Going into Agriculture

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Acknowledgments:

From the time I was selected to go to the Global Youth Institute to my future return to it as a Borlaug-Ruan intern, I have had so many people to be with me through it all. First and foremost, I want to thank the World Food Prize for exposing me to the issues going on globally with food security. Before getting involved with the World Food Prize, I knew nothing about the hunger issues worldwide. Also, I want to thank the World Food Prize for its youth programs so that more young people can be exposed to these issues.

Thank you Lisa Fleming and the selection committee for choosing me and 23 other young adults for the Borlaug-Ruan internship. Lisa, your long hours of work and dedication to our safety and wellbeing means a lot to me. Thank you for being a mom even from thousands of miles away. Katherine Walther, thank you for keeping us on our toes for abstracts and pictures. I truly appreciate your scientific knowledge and help with the abstracts.

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Everyone at home, thank you for your kind and cheering remarks. They all helped me to keep moving on during this program. My friends I made at CIMMYT, you all also helped me through this experience. Whether it was taking a two-hour lunch or walking around CIMMYT, I had a great time with you. I personally want to thank Alyssa Dougherty. You were a great group leader at the GYI and an amazing friend during the Borlaug-Ruan Internship. Even though we both had the same amount of work, you always had words of encouragement to help me get mine done.

Lastly, thank you everyone at the Alabama School of Mathematics and Science in Mobile. Ever since October 2016 you all have been a part of my WFP journey. Whether it was motivation, picture taking, or plane ride tips, I appreciate it all. I could not have asked for any other family better than my ASMS family.

Synopsis:

The internship will come in two parts: general agriculture and special project. Starting from June 15, 2017 to August 8, 2017, the understanding of general agriculture will commence. This will include understanding conservation agriculture, plant breeding, plant fertility, agricultural terminology, mechanical usages, and agriculture in different environments. The special project will be a screening of herbicide in corn, wheat, and beans, which will be monitored to analyze the herbicide's impact on these crops' yield and weed management. Corn, wheat, and beans are important because of their heavy use in Mexican cuisine, and these crops are sometimes used in crop rotation together. The reason for starting this screening is due to weeds' competition against the crops for sunlight, water, and nutrients. Weeds can have a negative effect on the yield of these crops, so this project will show what herbicide is more effective. Primarily, to evaluate this research visual interpretation will be used. By comparing the yield of the crops with herbicide versus the yield of the control group crops without herbicide, the data produced will provide the necessary solution to what herbicide should be used for these crops and how much of it should be applied.

During the duration of this screening, different procedures will take place. In each of the three crops (corn, wheat, and beans) the weeds present will be collected and cataloged for identification. The weeds will be documented by a picture copy of its three stages: early, growing, and reproduction (flowering). Also, the scientific name and common name will be used to label each weed. The crop weed competition will be analyzed in the herbicide screening trial. In each trial, there is a weedy and weed free plot. The weedy plots will serve as controls and will experience full competition of weeds and show how they affect the crops' yield. Similarly, the weed free plot will serve as opposite to the weedy for results of no competition by weeds on the crops. Weed samples will be collected separately from each herbicide used and the biomass of the weeds will be recorded; this will take place 30 and 45 days after sowing of seeds (DAS). The data that will be collected for the crops are their emergence date, flowering date, and yield date. The details of the treatments can be found below in the following tables:

*Table 1 shows the herbicides used for **corn** and amount of herbicide applied.

Trat	**Herbicida**	**Ingrediente activo**	**Modo de acción**	**Dosis (g o mL/ha)**
1	Sin (Testigo)	-	No aplica	No aplica
2	Sin (weed free)	-	No aplica	No aplica
3	Gesaprim	Atrazine	PS2	1388
4	Surpass	Acetachlor	Energy synthesis	2000
5	Gesaprim+Surpss	Acetachlor+ Atrazine	PS2+ energy synthesis	1111+2000
6	Primagram gold	Atrazine+S-metalachlor	PS2+ energy synthesis	4000

7	Sempra	Halosulfuron	ALS inhibitor	100
8	Adengo	Isoxaflutole+Thiencarbazone	Carotenoids Inhibition	250
9	Calistto	Mesotrione	Carotenoids Inhibition	415
10	Laudis	Tembotrione	Carotenoids. Inhibition	300
11	Marvel	Dicamba+ Atrazine	Phenoxy+ PS2	3000
12	Gesaprim+Banvel	Atrazine+ 2,4-D+ Dicamba	Phenoxy+ PS2	1111+1000
13	Gesaprim+ Veloz	Atrazine fb Carfentrazole	PS2 for atrazine, for carfentra: Contact, inhibitors of protoporphyrinogen oxidase	1111+1000
14	Sanson	Nicosulfuron	ALS inhibitor	1000

*Table 2 shows the herbicides used for **wheat** and amount of herbicide applied

Trat	**Herbicida**	**Ingrediente activo**	**Modo de acción**	**Dosis (g o mL/ha)**
1	Sin (Testigo)	-	No aplica	No aplica
2	Sin (weed free)			
3	Peak	Prosulfuron	ALS inhibitor	30
4	Amber	Triasulfuron	ALS inhibitor	10
5	Peak+Amber	Prosul+Traisul	ALS inhibitor	26.3+6.66
6	Banvel 12-24	Dicamba+2,4-D	Cytokinosis	1000
7	Esteron	2,4-D	Cytokinosis	500
8	Puma	Fenoxaprop	ACC inhibitor	1000
9	Starane	Fluroxypyr	Syn.Auxin, protein synthesis	400
10	Everest+Topic	Flucarbazone sodium + Clodinofop	ALS inhibitor	30+750
11	Topik	Clodinofop	ALS inhibitor	750
12	Axial	Pinoxoden	ACCase inhibitor	600
13	Sigma	Mesosul.+ Idosul.	ALS inhibitor	500
14	Veloz	Carfentrazone	Contact, inhibitors of protoporphyrinogen	1000

			oxidase	

*Table 3 shows the herbicides used for **<u>beans</u>** and amount of herbicide applied

Trat	**Herbicida**	**Ingrediente activo**	**Modo de acción**	**Dosis (g o mL/ha)**
1	Sin (Testigo)	-	No aplica	No aplica
2	Sin (weed free)	-		
3	Prowl	Pendimethalin	meristematic inhibitor	2631
4	Flex BIW	Fomesafan	Inhibition of protoporphyrinogen oxidase (PROTOX) enzyme	1000
5	Fusilade	Flauzifop	ACCase inhibitor	1000
6	Fusiflex	Fomesan+ Flauzifop		1000
7	Pivot	Imizathapyr	ALS/AHAS inhibitor	500
8	Pivot	Imizathapyr	ALS/AHAS inhibitor	400
9	Pivot	Imizathpyr	ALS/AHAS inhibitor	300
10	Basagran	Bentazone	PS2	2000

Three observations will be made every 30 and 45 days of the plants sowing: plant height, weed presents, and weed biomass. At 30 and 45 days, the average plant height in each plot will be taken and compared to all other plots in the same crop. The weeds in each plot will be taken note of, which includes species of weeds present and if it is a grass, sedge, or broadleaf. These weeds will also be collected to weigh their collected biomass for each plot. (One key note of this screening is the completion of this research will not fully be made by August 8th. However, a conclusion can be made for yielding based off of crop development which includes if the crop is growing large, if the crop has healthy green leaves, and if the crop has visible harvestable produce.)

Weed management is very important to sustainable agriculture and the sustainable system. The key issue is the amount needed for herbicide usage, and the problem this brings up is how much money should be going into herbicides. After conducting this research, it is hoped to see positive results in what herbicide is more effective to their respective weed(s) and economically wise for the farmer. Knowing what is needed will lead to positive changes in farmer spending and will lead to reducing spending on herbicides and more spending on other resources necessary for a more productive cropping system.

Journey to CIMMYT:

My agricultural journey started in Orrville, Alabama. Orrville is a rural area, with a population of about 200, where almost everyone has some agricultural involvement, whether it be a small garden during the spring or a large farming industry throughout the year. My interest in agricultural did not start to blossom until after attending a two-week program at Tuskegee University in the summer of 2015. After going again in 2016, I was on my way to Iowa that October, which lead me to going further.

In May of 2015, I was selected to go to Tuskegee University for their summer program in agriculture. In this program, I learned about the food security issues worldwide, and I was interested to learn more and get involved in solving the issues. While at this program, I had another opportunity come my way to help achieve my goal: The World Food Prize's (WFP) Global Youth Institute (GYI). After competing against other talented students for a representative spot for Alabama, I was not chosen to go my first year. However, I returned to the program at Tuskegee in summer 2016. At the end of the program, I not only learned more about food security but I also I was selected to go to Iowa for the 2016 Global Youth Institute. This then led me to apply and later become a Borlaug-Ruan internship scholar for the summer of 2017 at the Centro Internacional de Mejoramiento de Maíz y Trigo (CIMMYT).

I got into the Borlaug-Ruan International Internship because of all the issues I learned about food security in the world. I realized that the commercials about children in Africa were more than just commercials asking for money but they were outlets to educate people on the food issues in Africa. It hurt me to know that in the U.S. alone, 30 percent of prepared food goes to waste while there are people in the world who do not eat in a day. I applied for this internship to do my part in humanity.

While at CIMMYT, I worked on herbicides in corn, wheat, and beans. I found the appropriate herbicides to control broadleaf and grass weeds in each crop. Weed management is important to the yield of crops. This ties with food security because with more yield, it helps fill the gap of food needed for the population in 2050. Finding an effective and cost-efficient herbicide were the two goals of my research. If the farmer can save money, it can be used to better his/her enterprise. I am happy my supervisor gave me this project because I got to conduct my own studies and make a potential impact on food security.

Main Project: Herbicide Research

Executive summary:

Herbicides are very important to weed management as they help farmers eliminate weeds easier than hand weeding and by giving the crops more availability to the nutrients they need to grow. During June and July 2017, the research of herbicides' effects on weeds in corn, wheat, and beans took place at CIMMYT's main experimental station in El Batán. The experiment station is located in El Batán, Mexico 45 km away from Mexico City in the state of Mexico (Bell and Braun, 2015). The altitude is 2,270 msl. The latitude is 19.53123, and the longitude is -98.84746. The station has an average annual rainfall of 570 mm. The temperature ranges from -7°C to 31°C, and average annual temperature of 14.48°C. Three experiments were conducted on corn, wheat, and bean crop. There were 12 herbicides tested in the corn and wheat crops and 8 herbicides tested in the bean crop. Measurements of plant height, weeds present, and weed dry biomass were recorded every 30 and 45 days after sowing (DAS). The conclusion for what herbicide would work best for weed control was primarily based on weed dry biomass at 45 DAS. In the corn trial, the best herbicide that meets the research's objective is Atrazine + S-metalachlor 1348 + 1044 g ai/ ha. This herbicide had the lowest biomass at 45 DAS compared to Acetachlor 1370 g ai/ ha (the second-best herbicide) and Acetachlor + Atrazine 1000 + 1370 g ai/ ha (the third best herbicide). Acetachor alone or in combination with atrazine was cost effective when compared to other formulated mixtures or herbicides. In the wheat trial, Prosuluron + Triasulfuron 15 + 5 g ai/ ha and Mesosulfuron + Idosulfuron 15 + 3 g a.i./ ha proved the best for this research's objective. Both of these did an equal job at controlling weeds, and they were both the lower weed dry biomass at 45 DAS, only being a few grams apart from each other. Flucarbazone sodium + Clodinofop 50 + 50 g ai/ ha also proved to be a good herbicide in wheat; it had the next lower biomass compared to the other two herbicides best for controlling weeds in wheat. The tank mixture of Prosulfuron and Triasulfuron was cost effective for controlling broadleaf weeds. In the bean trial, Pendimethalin 1000 g ai/ ha proved to be the best herbicide for this research. In this herbicide's treatment plot, it had the tallest height and the lowest weed biomass compared to the others. Its weed presence was multiples lower than any other plot in the trial. Imizathapyr 30 g ai/ha and Imizathapyr 40 g ai/ ha are also good herbicide options for beans because they were second and third, respectively, for the lower weed dry biomass. This research will benefit farmers by giving them a clear solution to what herbicide would be best to use in these specific crops under varying weed ecologies.

Project Introduction:

Poor weed management can cause a lesser yield than expected by farmers. Therefore, choosing the right weed management practice, specifically the correct herbicide, is important because some may cause an adverse effect on yield as well. During my time at CIMMYT, my research project revolved around finding the best herbicide for weed management and cost-effective herbicide solutions for corn, wheat, and bean crops. These crops are important not only to Mexican cuisine but also to international cuisines. With the international use of these crops, finding suitable weed management can potentially assist in closing the yield gap and improving availability of the food needed by year 2050.

The experiments were conducted at J8 and J9 blocks on CIMMYT's main experimentation station in El Batán. The soil was silty clay loam soil of pH 5.9-7.6 being medium to low in organic matter (1.77-1.9%), high in P (52-58 kg/ha) and K (378-456 kg/ha). The experiment station is located 45 km away from Mexico City in the state of Mexico. The altitude is 2,270 msl, Lat 19.53123 and Long -98.84746, average annual rainfall 570 mm, temperature ranges from -7°C to 31°C. The station has an average annual temperature of 14.48°C, and the main growing season is March-December. This experiment was conducted from the month of May to July during the rainy season of this area.

The three main grass weeds present in the corn and wheat crops include *Eragrostis mexicana*, *Elusine indica*, and *Bromus* spp. Broadleaves including *Oxalis* sp., *Portulacca oleracea*, and *Euphorbia microphylla*. The only sedge present in the experiment was *Cyperus esculentus*. The main grasses present in the bean crop included *E. mexicana* and *E. indica.* The broadleaves included *Oxalis sp., P. oleracea*, and *Amaranthus sp.* The only sedge species present was *C. esculentus*.

In the corn and wheat crops there were 12 herbicide treatments being tested, and in the bean crop there were 8 herbicide treatments being tested (Annexure I, II, and III). There were two weedy and weed free plots in each experiment to serve as controls. In each crop, there were two repetitions of the treatments used; in total, there were 28 plots in corn and wheat and 20 plots in the beans. The data shown in the graphs below will be the average of the two treatment plots. Each plot in the corn and wheat were 3m x 10m and in the beans, they were 3m x 7m. All crops were under rain-fed condition and were in a conservation agricultural environment with residue and no tillage. The corn and wheat crop were fertilized with 40 kg P_2O_5/ha + 150 kg nitrogen/ha + 1.5 kg/ha of borax. The bean crop was fertilized with 40 kg P_2O_5/ha + 25 kg of nitrogen/ha + 1 kg/ha of borax.

In order to make a logical conclusion for this research four pieces of data were collected: average plant height, weed types present in plots, weed dry biomass, and herbicides' effects on weeds. The plant heights were recorded, and the weeds present were collected and cataloged every 30 and 45 days after sowing (DAS). These two pieces of information were enough to decide what herbicide was best to be used; however, the biomass of the dry weeds gave insight of the potential weeds in the plot. Also, the herbicides' effects gave insight on what herbicide is best for specific types of weeds and the names of those weeds.

The majority of this research was done in the field under the guidance of Dr. Ravi Gopal Singh and the help of the field workers of CIMMYT. All data was analyzed and put into word documents and excel sheets. Even though I cannot be present for final yield, as stated above a conclusion was made primarily based on biomass of dry weeds collected in the treatment plots.

Project Methods & Results:

Corn

Average Height: To get the heights of the crops, a meter stick was used (all measurements are in centimeters). Since there were two repetitions of herbicides, the measured height of both repetitions was averaged. This practice was done for all crops and every 30 and 45 DAS.

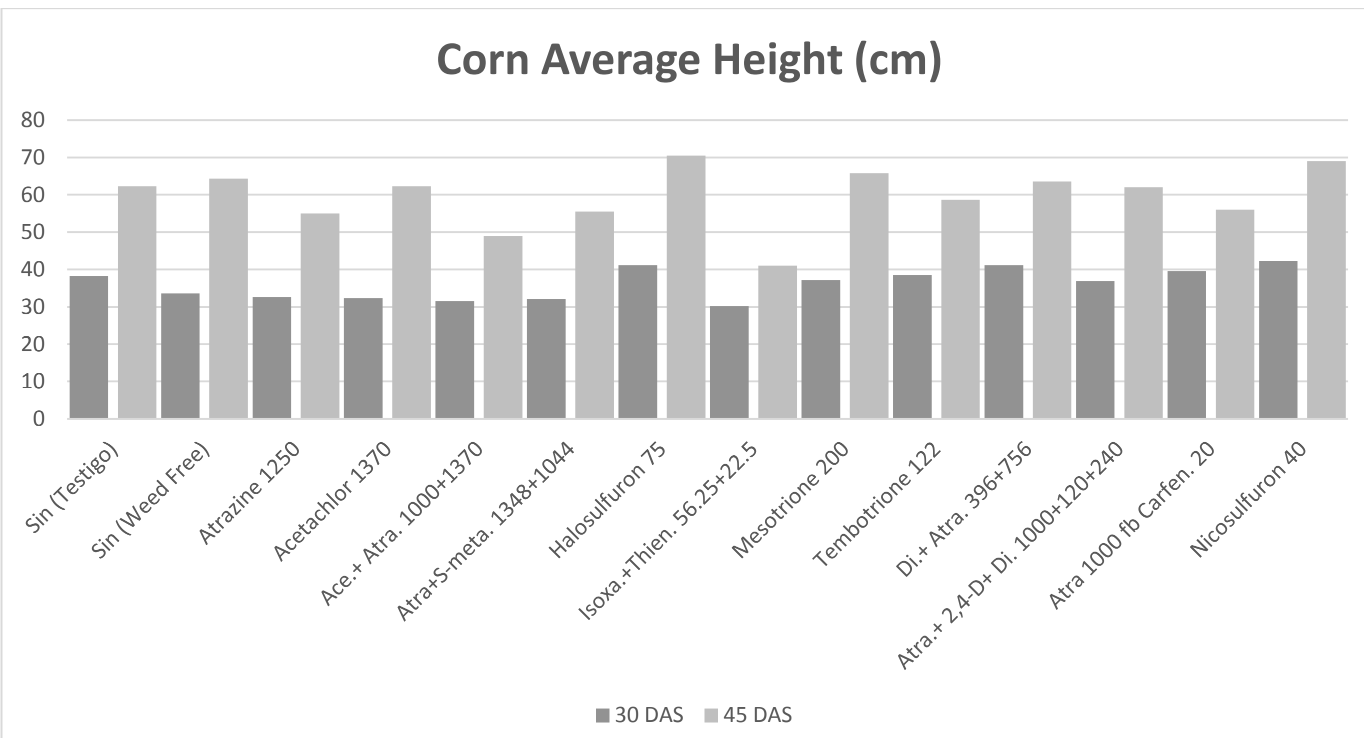


Fig 1. Effect of weed management practices on corn plant height (cm) at 30 and 45 days after sowing

In the corn crops, the four herbicide treatments that had the taller plants after the first 30 days were Halosulfuron 75 g ai/ ha, Dicamba + Atrazine 396 + 756 g ai/ ha, Atrazine 1000 fb

Carfentrazone 20 g ai/ ha, and Nicosulfuron 40 g ai/ ha. All of these had an average height of about 40cm. At 45 DAS, the taller plants were recorded in the plots treated with Halosulfuron and Nicosulfuron. Dicamba + Atrazine fell to fourth tallest and Atrazine fb Carfentrazone fell to about fourth shortest; this was probably due to partial and temporary toxicity of Carfentrazone on corn.

Effect of herbicides on Grasses, Broadleaves, and Sedges Present: During this research, all weed types were accounted for: grasses, broadleaf, and sedges. The weeds were collected every 30 and 45 DAS. Every weed collected counted as one, so every mature weed and germinating weed had the same value during collection. The weeds were initially counted in a 50cm x 50cm area; however, for the data it needed to be accounted for in a m^2 (1m x 1m) area. After computing all numbers in a 50cm x 50cm, the numbers were multiplied by four to convert the results as counted for in a m^2 area.

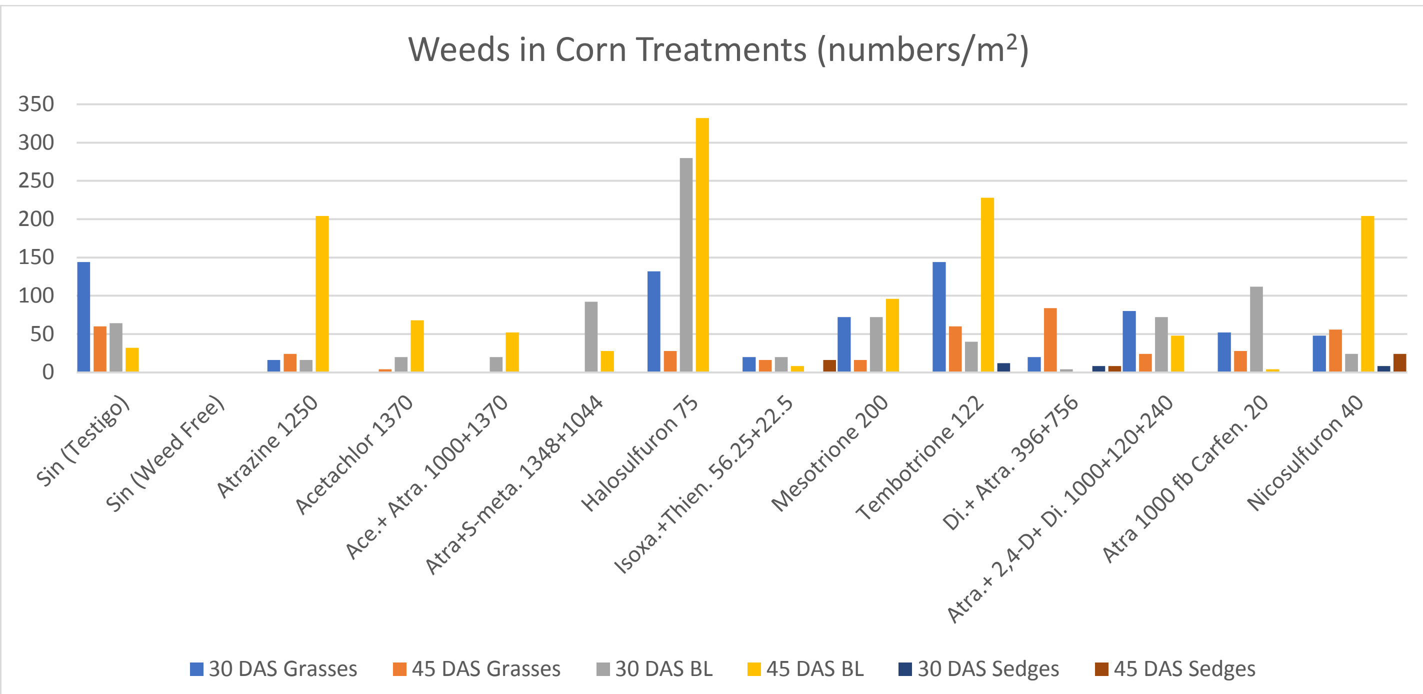


Fig 2. Effect of weed management practices on weeds community composition in Corn.

At 45 DAS, there were between 0 and $84/m^2$ grasses present in the different treatment plots. No grasses were present in Acetochlor + Atrazine 1000 + 1370 g ai/ ha and Atrazine + S-metolachlor 1348 + 1044 g ai/ ha, and only $4/m^2$ were present in Acetochlor 1370 g ai/ ha. These three grass herbicides are the most effective against all species of grasses. There were between $332/m^2$ to 0 broadleaves present in the treatment plots. The broadleaf herbicides Dicamba + Atrazine 396 + 756 g ai/ ha ($0/m^2$), Atrazine 1000 fb Carfentrazone 20 g ai/ ha ($4/m^2$), and

Isoxaflutole + Thiencarbazone 56.25 + 22.5 g ai/ ha (8/m^2) are the top three for best control over broadleaves in this order. Sedges were only present in three plots, but the reason why sedges have a low presence is because of the high amount of residue left from the previous harvest.

Weed Dry Biomass: After the weeds were collected and documented for each plot, they went through a drying process for about 4 days to remove all moisture from the plant. This gave the weeds' dry biomass. The biomass represents the states of the weeds present whether they were in the mature or germinating phase of plant life. If the weed count is high but biomass low it can be interpreted that many of the weeds were germinating and were potential future threats when reaching maturity. If the weed count was low but the biomass high then this likely means many of the weeds present were mature and were direct competition for sunlight and nutrients with the crop it was in. The weeds used for the biomass were collected in a 50cm x 50 cm area so like the weed types above; all the number from the 50 cm x 50 cmx area were multiplied by four to get the numbers in m^2 area.

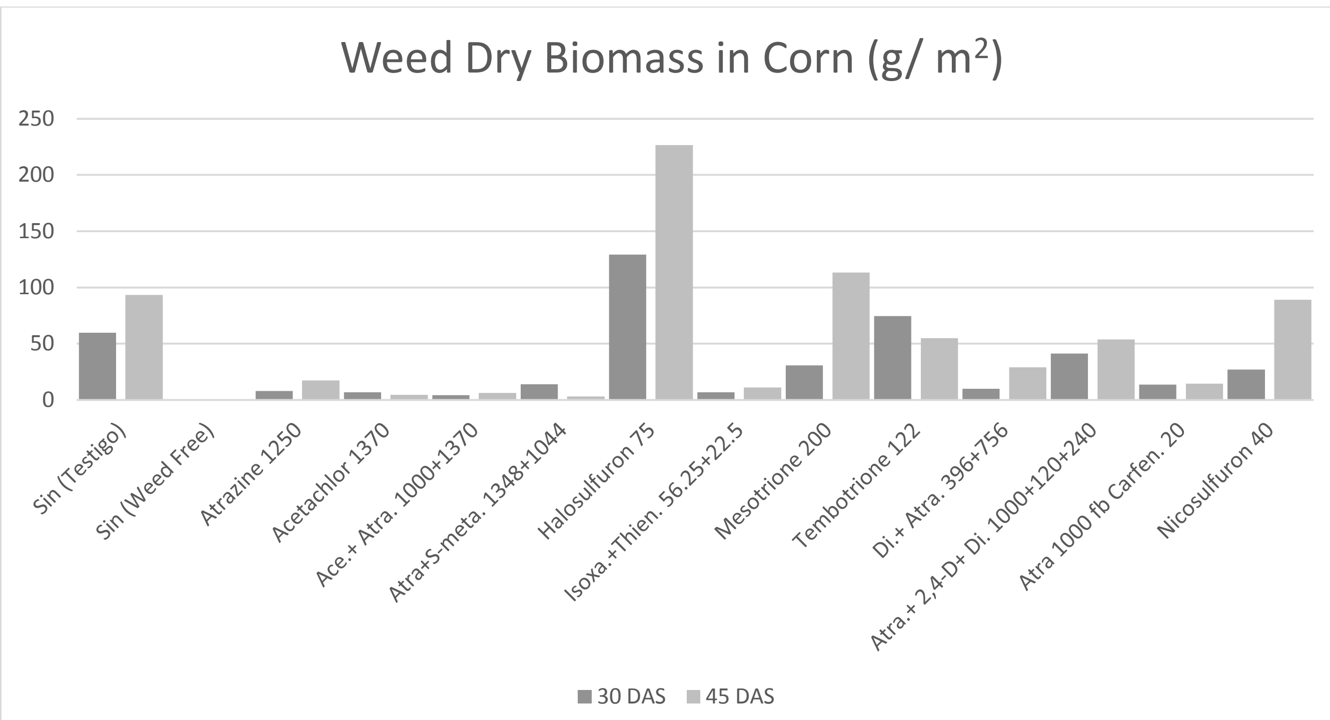


Fig 3. Effect of weed management practices on weeds dry biomass in Corn

The treatment plots Acetochlor 1370 g ai/ ha, Acetochlor + Atrazine 1000 + 1370 g ai/ ha, and Atrazine + S-metolachlor 1348 + 1044 g ai/ ha had the lower biomass at 45 DAS, and at 30 DAS they all had low recorded biomasses. Atrazine + S-metolachlor had the lowest biomass at 45 DAS with 3.2 g/ m^2. After both 30 & 45 DAS, the Halosulfuron 75 g ai/ ha plot had the highest weed dry biomass. Looking back on the weed chart for corn in the last section, the Halosulfuron plot also had the highest number of weeds 30 & 45 DAS. Based off this information, Halosulfuron had a large number of mature weeds growing in the treatment plot.

Herbicides' Effects on Weeds: When the weeds were collected in every treatment plot, the specific names of those weeds were recorded. This was done to identify what herbicide was most effective on a specific weed. The effect of each herbicide was cataloged by weak/no effect meaning the herbicide had no noticeable effect on the weed population, ok effect meaning the herbicide had some effect on the weed population, and strong effect meaning it was easy to detect weed damage and population drop of that weed. In the graphs, CBA stands for can be assumed. This is used because the certain herbicide's description states it mainly eliminates those weeds. If that weed is not present, then it can be assumed the herbicide eliminated all those weeds. Also, the letters beside the herbicide indicate what weed the herbicide mainly kills i.e. G=grasses and BL=broadleaf. Also the prefix pre indicates if the herbicide is a pre-emergence herbicide.

Table 1. Effect of herbicides on the weed community composition in Corn.

Treatments in Corn	Strong Effect	Ok Effect	Weak or No Effect
Atrazine- Pre. BL		*Amaranthus*	*Oxalis, Bromus, Eragrostis mexicana*
Acetochlor- Pre. G	Grasses (CBA)	*Oxalis, Portulaca*	
Acetochlor+ Atrazine- Pre. G BL	Grasses (CBA)	*Oxalis*	
Atrazine+S-metolachlor- Pre. BL	*Oxalis*	*Cyperus*	
Halosulfuron- BL Sedge	Oxalis, *Bromus*	*Portulaca, Eragrostis mexicana*	
Isoxaflutole+Thiencarbazone-Pre. BL G	*Bromus, Oxalis*	*Eleusine, Cyperus*	
Mesotrione- G BL	*Bromus, Eragrostis mexicana*	*Portulaca, Euphorbia, Eleusine*	
Tembotrione- G BL	*Sicyos, Portulaca*	*Oxalis, Eragrostis mexicana*	
Dicamba+ Atrazine- G BL	*Portulaca*	*Cyperus*	*Eragrostis mexicana*
Atrazine+ 2,4-D+ Dicamba- G BL	*Eragrostis mexicana*	*Portulaca, Bromus*	
Atrazine fb Carfentrazone- G BL	*Oxalis, Bromus*	*Eragrostis mexicana*	
Nicosulfuron- G BL		*Eragrostis mexicana, Eleusine*	*Oxalis, Portulaca, Cyperus*

The majority of these herbicides' effects were chlorosis or chlorosis followed by necrosis (stunting). The leaves of the weeds were discolored and turning white. The notable herbicide is Atrazine+2,4-D+Dicamba 1000+120+240 g ai/ha. Its effect on *Portulaca* and other herbicide was systemic. The weed was completely killed and dried out. On the other hand, Carfentrazone had a contact effect causing chlorosis followed by necrosis.

Wheat

Average Height: To get the heights of the crops, a meter stick was used (all measurements are in centimeters). Since there were two repetitions of herbicides, the measured height of both repetitions was averaged. This practice was done for all crops and every 30 and 45 DAS.

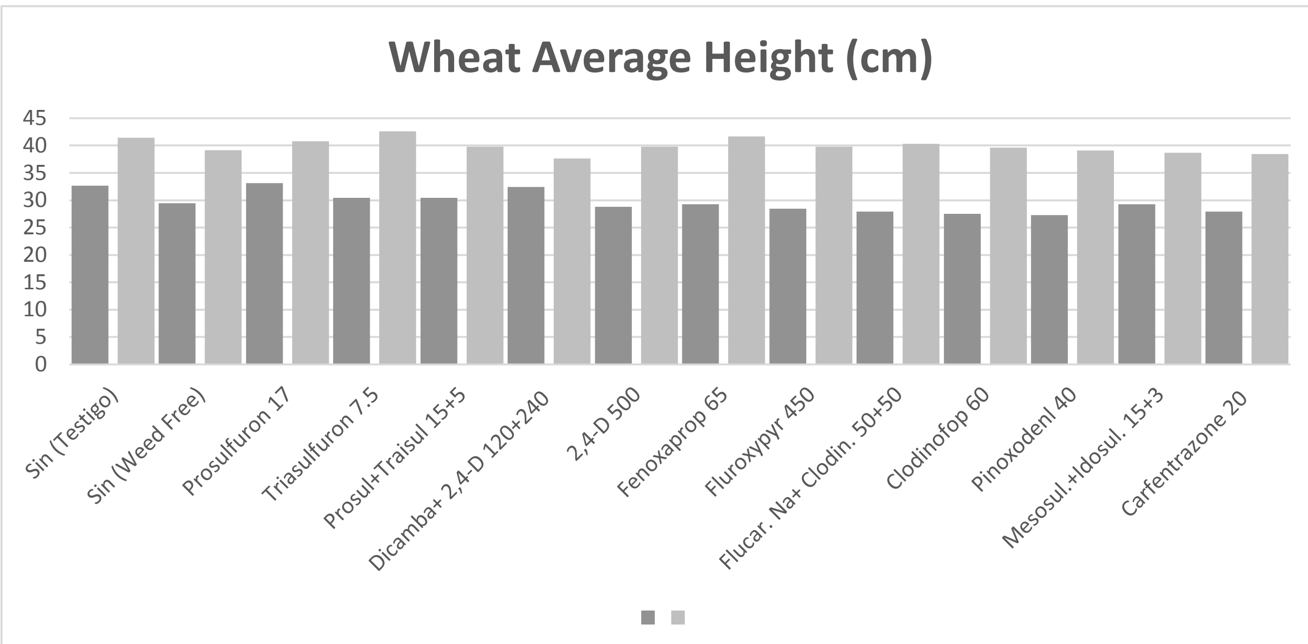


Fig 4. Effect of weed management practices on wheat plant height (cm) at 30 and 45 days after sowing

In the wheat crops, the three herbicide plots that had the taller height after the first 30 days were Prosulfuron 17 g ai/ ha, Dicamba+ 2,4-D 120 + 240 g ai/ ha, and Prosulfuron + Triasulfuron 15 + 5 g ai/ ha. The average plant height in these treatments was about 31cm. After 45 DAS, the plot with Prosuluron treatment had the third tallest plot and Prosuluron + Triasulfuron treatment plot had about the fourth tallest plants. The tallest plot 45 DAS was with Triasulfuron 7.5 g ai/ ha. The Dicamba+ 2,4-D plot went down to being the shortest plot 45 DAS.

Grasses, Broadleaves, and Sedges Present: During this research, all weed types were accounted for: grasses, broadleaf, and sedges. The weeds were collected every 30 and 45 DAS. Every weed collected counted as one so every mature weed and germinating weed had the same value during collection. The weeds were initially counted in a 50cm x 50cm area, however, for the data it needed to be accounted for in a m^2 (1m x 1m) area. After computing all numbers in a 50cm x 50cm, the numbers were multiplied by four to convert the results as counted for in a m^2 area.

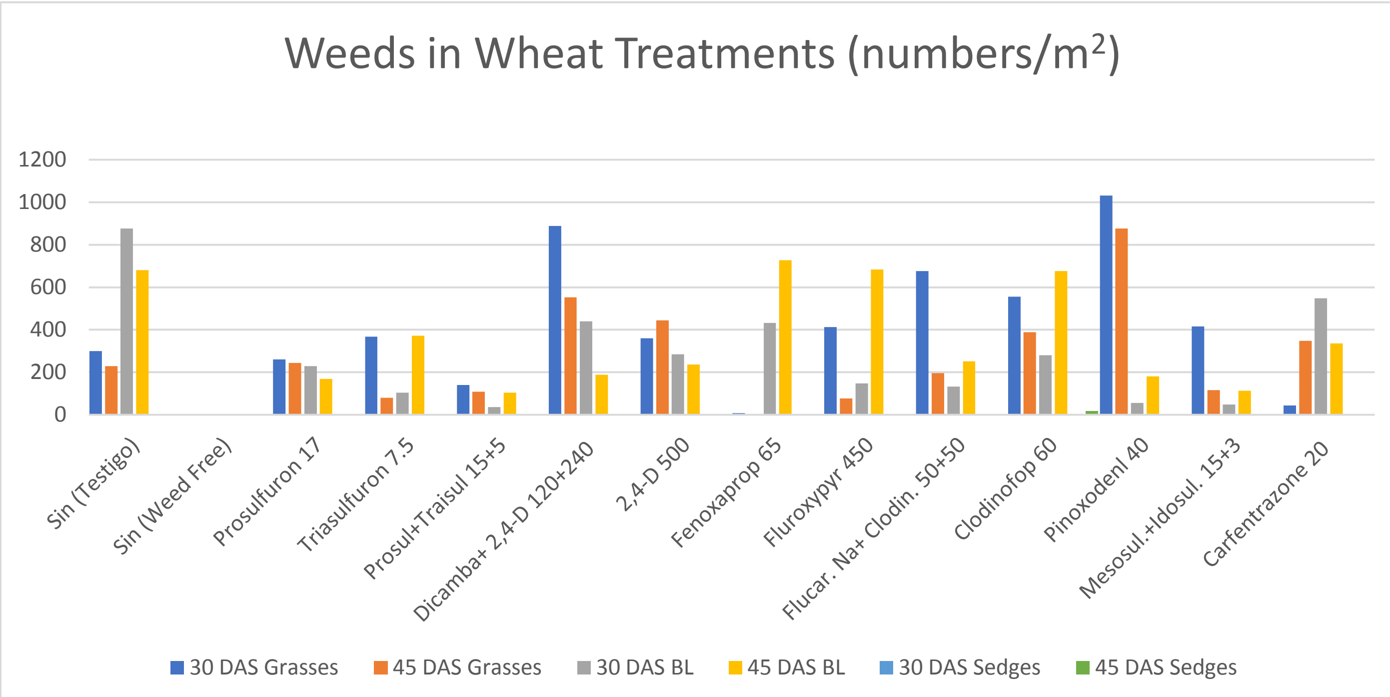


Fig 5. Effect of weed management Practices on weeds community composition in Wheat.

At 45 DAS, there were between 0 and 876/m^2 grasses present in the treatment plots. The top three herbicides that controlled grasses well are Fenoxaprop 65 g ai/ ha, Fluroxypyr 450 g ai/ ha, and Triasulfuron 7.5 g ai/ ha. Fenoxaprop was the best with 0 grasses present at 45 DAS. Broadleaves in the treatment plots ranged between 728/m^2 to 104/m^2. The herbicides that worked best against broadleaves are Prosulfuron 17 g ai/ ha, Dicamba + 2,4-D 120 + 240 g ai/ ha, and 2,4-D 500 g ai/ ha. Dicamba + 2,4-D is the best herbicide because of its control of a population of 440/m^2 broadleaves at 30 DAS to 188/m^2 at 45 DAS. Sedges are only present in two plots, and their low presence is strongly suggested to be due to residue in the cropping area.

Weed Dry Biomass: After the weeds were collected and documented for each plot, they went through a drying process for about 4 days to remove all moisture from the plant. This gave the weeds' dry biomass. The biomass represents the states of the weeds present: if they were mature or germinating. If the weed count is high but biomass low it can be interpreted that many of the weeds were germinating and were potential future threats when reaching maturity. If the weed count was low but the biomass high then this likely means many of the weeds present were mature and were direct competition for sunlight and nutrients with the crop it was in. The weeds used for the biomass were collected in a 50cm x 50 cm area so like the weed types above; all the number from the 50 cm x 50 cm area and then the numbers were multiplied by four to get the weed density in numbers per m^2 area.

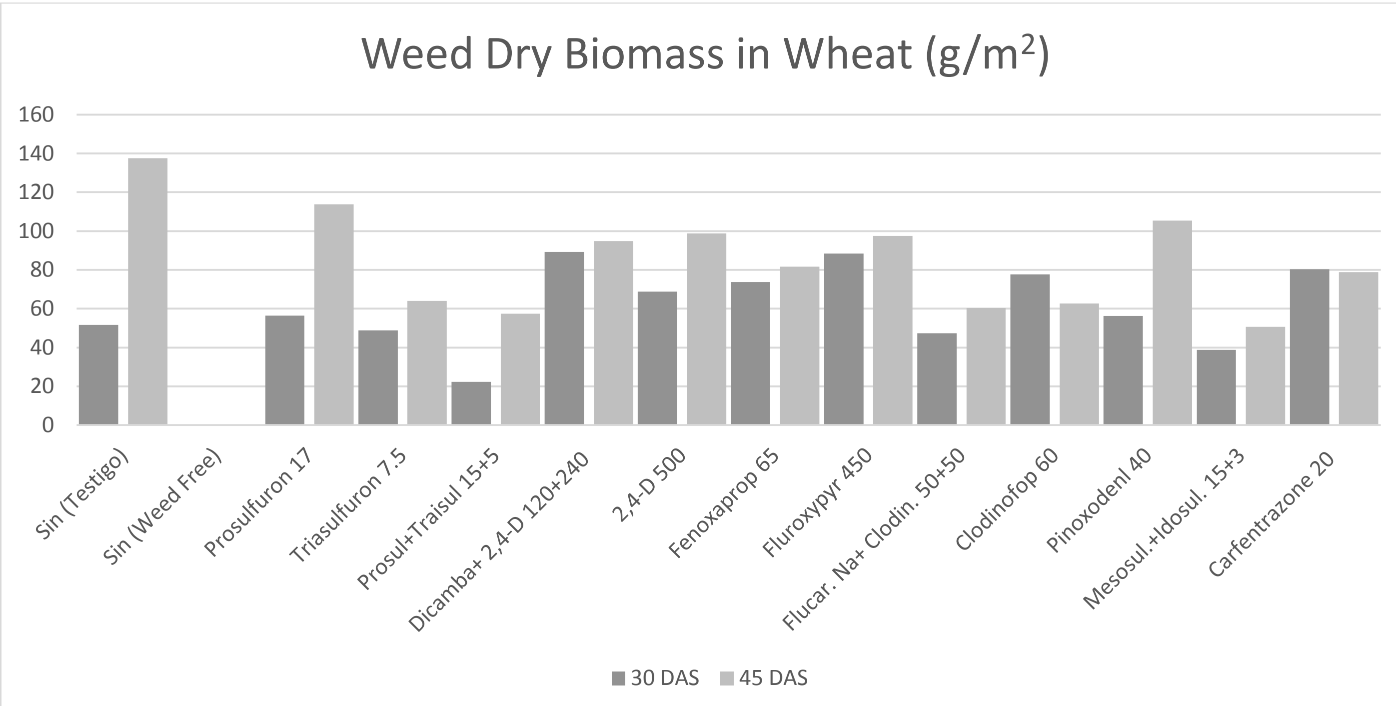


Fig 6. Effect of weed management Practices on weeds dry biomass in Wheat

The treatment plot Prosuluron + Triasulfuron 15 + 5 g ai/ ha had the lowest biomass 30 DAS (22.2 g/ m^2) and the lowest number of weeds. The Prosuluron + Triasulfuron plot at 45 DAS had the second lower biomass at 57.4 grams/ m^2. Also, this treatment had the fewest number of weeds present. Mesosul. + Idosul. 15 + 3 g ai/ ha at 45 DAS had the lowest weed dry biomass at 50.6 g/ m^2.

At 30 DAS, the Dicamba + 2,4-D 120 + 240 g ai/ ha plot had the highest biomass of 89.2 grams/ m^2. This treatment also had the most weeds present at 30 DAS. Since Dicamba + 2,4-D had a high weed count and high biomass, it can be inferred that the weeds present were at their mature state. At 45 DAS, Prosulfuron 17 g ai/ ha had the highest biomass in the treatments at 113.8 grams/ m^2. This is strange because Prosulfuron did not have the most weeds present. It can be concluded that the weeds present in these plots were all mature.

Herbicides' Effects on Weeds: When the weeds were collected in every treatment plot, the specific names of those weeds were recorded. This was intended to know what herbicide has the most effect of what specific weed. The effect of each herbicide was cataloged by weak/no effect meaning the herbicide had no noticeable effect on the weed population, ok effect meaning the herbicide had some effect on the weed population, and strong effect meaning it was easy to detect weed damage and population drop of that weed. (In the graphs, CBA stands for can be assumed. This is used because the certain herbicide's description states it mainly eliminates those weeds. If that weed is not present then it can be assumed the herbicide eliminated all those weeds. Also, the letters beside the herbicide indicate what weed the herbicide mainly kills i.e. G=grasses and BL=broadleaf. Also, pre indicates if the herbicide is a pre-emergence herbicide or not.)

Table 2. Effect of herbicides on the weed community composition in wheat.

Treatments in Wheat	Strong Effect	Ok Effect	Weak or No Effect
Prosulfuron- BL	*Portulaca, Malva, Amaranthus*	*Oxalis, Sonchus oleraceus*	*Bromus, Euphorbia Eragrostis mexicana,*
Triasulfuron- BL	*Portulaca, Malva*	*Eragrostis mexicana, Sonchus oleraceus, Euphorbia*	*Oxalis, Bromus, Elesuine*
Prosul+Traisul- BL	*Portulaca Malva, Amaranthus*	*Oxalis, Euphorbia*	*Bromus, Elesuine*
Dicamba+ 2,4-D- BL	*Portulaca*	*Malva, Sicyos*	*Oxalis, Bromus*
2,4-D- BL Sedges	*Portulaca, Eragrostis mexicana*	*Euphorbia*	*Bromus*
Fenoxaprop- G	*Bromus, Eleusine, Eragrostis mexicana* (CBA)	*Portulaca*	*Oxalis, Sonchus oleraceus, Euphorbia*
Fluroxypyr- BL	*Bromus*, Elesuine, *Eragrostis mexicana* (CBA)		*Portulaca, Euphorbia*
Flucarbazone sodium+ Clodinofop		*Bromus, Portulaca*	*Oxalis, Malva, Sonchus oleraceus*
Clodinofop- G		Elesine, *Eragrostis mexicana*	*Oxalis, Bromus, Euphorbia*
Pinoxodenl- G			*Oxalis, Bromus, Portulaca, Euphorbia*
Mesosul.+Idosul.- G	[*Eleusine Eragrostis mexicana*] (CBA)		*Oxalis, Bromus, Euphorbia*
Carfentrazone	*Portulaca*	*Eragrostis mexicana*	*Oxalis, Bromus*

The majority of weeds affected by herbicides underwent chlorosis. However, *Portulaca* in Fluroxypyr 450 g ai/ha and Carfentrazone 20 g ai/ha had unique effects compared to the other weeds. Fluroxypyr eliminated foliage to the weed. This in turn caused *Portulaca* to undergo chlorosis in the stem. Carfentrazone also had the same effect as Fluroxypyr but at a faster rate. The latter effect was the stem drying out and causing the whole weed to die.

Beans

Average Height: To get the heights of the crops, a meter stick was used (all measurements are in centimeters). Since there were two repetitions of herbicides, the measured height of both repetitions was averaged. This practice was done for all crops and every 30 and 45 DAS.

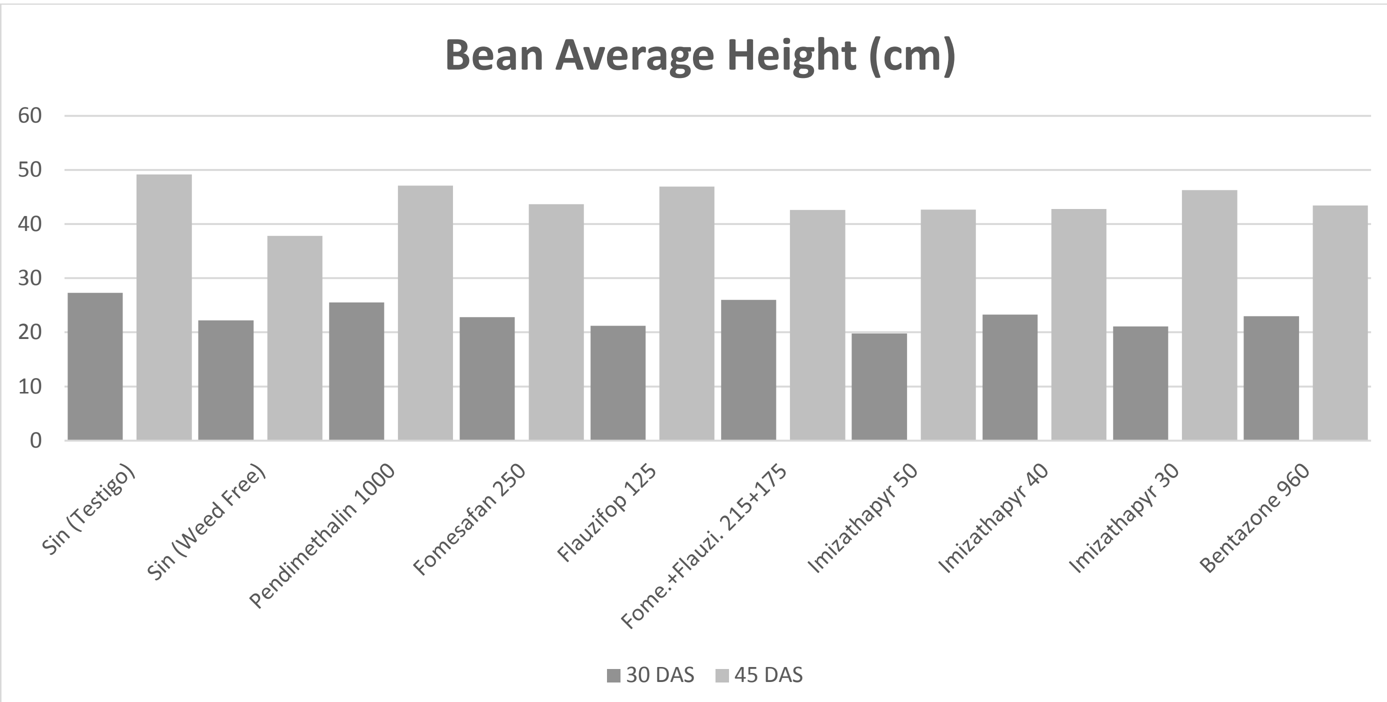


Fig 7. Effect of weed management practices on bean plant height (cm) at 30 and 45 days after sowing

In the bean crop, the three herbicide treatment plots with the taller heights after the first 30 days were Pendimethalin 1000 g ai/ ha, Fomesan + Flauzifop 215 + 175 g ai/ ha, and Imizathapyr 40 g ai/ ha. All of these had a height of about 24cm. After 45 DAS, the Pendimethalin plot still had the tallest plant height and Flauzifop was second to that. Fomesan + Flauzifop fell to the shortest plot 45 DAS.

Grasses, Broadleaves, and Sedges Present: During this research, all weed types were accounted for: grasses, broadleaf, and sedges. The weeds were collected every 30 and 45 DAS. Every weed collected counted as one so every mature weed and germinating weed had the same value during collection. The weeds were initially counted in a 50cm x 50cm area, however, for the data it needed to be accounted for in a m^2 (1m x 1m) area. After computing all numbers in a 50cm x 50cm, the numbers were multiplied by four to convert the results as counted for in a m^2 area.

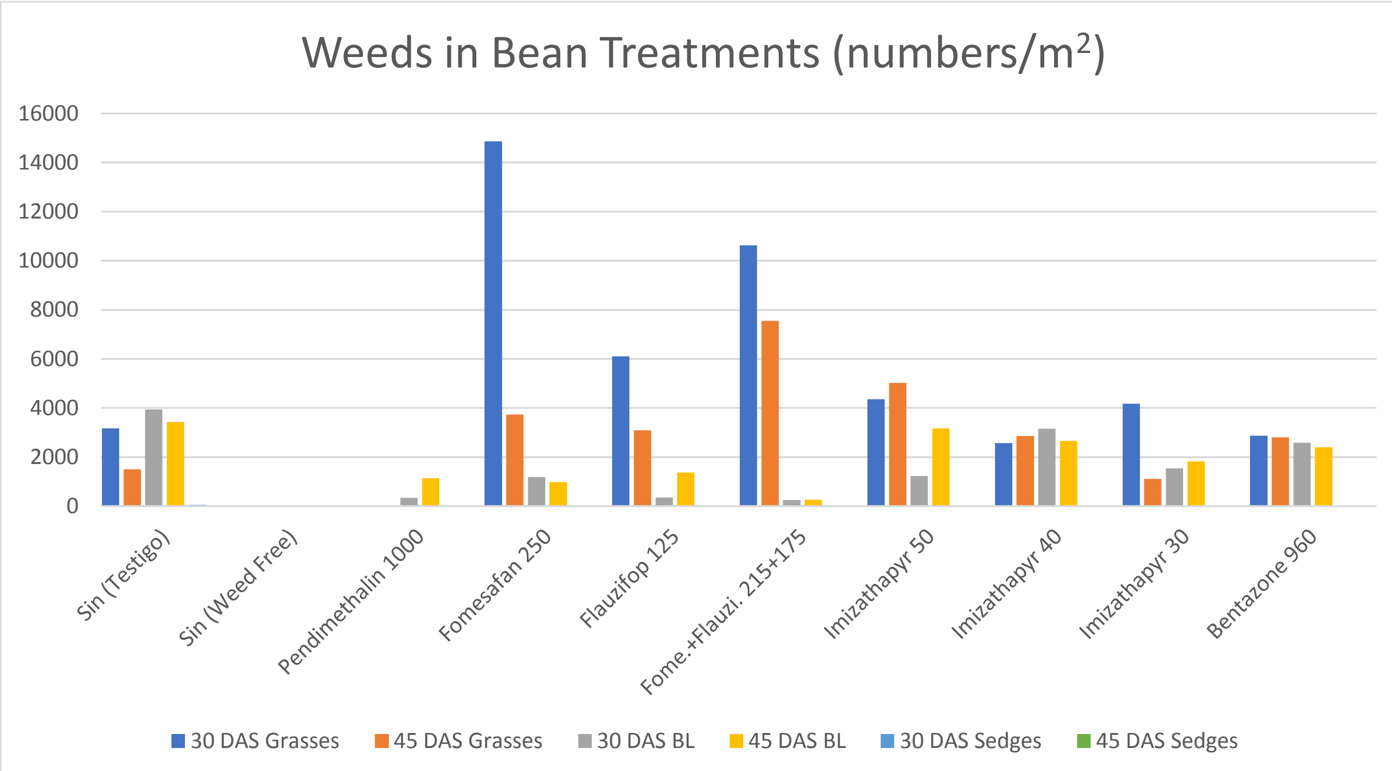


Fig 8. Effect of weed management practices on weeds community composition in bean.

The bean trial had the highest number weeds in the research. This is thought to be due to less residue being left behind from the previous harvest which was wheat.

At 45 DAS, grasses in the treatment plots ranged from 24/m^2 to 7548/m^2. The three herbicides that had the best control over grasses are Pendimethalin 1000 g ai/ ha, Imizathapyr 30 g ai/ha, and Imizathapyr 40 g ai/ ha. Pendimethalin had the lowest amount of grasses at 24/m^2. Imizathapyr 30 g ai/ ha had 1112/m^2 grasses which is the second lowest number of grasses. The broadleaves in the treatment plots ranged from 3176/m^2 and 264/m^2. The best herbicides for broadleaf control were Fomesan + Flauzifop 215 + 175 g ai/ ha, Fomesafan 250 g ai/ ha, and Pendimethalin. Fomesan + Flauzifop had the lowest number of broadleaves at 264/m^2. Sedges were not present at all in the bean crop at 45 DAS.

Weed Dry Biomass: After the weeds were collected and documented for each plot, they went through a drying process for about 4 days to remove all moisture from the plant. This gave the weeds' dry biomass. The biomass represents the states of the weeds: if they were mature or germinating. If the weed count is high but biomass low it can be interpreted that many of the weeds were germinating and were potential future threats when reaching maturity. If the weed count was low but the biomass high then this likely means many of the weeds present were mature and were direct competition for sunlight and nutrients with the crop it was in. The weeds used for the biomass were collected in a 50cm x 50 cm area so like the weed types above; all the number from the 50 cm x 50 cmx area were multiplied by four to get the numbers in m^2 area.

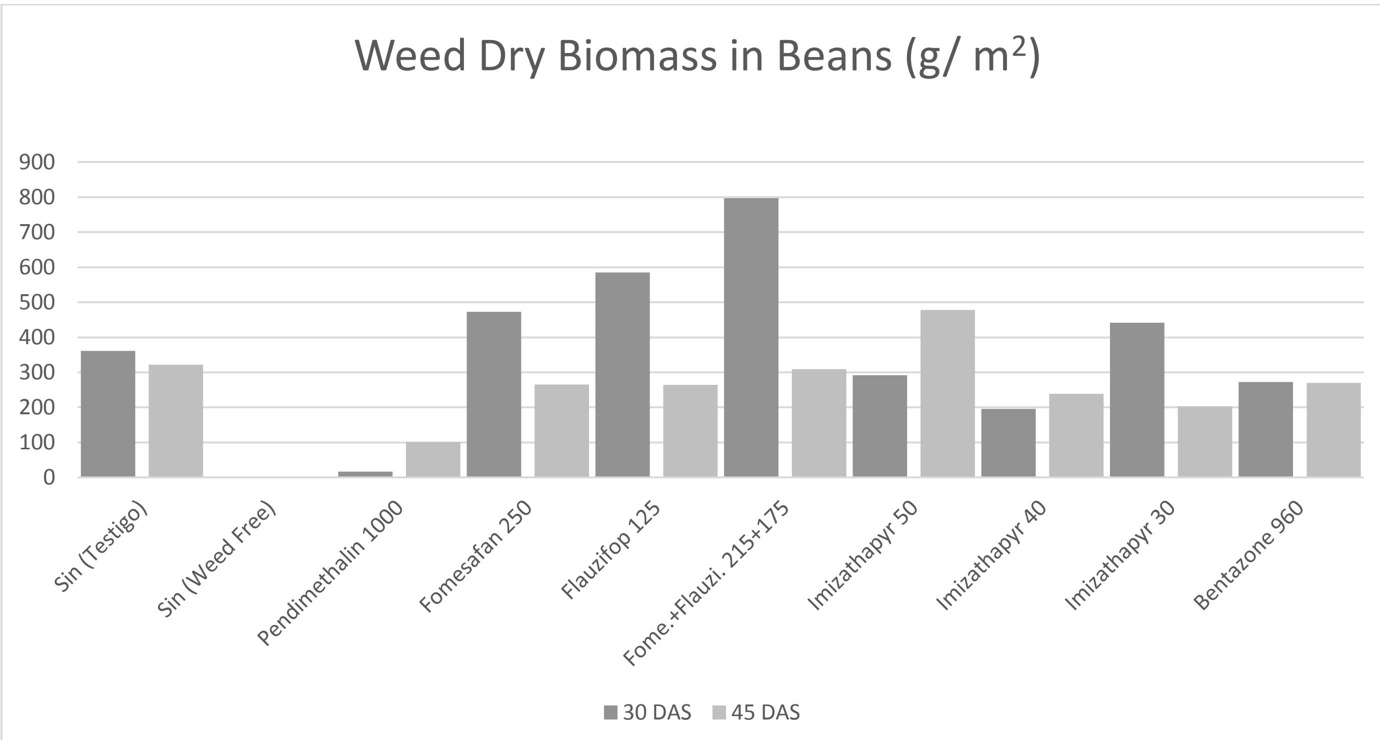


Fig 9. Effect of weed management practices on weeds dry biomass in Beans

The Pendimethalin 1000 g ai/ ha plot had the lowest biomass at 30 & 45 DAS. It also had the least number of weeds present at both of these times. Compared to the other treatment plots, this plot had multiples less than weeds than the other plots. This shows Pendimethalin is the best at controlling the weed population. The Fomesan + Flauzifop 215 + 175 g ai/ ha plot had the highest biomass 30 DAS. However, the Fomesafan 250 g ai/ ha plot had the most weeds present, but the Fomesan + Flauzifop plot has almost double its biomass. This may be because the majority of the weeds present were mature while in the other plot the weeds may have been germinating.

Herbicides' Effects on Weeds: When the weeds were collected in every treatment plot, the specific names of those weeds were recorded. This was intended to know what herbicide has the most effect of what specific weed. The effect of each herbicide was cataloged by weak/no effect meaning the herbicide had no noticeable effect on the weed population, ok effect meaning the herbicide had some effect on the weed population, and strong effect meaning it was easy to detect weed damage and population drop of that weed. (In the graphs, CBA stands for can be assumed. This is used because the certain herbicide's description states it mainly eliminates those weeds. If that weed is not present then it can be assumed the herbicide eliminated all those weeds. Also, the letters beside the herbicide indicate what weed the herbicide mainly kills i.e. G=grasses and BL=broadleaf. Also, pre indicates if the herbicide is a pre-emergence herbicide or not.)

Table 3. Effect of herbicides on the weed community composition in bean.

Treatments in Beans	Strong Effect	Ok Effect	Weak or No Effect
Pendimethalin-G BL	[*Portulaca*, *Eleusine*] (CBA)	*Eragrostis mexicana*, *Amaranthus*	*Oxalis*, *Solanum*
Fomesafan- G	*Eleusine*	*Oxalis*, *Portulaca*, *Eragrostis mexicana*, *Amaranthus*	*Solanum*
Flauzifop- BL		*Eleusine*, *Eragrostis mexicana*	*Oxalis*, *Portulaca*, *Amaranthus*
Fomesan+Flauzifop-G BL	*Portulaca*	*Oxalis*, *Eragrostis mexicana*	*Solanum*
Imizathapyr 50- G BL Sedge	*Cyperus*	*Eragrostis mexicana*, *Sonchus oleraceus*, *Solanum*	*Oxalis*, *Portulaca*
Imizathapyr 40- G BL Sedge		*Eragrostis mexicana*, Amaranthus	*Oxalis*, *Portulaca*, *Solanum*
Imizathapyr 30- G BL Sedge		*Oxalis*, *Eleusine*, *Eragrostis mexicana*, *Amaranthus*, *Solanum*	*Portulaca*, *Sonchus oleraceus*
Bentazone- BL Sedge	*Portulaca* (CBA)	*Sonchus oleraceus*, *Amaranthus*	*Oxalis*, *Eragrostis mexicana*, *Solanum*

All of these herbicides had about the same effect. These herbicides caused darkening spots on the leaves of the weeds. The effects of these herbicides can be seen clearly on *Oxalis*.

Conclusion:

In the corn trial, the best herbicide that meets the research's objective is Atrazine + S-metolachlor 1348 + 1044 g ai/ ha. Though the height 45 DAS does not seem promising, the herbicide's control over weeds shows that the plant has better control over receiving nutrients. Since the crop has little competition, it can absorb the water and nutrients from the soil more so than if it had competition. Acetochlor 1370 g ai/ ha is a second best for corn. Its weed dry biomass is second to the lowest even though it had a higher weed count than other plots. These two herbicides also had the less diversity of weeds present as shown by the "Herbicides' Effects" table. Specifically aiming at grasses, Acetochlor alone or in combination with Atrazine controlled grasses very well; Atrazine with S-metolachlor was also effective on grasses. For broadleaves, Atrazine with Dicamba or Carfentrazone, or Isoxaflutole + Thiencarbazone did the best job.

In the wheat trial, Prosuluron + Triasulfuron 15 + 5 g ai/ ha and Mesosul. + Idosul. 15 + 3 g ai/ ha prove the best for this research's objective. The Prosuluron + Triasulfuron plot was one of the tallest growing plots 45 DAS. At 45 DAS, it also had the lowest weed count and the second to lowest weed dry biomass of the trial. Mesosul. + Idosul. had the lowest biomass and second to lowest weed count to Prosuluron + Triasulfuron. Both of these two did about an equal job controlling weed population in general. Fenoxaprop controlled grasses best with no grasses at 45 DAS. Prosulfuron, Dicamba + 2,4-D, and 2,4-D controlled broadleaves the best in wheat.

In the bean trial, Pendimethalin 1000 g ai/ ha proved to be the best herbicide for this research. The Pendimethalin plot had the tallest height at 45 DAS, lowest weed count 30 & 45 DAS, and lowest biomass by multiple amounts compared to the other treatments. Imizathapyr 30 g ai/ ha is the second best for beans. It had the second to lowest weed count and biomass in the whole crop. These two herbicides mentioned including Imizathapyr 40 g ai/ ha are best for grass control. Fomesan + Flauzifop, Fomesafan, and Pendimethalin are the best herbicides for broadleaf control; Fomesan + Flauzifop had the lowest number of broadleaves at 45 DAS. Overall, Pendimethalin did the best job controlling grasses and broadleaves in the bean crop.

In general, it can be said that pre-emergence herbicides work best with weed management. Atrazine + S-metalachlor 1348 + 1044 g ai/ ha and Pendimethalin 1000 g ai/ ha are both pre-emergence herbicides and other pre-emergence herbicides show great results on weeds. As shown by the graphs, though an herbicide may control weeds very well their heights may not reflect that. This is because the plots with more competition are forced to grow taller to receive more sunlight. So even if a plant is taller than other, the yield of each can be extremely different.

Sub-Conclusion: Impact on Food Security

This research impacts food security by identifying an effective herbicide for farmers, especially for those who hand pick weeds. From my experience, picking out weeds by hand takes a very long time and could be harmful due to staying on your knees, working through the weather, and hurting your hands. Herbicides can reduce this time and stress by letting the farmer be able to do something else beneficial for their farm. Time is very important in the farming industry. If a farmer can use their time to upgrade their farm to produce more, then that will be beneficial for their enterprise. Also, if a farmer who pulls weeds out by hand in an underdeveloped place without gloves gets hurt, that farmer will not be able to take care of their other needs if they cannot use their hands.

Farmers can use money wisely by knowing what herbicide best meet their needs for certain weeds present. Also, having different options of what to use can help the farmer financially as well. Atrazine + S-metolachlor may be the best herbicide for corn at the cost of $244 Mxn/L, but Acetochlor works almost as well at the cost of $200 Mxn/L. In wheat, Prosulfuron + Triasulfuron is the best herbicide to use with their components' make up of Prosulfuron at $267 Mxn/gr and Triasulfuron $160/10 gr. In beans, Pendimethalin is $279 Mxn/L and Imizathapyr is $876 Mxn/ L. Pendimethalin is much cheaper than Imizathapyr and Pendimethalin works better. The money farmers save on small items such as herbicides can go towards something beneficial to their enterprise.

Personal Experience/ Self Development:

My personal development started a day before I arrived at the airport. My mom could not take me to the airport the day of my departure because her car broke down two days before. That's when I decided to take the adult role and buy a bus ticket and motel in Mobile, Alabama. When I got to Mobile, I felt a change start to happen; I knew it was my time to prepare for adulthood. Early that next morning, I ordered my Lyft and went to the airport to make what I have been dreaming of come to truth.

In the terminal, twenty minutes before departure from Atlanta to Mexico City, I felt the first feelings of Mexico. The majority of people I was sitting around were Mexican, and not one person spoke English; even the attendants spoke in Spanish. When I reached Mexico and went through customs, I was eased to see a bright yellow CIMMYT sign. I practiced my Spanish on the way to CIMMYT, and at that time it was rough. Little did I know then that it was going to change.

While at CIMMYT, I made many friends, and some of my friends only spoke Spanish. Many of these people were the field workers. I loved working in the field because though the work was hard they always had a way to make it fun. They treated me like someone who worked there for a year and helped me with my research and Spanish. My best experience with them was lunch one Monday afternoon. I made two dishes of banana pudding, and we ate that for dessert. In turn, I had some of their lunches, which were very good.

One person in my office space introduced me to authentic tacos at a restaurant called Javy Tacos. This was the best because I always wanted to try Mexican tacos. One of my favorite places to eat tacos is Tacos Chucho. The employees were very nice every time I came and even gave me free food before. To return the favor, I cooked southern food in my apartment and shared it with the person who took me out and others.

I am glad that I had the apartment not because I was alone but because it gave me responsibility. I went to boarding school and had a roommate. It was needed for us to clean up for dorm checks, but here it was all on me. I used the skills my mom imbedded in me from youth and made sure I kept it clean. I did have a maid come in to clean but she was kind and appreciated how well I cleaned because many people leave everything up to them to clean.

On the weekends, I took breaks to relax and explore a bit of Mexico. The person in my office space took me on my first trip to Mexico City, and it was amazing! I saw so many museums and historical features. I truly love history because it helps me understand situations of today and compare them to ones from the past. Whenever I visited Mexico City, I always went to a museum and learned something new. One weekend, I visited the Sun and Moon pyramid. The Sun pyramid is very tall and steep, so when I reached the top I was very proud. Being able to see these pyramids was a check off my bucket list, because I never thought I would be able to see or even climb one before thirty.

The last key point I want to make is how I developed after my trip. Taking into account my work, cultural experiences, and living arrangements, I grew so much. Since I am half Mexican on my dad's side, I felt a bit like I was at home. I started to understand myself more because I was around people with my heritage. Actions I thought were "weird" in the U.S. were normal in Mexico. I also began to learn Spanish after about a month in. It was like something in my mind switched so that I could understand people who spoke in Spanish even though I could not readily respond to them. Also, I could truly be myself and grow in a culture that reflected myself.

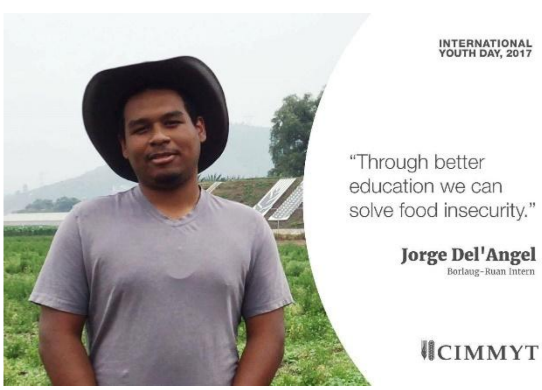
I am so happy that God blessed me with this experience. I think this helped me not only prepare for college but for life. I was able to be around people much older than me and learn from them both education wise and life wise. After 18 years on this earth I could understand both halves of myself: African-American and Mexican. I felt very upset to leave Mexico, but what I learned will never leave. This experience was the best I could ever want. When I returned to America I had a lot of information on agriculture, how to tackle world issues, and my country, Mexico.



Trip to Sun and Moon Pyramids (Moon Pyramid in background) Checking corn size and signs of disease Dr. Ravi Gopal Singh, in front of Borlaug's office


Trip to Mexico City (golden angel in background) Museum in Mexico City


Taking corn height at 30 DAS Preparing for herbicide application (Below) Team I worked with



References

Mark, B. and Braun, J.2015. *El Batan Experiment Station Manual*. CIMMYT, Mexico.2015. pp 66.

<u>Annexure I</u> Treatments in Corn

Treatments	Dose (g ai/ha)
Atrazine (pre)	1250
Acetachlor (pre)	1370
Acetachlor+ Atrazine (pre)	1000+1370
Atrazine+S-metalachlor(pre)	1348+1044
Halosulfuron	75
Isoxaflutole+Thiencarbazone(pre)	56.25+22.5
Mesotrione	200
Tembotrione	122
Dicamba+ Atrazine	396+756
Atrazine+ 2,4-D+ Dicamba	1000+120+240
Atrazine fb Carfentrazole (pre)	1000 fb 20
Nicosulfuron	40

<u>Annexure II</u> Treatments in Wheat

Treatments	Dose (g ai/ha)
Prosulfuron	17
Triasulfuron	7.5
Prosul+Traisul	15+5
Dicamba+ 2,4-D	120+240
2,4-D	500
Fenoxaprop	65
Fluroxypyr	450
Flucarbazone sodium+ Clodinofop	50+50
Clodinofop	60
Pinoxodenl	40
Mesosul. + Idosul.	15+3
Carfentrazone	20

Annexure III Treatments in Bean

Treatments	Dose (g ai/ha)
Pendimethalin (pre)	1000
Fomesafan	250
Flauzifop	125
Fomesan+Flauzifop	215+175
Imizathapyr 5	50
Imizathapyr 4	40
Imizathapyr 3	30
Bentazone	960

Annexure IV Treatment Effects in Corn

Treatment #3	Effect of Atrazine 1250 g ai/ha
Weed Pictured	Oxalis 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Pre-emergence herbicide for BL

Treatment #4	Effect of Acetachlor 1370 g ai/ha
Weed Pictured	---- 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Pre-emergence herbicide for grasses, controls very well; no grasses present

Treatment #5	Effect of Acetachlor + Atrazine 1000+1370 g ai/ha
Weed Pictured	Oxalis 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Pre-emergence herbicide for grasses and BL, controls well with some effect on mature oxalis

Treatment #6	Effect of Atrazine+S-metalachlor 1348+1044 g ai/ha
Weed Pictured	Oxalis 14 days after application and 45 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 3, 2017
Remarks	Systemic effects in weed

Treatment #7	Effect of Halosulfuron 75 g ai/ha
Weed Pictured	Cyperus 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Systemic effects, restricts cell division in crown region, kills leaves

Treatment #8	Effect of Isoxaflutole+Thiencarbazone 56.25+ 22.5 g ai/ha
Weed Pictured	Eleusine 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Systemic effect, chlorosis followed by necrosis in crown region

Treatment #9	Effect of Mesotrione 200 g ai/ha
Weed Pictured	Cyprus & Eragrostis 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Systemic effect, effects crown region of weed

Treatment #10	Effect of Tembotrione 122 g ai/ha
Weed Pictured	Eragrostis 11 days after application and 42 Days After Sowing
Collected By	Jorge Del Angel
Collected on	June 30, 2017
Remarks	Systemic effect, kills leaves

Treatment #11	Effect of Dicamba+Atrazine 396+756 g ai/ha
Weed Pictured	Oxalis 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Chlorosis

Treatment #12	Effect of Atrazine+2,4-D+Dicamba 1000+120+240 g ai/ha
Weed Pictured	Portculaga 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Systemic effect, kills leaves and causes twisting in plant

Treatment #13	Effect of Atrazine fb Carfentrazone 100 fb 20 g ai/ha
Weed Pictured	----- 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Pre-emergence herbicide, no new growth of BL

Treatment #14	Effect of Nicosulfuron 40 g ai/ha
Weed Pictured	---- 23 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Systemic effect on grasses and broadleaf, chlorosis in treated weeds,

Treatment #3	Effect of Prosulfuron 17 g ai/ha
Weed Pictured	Young seedling of Malva 18 days after application and 45 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 3, 2017
Remarks	Chlorosis of leaf and restricted growth of apical portion

Treatment #4	Effect of Triasulfuron 7.5 g ai/ha
Weed Pictured	Malva seedling 18 days after application and 45 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 3, 2017
Remarks	Effects center of plant, chlorosis, stunted growth

Treatment #5	Effect of Prosul + Traisul 15+ 5 g ai/ha
Weed Pictured	Ipomia 18 days after application and 45 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 3, 2017
Remarks	Stunted growth and chlorosis

Treatment #6	Effect of Dicamba + 2,4-D 120+240 g ai/ha on X
Weed Pictured	Malva & Portculaga 19 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Keeps BL down and notice chlorosis

Treatment #7	Effect of 2,4-D 500 g ai/ha
Weed Pictured	Portulaca 18 days after application and 45 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 3, 2017
Remarks	Kills leaves & causes chlorosis

Treatment #8	Effect of Fenoxaprop 65 g ai/ha
Weed Pictured	Portulaca 22 days after application and 45 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 7, 2017
Remarks	Systemic herbicide; causes whole plant to lighten

Treatment #9	Effect of Fluroxypyr 450 g ai/ha
Weed Pictured	Portulaca 18 days after application and 45 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 3, 2017
Remarks	Systemic herbicide

Treatment #10	Effect of Flucarbazone sodium+ Clodinofop 50+50 g ai/ha?
Weed Pictured	Portulaca 20 days after application and 55 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 13, 2017
Remarks	Contact herbicide

Treatment #11	Effect of Clodinofop 60 g ai/ha
Weed Pictured	Bromus 19 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Causes stress to leaves of grass?

Treatment #12	Effect of Pinoxoden 40 g ai/ha
Weed Pictured	Bromus 19 days after application and 54 Days After Sowing
Collected By	Jorge Del'Angel
Collected on	July 12, 2017
Remarks	Causes stress to leaves stopping photosynthesis

Treatment #13	Effect of Mesosul. + Idosul. 15+3 g ai/ha
Weed Pictured	Elusine 19 days after application and 54 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Early stages of chlorosis

Treatment #14	Effect of Carfentrazone 20 g ai/ha
Weed Pictured	Portulaca 18 days after application and 45 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 3, 2017
Remarks	Has contact effects and killing the entire plant

Annexure VI Treatment Effects in Beans

Treatment #3	Effect of Pendimethalin 1000 g ai/ha (applied on June 2nd)
Weed Pictured	Oxalis & Cyprus 40 days after application and 42 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 12, 2017
Remarks	Pre-emergence herbicide,checked germination on has no effect on mature weeds; causes stress to leaves

Treatment #4	Effect of Fomesafan 250 g ai/ha
Weed Pictured	Oxalis 16 days after application and 35 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 5, 2017
Remarks	Starts in center of plant and spreads to leaves

Treatment #6	Effect of Fomesan+Flauzifop 215+175 g ai/ha
Weed Pictured	Oxalis XX days after application and XX Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 5, 2017
Remarks	Systemic effect

Treatment #8	Effect of Imizathapyr 40 g ai/ha
Weed Pictured	Oxalis
Collected By	Jorge Del Angel
Collected on	July 5, 2017
Remarks	Systemic effect on apical portion

Treatment #9	Effect of Imizathapyr 30 g ai/ha
Weed Pictured	Cyprus 24 days after application and 43 Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 13, 2017
Remarks	Leaf chlorosis and restricted growth of crown region

Treatment #10	Effect of Bentazone 960 g ai/ha
Weed Pictured	Oxalis & others XX days after application and XX Days After Sowing
Collected By	Jorge Del Angel
Collected on	July 5, 2017
Remarks	Appears as contact effect did not affected new growth

Annexure VII Herbarium

Common Name	Tomatillo
Latin Name	*Physalis sp.*
Type of Weed	Braod Leaf
Family	Solanaceae
Collected From	Corn Field in J9
Collected By	Jorge Del Angel
Collected on	June 22, 2017
Remarks	


Common Name	Shocoyol
Latin Name	*Oxalis* sp.
Type of Weed	Broadleaf
Family	Oxalidaceae
Collected From	Wheat Field in J8 plot #113
Collected By	Jorge Del Angel
Collected on	June 27, 2017
Remarks	Flower is purple

Common Name	
Latin Name	*Bromus* sp
Type of Weed	Grass
Family	Poaceae
Collected From	Wheat Field J8 Plot # 107

Collected By	Jorge Del Angel
Collected on	June 27, 2017
Remarks	Looks like a wheat plant before flowering

Common Name	Verdolaga
Latin Name	*Portulaca*
Type of Weed	Broadleaf
Family	Portulacaceae

Collected From	Side of M7
Collected By	Jorge Del Angel
Collected on	June 19, 2017
Remarks	Small purple like leaves. Taste like a raw peanut.

Common Name	Pata de Gallo
Latin Name	*Eleusine* sp.
Type of Weed	Grass

Family	Poaceae
Collected From	G5
Collected By	Jorge Del Angel
Collected on	June 30, 2017
Remarks	

Common Name	Alpistillo
Latin Name	*Eragrostis mexicana*
Type of Weed	Grass
Family	Poaceae
Collected From	Wheat Field J8
Collected By	Jorge Del Angel
Collected on	June 28, 2017 & June 30th

Remarks	Grows straight up

Common Name	Lechuguilla
Latin Name	*Sonchus oleraceus* L.
Type of Weed	Grass
Family	Asparagaceae
Collected From	Wheat Field J8 Plot #101
Collected By	Jorge Del Angel
Collected on	June 27, 2017 & June 30th

Remarks	Leaves resemble a early cabbage and/or lettuce


Common Name	Quintonil
Latin Name	*Amaranthus* sp.
Type of Weed	Broadleaf
Family	Amaranthaceae
Collected From	Wheat Field J8 Plot #101
Collected By	Jorge Del Angel
Collected on	June 27, 2017 & June 30th flowering
Remarks	Root is long and red with smaller roots growing from it

Common Name	Golondrina
Latin Name	*Euphorbia* sp.
Type of Weed	Broadleaf
Family	Euphorbiaceae
Collected From	Wheat Field J8 Plot #101
Collected By	Jorge Del Angel
Collected on	June 27, 2017
Remarks	When stem is damage a white milk forms. Not to be mistaken for Verdolaga.

Common Name	Campanilla/ Morning Glory
Latin Name	*Convolvulus* sp.
Type of Weed	Broadleaf
Family	Convolvulaceae
Collected From	Experimental Field G5
Collected By	Jorge Del Angel
Collected on	June 30, 2017
Remarks	Grows in big weedy bunch.

Common Name	Hierba mora
Latin Name	*Solanum* sp.
Type of Weed	Broadleaf
Family	Solanaceae
Collected From	G5
Collected By	Jorge Del Angel
Collected on	June 30, 2017
Remarks	Fruit looks like a small tomato

Common Name	Chayotillo
Latin Name	*Sicyos* sp.
Type of Weed	Broadleaf
Family	Cucurbitaceae
Collected From	Wheat Field J8 Plot #207
Collected By	Jorge Del Angel
Collected on	June 27, 2017
Remarks	Leaves look like cucumber leaves. Stem can grow very long. Effect on Puma stopped plant growth in this picture.

Common Name	Coquillo
Latin Name	*Cyperus* sp.
Type of Weed	Sedge
Family	Cyperaceae
Collected From	In front on Main Building
Collected By	Jorge Del Angel
Collected on	June 30, 2017
Remarks	Has main shoot growing up with smaller leaves coming from center

Common Name	Malva
Latin Name	*Malva* sp.
Type of Weed	Broadleaf
Family	Malvaceae
Collected From	Wheat Field J8 Plot #103 & G5
Collected By	Jorge Del Angel
Collected on	June 27, 2017 & June 30^{th}
Remarks	Leaves are very round. Flower is yellow bud and seeds are dark green