	0.01	
2012	November	16	59.6	30.1	0	
2012	November	17	62.8	29.9	0	
2012	November	18	62.6	29.4	0	
2012	November	19	63.3	30.9	0.01	
2012	November	20	67.4	36.3	0	
2012	November	21	68.9	39.4	0	
2012	November	22	69.1	34.5	0.01	
2012	November	23	60.4	34.9	0	
2012	November	24	44.9	26.3	0	
2012	November	25	54.9	23.5	0	
2012	November	26	62.5	27.9	0.04	
2012	November	27	47	41.2	0.2	
2012	November	28	52.3	29.9	0	
2012	November	29	57.9	25.4	0	
2012	November	30	61.4	27.9	0	0.94
2012	December	1	66.2	37.5	0.01	
2012	December	2	70.9	36.9	0	
2012	December	3	73.2	41.6	0	
2012	December	4	70.7	42.8	0.01	
2012	December	5	62.1	37.9	0.02	
2012	December	6	52	36.8	0.01	
2012	December	7	65.8	40.9	0	
2012	December	8	70.8	49.7	0	
2012	December	9	70.8	52.8	0.01	
2012	December	10	59.1	42	1.04	
2012	December	11	42.3	32.9	0	
2012	December	12	47.1	30.1	0	
2012	December	13	54.3	26.6	0	
2012	December	14	57	27.8	0	
2012	December	15	60.3	34.9	0	
2012	December	16	57.3	47.1	1	
2012	December	17	57.8	46	0.2	
2012	December	18	54.6	34.6	0.01	
2012	December	19	64.5	34	0	

Table 35. Continued

Year	Month	Day	Max Temp (C°)	Min Temp (C°)	Rain (in)	Average rain (in)
2012	December	20	51.5	37.8	0.94	
2012	December	21	42.1	31.7	0	
2012	December	22	45.2	22.8	0	
2012	December	23	49	22.1	0.11	
2012	December	24	46.5	41.3	0.73	
2012	December	25	48.8	43.6	0.26	
2012	December	26	48.6	34.1	0.62	
2012	December	27	35	32.8	0	
2012	December	28	42.2	32.6	0.09	
2012	December	29	41.3	32	0.08	
2012	December	30	41.1	26.1	0	
2012	December	31	43.9	25.3	0	5.14

Conclusion

Soybeans have been grown around the world since about 1100 BC, and in United States since the late 1800s (ncsoy.org 2013). We've gone from incomplete weed control in the 1970s and 80s, to good control in the early 1990s, to essentially perfect control with no soybean injury in the Roundup Ready era. As GR weeds become more prevalent, this new post-RR era of weed control of soybeans will be more complicated, more expensive, with less complete weed control and higher possible crop injury to both the target crop and non-target species. This study clearly indicates that weed control can be accomplished with glyphosate in a RR system, but also that soybeans can be profitably grown in a non-RR production system.

Vita

The first of two daughters, Brittany L. Gaban was born March 30, 1988 in Easton, Maryland. Brittany grew up in Centreville, MD on Maryland's Eastern Shore. After finishing high school, she attended the University of Maryland where she was introduced to agronomic technologies at an academic level. In May of 2011 she graduated from the University of Maryland with two Bachelors of Science degrees; one in Agricultural Sciences and Technologies, and the other in Plant Sciences. By the first week of June 2011, she had already started her graduate studies at the University of Tennessee, Knoxville. Brittany graduated from the University of Tennessee in May 2013 with a Masters of Science degree in Plant Sciences. She has since moved home, is currently happily married to Timothy E. Fahrman and is working for Monsanto Company as a Discovery Soybean Breeding Research Assistant in Galena, Maryland.