Traversing Turkey: The Effect of Soil-Bourne Pathogens on Wheat

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A Brief History of CIMMYT and Turkey

The International Maize and Wheat Improvement Center (CIMMYT) is a non-profit research organization and training center with links to over one hundred countries. CIMMYT began as a pilot program originated in Mexico in 1943 and eventually developed into sustainable collaboration between Mexico and the international scientific community. It was here that Dr. Norman Borlaug developed his famous and life-saving wheat varieties that formed the basis of the Green Revolution. CIMMYT has continued through the decades to find new ways to increase global food security, including the development of a gene bank, the development of better seed and cropping practices, the sharing of new information publically and world-wide, and providing aid in the aftermath of civil strife or natural disasters.

Since 1972, CIMMYT, or the International Maize and Wheat Improvement Center, has been working in conjunction with Turkey to improve the welfare of the people as well as global food security through increasing production, and nutritional value of wheat. After Dr. Norman Borlaug's Green Revolution swept the globe, Turkey saw its wheat production double within ten years thanks to the new varieties being grown. Now, Turkey is entirely self-sufficient for wheat production. However, with the world's population ever exponentially increasing, Turkey, in conjunction with CIMMYT and other research centers like ICARDA, needs to find ways to increase wheat production without expanding the growth area or increasing water or fertilizer usage. Furthermore, demand for wheat will increase beyond food and feed due to increasing importance of alternative products, like bio-degradable plastic. Because of this, wheat needs to have a Global Average Yield annual percent change of 1.8%, but unfortunately this change is currently at a mere 0.5%.

There are a myriad of influences which are causing this discrepancy in Turkey. A large problem is that new varieties developed are simply not reaching local farmers. In the study Adoption and Impacts of New Improved Wheat Varieties of Turkey, it was shown that, in the research center with the highest average of adoption, only 35% of farmers adopted the new, monitored varieties released after 1995. The farmers who adopted the new varieties saw yield improvements of up to eighteen percent more than the old varieties used and resulted in an income of an average of 25 US$ a day, which was far higher than any income yielded by the obsolete varieties. Several more studies are being conducted to determine why farmers are not adopting these new varieties, despite the proven advantages to planting the new varieties.

A second problem preventing Turkey's wheat production from reaching the needed annual percent change is soil-borne pathogens on wheat. The primary pathogens affecting wheat in Turkey are cereal cyst nematodes, root lesion nematodes, and root-rotting fungus. These are major inhibitors to wheat productions, as such pathogens as root lesion nematodes can lead to yield losses of up to 70%, especially in areas like Turkey where moisture stress is common. For this reason, CIMMYT has been diligently striving to develop new varieties of wheat which have both good resistance and tolerance to such pathogens.

Personal Remarks

Growing up on an isolated farm in small-town, rural Iowa tends to give a person a very narrow view of the world. From birth until elementary school, my life consisted solely of the farm, and its inhabitants and problems, and the outside world seemed like a fairly unimportant, if faintly interesting place. I spent my days outside, helping my father with his chores, or playing with the calves penned up to wean them away from their mother's milk, or running through the rustling cornfields. In time, I was sent to the local Catholic elementary school, where I began learning all about the outside world, and I found myself fascinated by the idea of an outside world, where countries and inhabitants had far more to worry about than I did on my secure little farm in North-West Iowa.

As time passed, and I reached middle school, I found myself increasingly concerned about this strange, beautiful world that existed outside the cultural bubble of my small town. When news reached my eighth grade class about a terrible earthquake that had rocked Pakistan, I desired desperately to assist in any way I could, especially in the face of the cold winter that was about to set in. Under the guidance of a caring and knowledgeable teacher, a group of three other students and I organized the Blankets for Pakistan project, where we collected dozens of blankets and other supplies like winter coats and mittens to send to Pakistan to keep needy citizens warm. However, this project was small-scale, helping relatively few in the long run.

It was not until I reached high school that I found a niche where I could fulfill my desire to help people globally, rather than just locally. Through the World Food Prize Youth Institute I learned about global food security, and just how many lives the Dr. Norman Borlaug's Green Revolution had managed to save. I also learned about a wonderful program that allowed high school students like me to travel far across the sea, out of the Iowa's relatively homologous society, to experience an entirely different culture all the while assisting in increasing global food security. This was exactly what I had always dreamed of doing, and I became determined to become a Borlaug-Ruan Intern.

One glorious day, that dream came true, and I learned that I would be traveling to Turkey, an ancient country full of mystique and history, to work with soil-borne pathogens on wheat. Upon arriving in Turkey, I discovered that it was everything that I had ever dreamed that it could be. At every moment I was challenged intellectually, and I felt my mind open farther than I ever dreamed it could. I was met with a diverse culture vastly different than the one I had left, and a landscape more beautiful than one of Monet's paintings. Even more importantly, I was incandescently happy to be helping people on a large, global scale even though my efforts were tiny specks in the great experiments being conducted by today's scientists. The Borlaug-Ruan internship changed my life, making me a better and more culturally accepting world citizen.

Identifying Wheat Lines Resistant and Tolerant to Dryland Wheat Rot under Field Conditions

Importance of Experiment

In today's times of increasing population and decreasing available land for agricultural use, dry-land root rot and nematodes have become increasingly important factors in food security. Because of this, modern scientists have been conducting many experiments to try and combat these pathogens, and thus improve global wheat yields. This goal is reflected in the first experiment I assisted, to identify wheat lines with good resistance and tolerance to dry-land wheat rot under field conditions.

Dry-land wheat rot, otherwise known as the fusarium fungi, or crown rot, is a devastating pathogen found in many countries worldwide. It can occur in all winter cereals, as well as a wide range of pasture grasses and grass weeds. Unfortunately, most modern varieties of wheat are susceptible to crown rot, and currently a chemical control for the fungus does not exist. Occasionally, however, partial resistance to the fungi can be found. A few of the many countries that it has been reported in include Australia, the United States of America, South Africa, New Zealand, Italy, Morocco, Syria and Turkey. Clearly, crown rot is a global problem not limited to Turkey. However, Turkey's climate makes it ideal for experiments dealing with both strains of the fusarium fungi, as F. pseudograminarium is most prevalent in areas where spring wheat is grown in winter under mild temperatures, and then ripens under hot, dry conditions, like the Marmara region of Turkey, and F. culmorum, which is favored under similar conditions, but appears more common in cooler conditions like the central Anatolian plateau.

Crown rot's effect on the yield of a wheat crop is particularly devastating, making this fungus all the more important. Losses on individual crops can exceed eighty percent. This is exacerbated in systems where there is reduced tillage and cereals are closely rotated. This fungus causes a high occurrence of "white heads," or prematurely ripened spikes of wheat which will bear either no grain or pinched grain and are a white color.

Because of crown rot, or the fusarium fungi's global distribution, its effect on wheat yield, and modern wheat varieties' susceptibility to it, crown rot is clearly an important pathogen. Thus, developing wheat varieties that are resistant and tolerant to the fungus is especially important to increasing the global wheat yield.

Methodology

As this experiment dealt with identifying wheat varieties resistant to dryland root rot under field conditions, my entire work on this project was conducted in the field. Furthermore, a variety of different types of data had to be gathered in order to determine which lines of wheat were the most resistant and tolerant. This data gathering included scoring for crown rot symptoms, hail damage, and measuring the number of plants per meter.

I visited many different experimental fields, including fields in Cifteler, Haymana, and Konya. At several of these fields, I worked to identify the presence of the fusarium fungi, more commonly known as crown rot. The most recognizable field symptom is the development of "white heads," prematurely ripened spikes of wheat, which will bear either no grain or pinched grain and are a white color. Another common symptom is browning of the crown and lower stem, and, under humid conditions, the fungi can present itself as a pink pigmentation in the crown and lower leaf sheath. After receiving training on how to recognize these field symptoms, I scored field plots according to the percentage of wheat affected by the fungi. My team and I utilized a scale from zero to five, with zero being completely unaffected by crown rot, one being 1-20% of the test plot bearing symptoms of crown rot, two being 21-40% affected, three being 41-60% affected, four being 61-80% affected, and five being 81-100% affected. The purpose of this exercise was to identify lines of wheat that were resistant to the crown rot fungus. Anything scored as two or under was considered to have at least some resistance, and was thus sent on for future testing.

My team and I also scored testing plots on the basis of growth reduction. As the crown rot fungus commonly causes growth reduction, this data was important for determining how susceptible a variety was to the fungus. This was scored on the same scale as the white head scoring, with zero having no growth reduction, one having a growth reduction score from one to twenty percent, and so on. This score was taken three times a season in order to get the most data possible. The first score was taken in the beginning of June, the second at the end of June, and the final scoring occurred just before harvest.

My second week in Turkey, there was a very unusual, unseasonal hail storm, which caused significant damage to crops across the Anatolian plateau, including Haymana and Konya, two experiment sites being used by CIMMYT. As damage done by the hail would cause our yield-loss due to crown rot or nematodes data to be substantially off, it was necessary to travel to the Haymana field and score the damage done by the hail to each plot. We scored each plot on a scale from zero to ten, with zero being completely unaffected by hail, one being 1-10% damaged by hail, two being 11-20 percent affected, etc. This information was also important to gather because it would be of particular interest to wheat breeders. Often, breeders, especially those looking for winter wheat varieties, look for hardiness against climate damage like storms, hail, or wind. The more affected the line by the hail, the less hardy it was, and thus the less desirable to a breeder.

Finally, in order to determine whether the presence of the fungus had stunted or hindered the proliferation of the variety, my team and I took measurements of the number of plants per meter. In order to do this, a person had to move to the middle rows of a test plot, lay down a meter stick, and count how many stalks of living wheat in the row were within the parameters of

that meter. In order to ensure that the data was accurate, and not skewed in any way, this had to be done three times for every plot. The average of the three scores was then taken, and used as the estimated number of plants per meter.

Results

While indicative data was found, it is important to remember that wheat breeding is a line of work that takes many growing seasons in order to substantiate an experiment's results, and therefore the lines that were found to be resistant this year will not be put into use for at least another six years, if they are put into use at all.

Konya Test Site Results		
Varieties with a GRS of 2 or less	Average GRS Score	WH Score
KEOVD 0708	0	3
KEOVD 0708	1	2
KEOVD 0708	2	2
KEOVD 0708	2	4
SEYÇBVD 0708	2	2
TVD 0708	1	0
TBVD 0708	1	0
TBVD 0708	0	0
TBVD 0708	0	0
338-K1-1//ANB/BUC/3/GS50A	1	3
0506 YT SA	0	2
0506 YT SA	2	2
0506 YT SA	0	2
0506 YT SA	0	2
0506 YT SA	0	1
0506 YT SA	0	1
KEVD 0506	0	0
ONJNSCX A0405	1	5
ONJNSCX A0405	1	1
ESK - Necmettin Bolat	2	3
08YT-SA	1	1

Identifying Wheat Lines Resistant to Soil-Bourne Pathogens under In-Vitro Conditions

Importance of Experiment

In my capacity as a Borlaug-Ruan intern, I worked assisting scientists in a laboratory as they scored wheat cultivars for their resistance to both fusarium and nematodes in an in-vitro environment. Before varieties are tested under field conditions for resistance and tolerance to pathogens, they must first be tested under in-vitro conditions in a sterile laboratory. Therefore, this experiment is extremely important, as its results will help to determine which varieties will move on to testing under field conditions. Furthermore, cereal cyst nematodes are as much of a danger to wheat crops grown both globally and in Turkey as the fusarium fungus. Documented distribution of cereal cyst nematode has occurred in a multitude of countries across the globe, but thus far yield loss has only been documented on cereals in Europe, north-western India, southern Australia, Pakistan, Saudi Arabia, and the Pacific Northwest of the USA. Thus, both cereal cyst nematodes and fusarium are important pathogens that need to be combated in order for Turkey's wheat production to meet its full potential.

Materials and Methodology

The method that the scientists at the Eskisehir lab used to inoculate young wheat with cereal cyst nematodes was "seedling dipping," which has been recently shown to be the most effective method for inoculating young wheat. In my capacity as intern, I washed the plants thoroughly with clean water, careful to retain the muddy water and soil, and then tagged plants and roots with numbered markers for identification. I then sifted the soil attached to the roots several times through a special sifter designed to catch nematodes but that would let other soil particles fall through. I would then transfer the remaining soil into a capsule. This soil was then viewed through a microscope, and white females (still-living female nematodes) and brown cysts (dead females filled with eggs) were identified and counted. This information, along with the damage score given to the plant and root, would be used to identify whether the plant merely was resistant to the symptoms caused by nematodes, or if nematodes were actually leaving the plant.

Secondly, I worked in assisting scientists to score for crown rot damage in plants raised in an in vitro environment. Seedling dipping was again used to inoculate these plants with the fungi. The task that I was given was to wash the roots and plants thoroughly with clean water, and then tag them with numbered markers so that the scientist might quickly examine the crown and stem of the plant and give them each a score from zero to ten based upon damage caused by crown rot. A score of zero meant the plant was unaffected, one indicated 1-10% was affected, a score of two meant 11-20% affected, etc. This was important because those lines which were identified as resistant in an in vitro environment would then be planted in a field trial the following growing season, thus furthering knowledge about wheat resistant lines.

Conclusions

Unfortunately, I was only able to assist on this project for a week, as the lab in which it was conducted was located in a town named Eskisehir, and I was living in the capital city of Ankara. As a result, I was not able to see the results of this experiment. However, this experiment was the very first assignment I received as a Borlaug-Ruan intern, and thus I received a great deal of my training at this laboratory during this experiment. It was at this laboratory that I was taught to identify brown cysts, and white females, as well as the proper procedure for gathering nematodes for identification. It was in Eskisehir that I was first introduced to the fusarium fungus, and taught to recognize symptoms of crown rot in young wheat plants. Furthermore, it was in Eskisehir when I began learning Turkish and Turkish customs as well as proper scientific procedure. Therefore, though I was unable to stay to assist with the gathering of concrete results, all of the training and educational experience I received at the laboratory made it all worthwhile.

Determining if Lines Resistant to Cereal Cyst Nematodes will Decrease the Population of Nematodes under Field Conditions

Methodology

My assistance on this experiment consisted of a combination of my work on all of my other experiments. Like I had been taught in Eskisehir, I worked in the laboratory of Ankara University's Agricultural Department sift soil samples, and then use the remaining soil to identify and count the number of brown cysts existing in the sample under a microscope. After counting all brown cysts present, I would record the data. Also, as part of my duties as intern I would dry soil samples taken from field sites, and then weigh them until I had one hundred grams of soil of each sample. Furthermore, I, under the supervision of several scientists, worked in the field to score growth reduction, white head scoring, number of and the average number of stalks per meter. The data for all of these factors was gathered in the same way detailed earlier, on a scale of zero to ten for growth reduction scores, and white head scores, and by counting the number of stalks in a meter at three different locations in the middle of the plot and then taking the average to find the number of stalks per meter.

Results

Like all other experiments that I assisted with over the course of my internship, I was forced to leave before the end of the experiment, as all of these experiments are long-term. Therefore, I was unable to draw a final conclusion from data gathered during the experiment. However, preliminary data indicates a distinctive lack of nematodes in the soil, even where nematodes are very much expected to be present. This may mean that there were no nematodes where the experiment was grown under field conditions, which in turn would mean that the entire experiment would have to be begun again at a new location where nematodes are present. More data from more soil samples would have to be taken in order to find a more definitive result.

Improving Global Access to Information on Wheat Pathogens

Importance

In my capacity of a Borlaug-Ruan intern, my favorite, and, in my opinion, most important duty was to increase the public wealth of information on soil-borne pathogens on wheat by working to update the Wheat Doctor website hosted by CIMMYT. The purpose of this website is to provide a wealth of information readily accessible to anyone, anywhere in the world about wheat pathogens, like nematodes and fungi. It succeeds in this respect by providing a wealth of information on a variety of pathogens, including symptoms of wheat affected by the pathogen. As John F. Kennedy once said, "In a time of turbulence and change, it is truer than ever that knowledge is power." As the world races its growing population in order to ensure global food security in the face of a myriad of physical, sociological, and scientific problems, this quote becomes more relevant than ever. Thanks to CIMMYT's website, Wheat Doctor, a rural farmer may now check the website to look for pathogens, which cause symptoms similar to issues with the crop. Armed with this knowledge, he or she can then determine whether a specialist or special treatment is needed to deal with the problem, or if the problem is being caused by soil-borne pathogens at all.

My Role

Using reports and information found by CIMMYT, I updated all existing information on crown-affecting fungi like common root rot, crown rot and take-all. I also updated information on several fungal diseases of the sheath, including stem rust and sharp eyespot, as well as nematodes like cereal cyst nematodes and seed gall nematodes. I then added new entries for those nematodes and fungi which have recently become of economic importance in wheat growing areas, so that farmers, scientists, and anyone else desiring knowledge about these pathogens could know what field symptoms to look for, the pathogen's economic importance, the pathogen's development and finally its hosts and distribution globally. I also found pictures in reports owned by CIMMYT which helped to illustrate some of the information about the pathogen, and included these in my renovating of the pages describing the pathogens.

Educational Experiences

International Winter Wheat Improvement Program

I was fortunate over the course of my internship to be able to attend a number of educational programs, including a traveling workshop, the International Winter Wheat Improvement Program. As a part of the workshop, I was able to travel about Turkey with the group, learning much about wheat and other countries. I met a great deal of people, from many different lands, like Russia, Romania, Iran, Nepal, India, and more. The majority of the scientists attending the program were breeders looking for lines to import to their own country for experiments there. During the conference, I learned to identify the traits the breeders were looking for in their lines, and then assisted in the finding of lines which fit these traits. This was important as these lines will be distributed globally, and may potentially have a great effect on increasing the yield in several foreign countries.

The program began with a short conference, before moving to a nearby testing site called Haymana, where the breeders were free to walk about the test plots and make note of which lines would do well in their own countries. It was during this time that I was taught by several Iranian scientists in the group about bunt, a fungus which invades the grains of the wheat, and causes a rather unpleasant smell. The workshop continued the next day with a sight-seeing excursion to Cappadocia, a beautiful, ancient part of Turkey famous for its underground city and rock formations. On the way, the group and I passed many beautiful landmarks, and stopped at several fields to examine more varieties of wheat. Finally, after a tour of Cappadocia, the workshop continued on to Konya, where, after a night's rest, we promptly toured the testing site at Konya. There, the breeders began teaching me which traits were desirable for increased wheat production in their countries, and I joined the breeders in searching for wheat varieties matching their descriptions. For example, the Iranian breeders were looking for short varieties that would not lodge, with heavy grain. The final stop on our tour was Eskisehir, where we toured the laboratory facilities, and then once more set out again on a quest for desirable wheat traits.

The chance to go on the traveling workshop was an opportunity that I will always remember. I learned much about wheat, not only relating to Turkey, but also from an international standpoint. Furthermore, I learned about the traits wheat breeders look for within varieties, as well as some new pathogens like bunt and saw-flies. The traveling workshop was an opportunity that I will always treasure.

The Impact Assessment of Variety Adoption Conference

The first educational opportunity I attended was a short conference, the Impact Assessment of Variety Adoption. I found this conference fascinating, and extremely important, it detailed the results of a recent experiment that detailed a major problem for improving Turkey's wheat production. This experiment discovered that most farmers are still using varieties released before 1995, making them obsolete. Furthermore, the study detailed several reasons why farmers were still using the out-dated varieties that have to be addressed before the farmers will switch to the modern varieties. This conference also raised my awareness of the necessity of studies which would look into exactly why farmers are not adapting to the newly released cultivars, and what can be done to help change that. I had never really been to an international scientific conference before, so this was a huge learning opportunity for me that I was grateful to receive.

The Plant Protection Congress

Located in Van, the Plant Protection Congress is a national Turkish congress that draws scientists from across Turkey and even some international scientists to Van University to discuss pathogens of various plants and new experiments and information emerging about these pathogens and plants. Unfortunately, the Congress (with the exception of two or three sessions) was conducted entirely in Turkish. However, I still managed to learn quite a bit about pathogens from posters hung by scientists in the hall, and from the hasty translations from Turkish to

English by my host sister, Didem. This Congress also showed me what a national congress is like in the scientific community, which is a valuable lesson for future years as I pursue a scientific career.

Furthermore, it was a great learning experience culturally, as Van is located in south-east Turkey, which is very different from western Turkey. Eastern Turkey is far more conservative, but at the same time very colorful and authentic. On the sight-seeing day of the Congress I was able to visit Akdamar Island, where the Armenian Church of the Holy Cross, dating from the 10th Century, is located, see the famous crater lakes, Van Castle, and even enjoy a famed Van breakfast. The very last night of the Congress, there was a dinner party where my new friends taught me how to dance in the authentic Turkish style. Culturally, as well as scientifically, traveling to Van for the Plant Protection Congress was a wonderful educational opportunity.

Cultural Experiences

Turkey is a land with an extremely unique culture, one full of kindness and friendliness. Strangers whom a person has just met will treat that person as if the pair had been best friends for years, inviting this perfect stranger into his or her home, offering unparalleled hospitality, even treating a foreigner as if they were family. A perfect example of this happened the very first week that I was in Turkey. I was living in Eskisehir with a woman named Gul, a fellow scientist at the lab. One night, after work she took me to her mother's house for dinner, so that I could meet her entire extended family. There, I had my fortune told the traditional Turkish way, using Turkish coffee grinds. Turks love anything caffeinated and have, over the centuries, developed their own extremely strong coffee. This coffee is only ever drunk in small amounts, but the coffee grinds which are left in the bottom half-inch of every cup are utilized for the telling of that person's future. I was lucky enough to have a kind woman, Gul's mother, read my fortune from the coffee. Sitting there, in the ornately decorated parlor of the apartment, Gul's mother and sister had me tip over my cup onto the small plate that held my cup, and began to argue over the meaning of the shapes they saw in the coffee grinds splayed out across the white plate. They read from my grinds that I had rarely traveled, and that this was my first trip out of the country. Then, as I sat quietly in the corner, a smile stole over Gul's mother's lips, and she prodded the sister and gestured to something that she saw plate, and whispered something in Turkish. The sister took the white plate, examined the indicated shape, and gave a sharp nod and a smile, signifying her agreement. The mother than announced something in Turkish, and everyone in the room began clucking their tongues, making noises of agreement, and smiling broadly at me. Confused, I asked Gul to translate what was happening, and she informed me that they had discovered a heart in my grinds, symbolizing that I would soon have a Turkish darling. I smiled, unsure how to react, but finding the whole thing inexplicably hilarious. They also then found a bird, a symbol which indicated that I would soon receive good news and perhaps even a present. This experience really embodies Turkish hospitality to me, as I was a perfect stranger to this family, and yet they included me in an ancient tradition still viewed very much with respect within the country.

The unparalleled best experiences I had in Turkey were largely because of the amazing people that I met in the country. Working in Turkey put me in contact with people from every possible country and made working for CIMMYT feel like working for the United Nations. I met Iranians, Afghans, a man from Nepal, Romania, Russia, Pakistan, Palestine, Sudan, Australians, Brits, Indians, Germans, people from China, as well as people from all over Europe, including Czechoslovakia and Hungary. These people all shared with me their own unique world views, helping to expand mine. I learned how to be a true diplomat, able to handle the changing customs of the people surrounding me with ease. During the Iranian riots and protests over the election, I sat in a café with a group of Iranian scientists for a few hours, and discussed the political situation with them. As I sat in the café, listening carefully to Jamal and watching his

slashing hand demonstrate just how angry the Iranian people were, how frustrated they are with their leaders, I was in awe of how insanely lucky I was to be experiencing this.

Of course, foreigners (*yabangi*, in Turkish), weren't the only people I encountered during my Turkish travels. I was lucky enough to be able to stay with a wonderful, kind family who adopted me as their own daughter. Didem, who became my *abla* (older sister), overwhelmed me with her generosity and warmth the second I stepped out of the airport to find her waiting for me. She spirited me away from the airport straight to the office, where I met my supervisor, Dr. Julie M. Nicol, had a whirlwind meeting about my schedule for the next few months, and then was promptly whisked away to meet the rest of my host family. They opened their home to me and cared for me more than I could ever have hoped for and showered me with more kindness than I could ever repay. I will never forget how, each night at dinner, my Turkish aunt, Suzie (Teze) would press me in Turkish to "eat more, eat more!" If she felt that I hadn't taken enough on my plate that night, she would simply take my plate away from me, load it up with more food than an entire troop of U.S. soldiers could possibly eat, and then place it back in front of me and watch me expectantly as I tried to force down more food. My Turkish mother, Gul, was also unbelievably kind and sweet, constantly going out of her way to make me feel at home. After a few days at the household, Anye (Gul) noticed that I typically at breakfast would get milk (sut) and she began pouring my milk for me in the morning. It was a small gesture, but those mornings after I had spent all day previously working in the fields, and I was ridiculously tired, such a tender gesture became unbelievably sweet. However, the job I took required constant traveling, which, though it kept my life interesting, to say the least, also forced me to constantly leave behind the caring people who would accept me into their lives. Two days after I arrived in Turkey, I traveled to a lovely city called Eskisehir to live and work for a week. There, I lived with a wonderful woman also named Gul, and her husband. Gul and her best friend, Serap, again adopted me into their ranks, taking me all over Eskisehir, and showing me everything that there was to see. They took me to open market bazaars, crowded, dusty wonderlands where you could find anything for a price and on boat rides down the river flowing gently between green banks where the local college students would gather to strum their guitars and sing. In the lab in Eskisehir, all of the workers made a pact to teach me Turkish since none but Gul could speak fluent English. In this way, I learned all of the Turkish numbers, many different Turkish names, and a great deal about Turkish tradition. At the office back in Ankara, all of the Turkish people again accepted me immediately into their number. One woman, Sehir, not only invited me to her wedding, but also inviting me to her henna, to which a woman normally only invites her close female relatives and close female friends. The henna party was another amazing cultural experience where I was able to see the richness of Turkish culture and tradition in action. The dusky red-brown circle on my hand, left over as a symbol of the henna painting that occurred there, faded all too soon, leaving me without a physical reminder of the amazing times I had. The women adopted me again, teaching me how to dance Turkish style. Some of the women would stick tea glasses filled with spoons or coins into the waistband of their pants or skirts, the more traditional way of making the tinkling noises for which belly dancers are famous. At the

wedding, I was again amazed at how friendly, how accepting Turks are. At weddings, it is traditional for the bride to receive gold for wedding gifts (the groom typically receives nothing other than the bride). The father of the bride bought Sehir an amazingly beautiful, enormously large gold necklace, and then asked me, a *yabangi*, to fasten the necklace around her neck for him. I was honored to be the one who settled the heavy weight of the gold about her thin neck, and who fastened the clasp tight. The people of Turkey are the most fascinating, kind, and passionate people I have ever had the pleasure of meeting, and they made my entire internship pass by all too quickly.

Conclusions

Up until my internship to Turkey, my life had been rather bland, as I had never experienced a culture that differed anything more than very slightly from the one in which I had been raised. Once I traveled to Turkey, with its rolling hills and fields of golden wheat, the cultural bubble that I had been raised in popped. I suddenly was flooded by new cultures, new ideas, and new perspectives on life. Nothing I had ever experienced prior to this trip had prepared me for how much my life would change as a result of this internship. Every day of my internship, I learned something new, whether it is about wheat, about pathogens, or even about myself. This internship stretched my mind open further than I ever dreamt possible.

Educationally as well, my internship to Turkey constantly found new ways to challenge me. I had the pleasure of assisting with three fascinating experiments, as well as helping with several projects outside of these three experiments. Whilst assisting, I learned about wheat, crown rot, and nematodes, three subjects in which my knowledge had previously been shockingly limited. However, most importantly, I was helping to increase global food security through the research being conducted at the CIMMYT-Ankara office in collaboration with the Turkish Ministry of Agriculture and Rural Affairs. With the world's population rapidly increasing, food security has never been more important, and the work being done in Turkey to find better resistance to wheat pathogens is, in my opinion, vital in the quest for increased food security. It was an honor to be able to assist such research.

The experiences and knowledge that I gained in Turkey will stay with me for the rest of my life, affecting my decisions and causing me to reminisce lovingly whenever some ordinary event reminds me of that beautiful, mysterious, and ancient country. The World Food Prize has changed my life forever for the better through its Borlaug-Ruan internship, and I am forever indebted to the World Food Prize for the experiences that it gave me.

Resources

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