Third in a Series of Four: **Orthman Exhumes Better Developed Corn Roots – 2009 Results**

March 10, 2010 **by: Michael Petersen, Precision Tillage Agronomist**

Introduction:

Most growers will say they have a good idea how corn develops, seed germinates, a root system starts small and the seedling root is delicate, most of the nutrition comes from the upper 7 to 8 inches and they want to keep from rootworms eating all the roots away. They understand roots are important and we need strong roots to grow a big yield – but how deep, how many, how many nodes of roots grow below ground, how much soil volume is explored by the corn root system, do the angle of the leaves tell you something about the roots below ground – a slightly different breed of farmer can have those facts. As one today wanting to be a better and a more informed grower with the right information, will root knowledge help you make sound management decisions so you can grow the best root systems for your fields in 2010? Are you and your seed salesman matching your tillage, fertility program, soils, residue, and water management program; whether you are an irrigated farmer or rely upon the clouds to farm those high sustainable yields? Are you gaining from your agronomist's skills and knowledge of root-zone agronomics? We at Orthman hope so or you are asking these questions.

Near Lexington, Nebraska in the heart of corn country, we are working with other input specialists of the fertilizer industry, seed reps and their agronomic specialists, to learn more about the below ground part of the corn factory – *ROOTS*! Yes, that is the Orthman 1tRIPr Strip-Till Implement Company. We feel that hair-like structures below ground might be the biggest clue to why corn stalls out, flops or excels.

In this third part of four part series from our 2009 field trials I will present some of what we did learn about roots that may give you more of the important puzzle pieces that make the picture on the front of the jigsaw puzzle come together.

Figure 1. A 25 day old corn plant root system,108RMD corn variety

After 29 years of excavating and exploring roots in hundreds of corn fields I believe this will turn your head a bit and cause a second look such like a good horse breeder when he or she sees an animal that exudes power, sturdy legs, speed, endurance and drive. Are you one of those? Are you ready to read some more?

Roots, what are they anyway? Some have said they are pathways to move sugars and nutrients, some say they expunge energy from the above ground part of the plant from developing the grain, others give a mixed set of ideas, and some are saying their importance is over rated. I will offer a bit of a different approach and will conclude a summary a little later in this report.

Purpose of this Study at Orthman Farm….

As we all look at fertilizers, fertilizer cost, whether the products are dry, liquid or anhydrous ammonia and/or combinations, spring or fall application – we are developing a system to feed the crop with macro and micro micronutrients to gain yield and a product to sell. The largest portion (>98%) of the nutrient uptake comes through the corn root structures. Yes we have symbiotic mycorrhizae hyphae that assist the roots to gain access to phosphorus, zinc, sulfur, water and organic sources of nitrogen (subject for another time). Our desire is to have a better frame of reference when root systems (even early on, see figure 2.) are accessing the soil profile which is greatly influenced by gravity, moisture and temperature. We know that roots are pulled downward by gravity and that they follow a warming front in the soil profile from May into October, the old way of applying N-P-K has been to apply it to the soil surface and expect water to move the products down. By the time some of the nutrients move downward, the roots are way out ahead of the nutrients following. Due to the efforts of what we at Orthman have done with strip-tillage since the late 1990's, improving seedbed soil preparation , relieving soil compaction, vertical soil structure shatter, and precise fertilizer placement – we are accentuating early root growth, larger root systems, and crop establishment for thousands of growers. We have asked ourselves how much is there to root development; in what time frame of the crop growth did we have those helpful effects, where does placing the fertilizer make the difference for root growth, and how can we transfer these results to growers considering strip-till as their tillage option? A tall order and one we do not think we have fully answered but we have a good deal of information to provide you some facts.

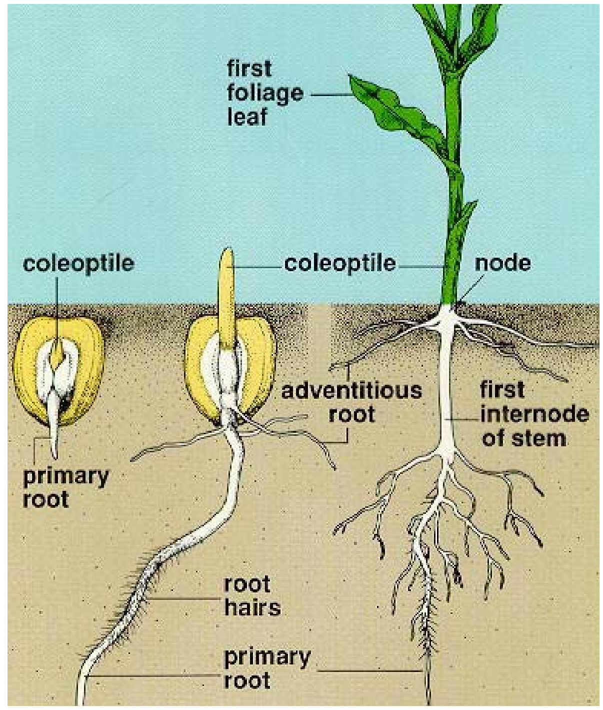

Figure 2. Depiction of corn root system to V3 stage

Methods:

To make three timed observations during the growth of the corn plant and in field conditions that you the farmer deal with was and is our approach. We look at 22-25 days after emergence (DAE) first with a spade, then at 55 DAE and the last time 105-110DAE with a backhoe. At 25DAE we are ahead of when the ear is forming, the numbers of leaves are determined, and the second and third nodal roots are forming which give us a real good indication of the roots that will feed the plant to the 45-50th day. At 55DAE the plant has physiologically and morphologically developed its ear size (that is kernels around) and number of leaves for the rest of the crops growth above ground. Last, at 105-110DAE the crop reaches maturity in its root growth and depth, the plant has topped out, all the kernels are developed, starch is stored and the kernels are going towards dent stage and the plant has taken in all its nutrient needs. At this late root dig and look at the roots, we want to visually see the extent of the root zone, see how much of the soil was examined and where water was absorbed in the soil profile and gain a better idea of the overall health of the plant.

Figure 3. Washing roots at 55DAE to expose roots

Discussion:

Making root observations demands a portion of patience and a time requirement. One just doesn't start whacking away to get after the task either. It has come on the heels of hundreds of pits that I have looked at, paying attention to plant population, leaf area, variety, irrigation or not, rainfall events, soil type, residue/tillage systems and farmers fertility program . Why? If the plant has been limited shallow root expression may be more dominant and not excavating a large enough diameter pit near the surface may really bias what occurred with shallow roots versus the deeper roots. Let me try to explain briefly.

Scenario: If the grower has a low plant population 13,000 plants per acre (dryland farming in Western Kansas for instance) after a winter wheat crop the season before and all chemically control of weed issues. Side dressed a small quantity of N at V7 stage with May and June being wet then it turned off dry the root system most likely has spread out near the surface because the roots may well have been lazy and not moved too deep following the temperature front. Digging a root pit only 18 inches square around a plant would miss the shallow roots to each side of the plant and the entire story of the root system would be incomplete and how well the crop will cope with the remainder of the season. The plant will have roots very likely extending 20 inches to either side of the plant going under the canopy of the next rows (left or right) and only down 8 to 12 inches deep. Yes the genetics may be dominated with shallow roots but soil climatic conditions, cooler soils were keeping roots more content to remain in the warm moist soils above 12 inches. This kind of work is likened to forensic sciences. Look for nuances and obscure facts and the ball of string will unravel.

Figure 4. Agronomist observing closely roots at the 30 inch depth near Burlington, in Eastern Colorado

Making the right root dig to explain to ourselves and to growers what is happening in their field is very important to diagnose and provide best case answers and/or selecting better adapted varieties and fertilizer management programs.

For the third year in a row (at Lexington), we have excavated roots in the fourth week after soil emergence (25DAE) to ascertain the improvements strip-till has provided the young corn plant compared to full width tillage and some direct seeded corn. This report we will cover what happened in 2009.

In the tables below we examined plants for the number of roots, depth, expanse between the rows and linear inches of total root development along with row direction to observe if there are any measurable changes due to sunlight capture.

Table 1. Early Plant Stage (25DAE) Root Observations near Lexington, NE Orthman Farm

	108 RMD Corn Variety-Dekalb E-W row direction								
	Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3
Roots/Depth/Dimension	Check Plots			4gpa InFurrow 15-15-2			6gpa InFurrow 15-15-2		
1st Nodal Roots+primary	9	9	8	11	13	11	13	13	13
2nd Nodal Roots	4	5	4	4	5	6	6	6	6
3rd Nodal Roots	0	1	1	2	2	2	3	4	3
Root Dimen (left to right)	10	11	10.5	9	10	10	9.5	12	10
Root Depth (in.)	12	11	12	13	13.5	13	15	13	16
Linear Inches of roots	295	286	304	324	337	381	445	456	499
Leaf Stage	6	6	6	6-7	6-7	6-7	7	7	6-7

InFurrow fertilizer treatment study

Table 2. Early Plant Stage (25DAE) Root Observations, Lexington, NE Orthman Farm

	108 RMD Corn Variety-Hoegemeyer N-S row direction								
	Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3
Roots/Depth/Dimension	Check Plots			4gpa InFurrow 15-15-2			6gpa InFurrow 15-15-2		
1st Nodal Roots+primary	11	11	9	11	13	13	10	12	10
2nd Nodal Roots	3	4	3	6	6	6	6	6	6
3rd Nodal Roots	0	0	0	2	1	1	2	2	2
Root Dimen (left to right)	12	11.5	12	13	12.5	12	12.5	13	12
Root Depth (in.)	10	13	13	21	19	17	22	24	17
Linear Inches of roots	303	291	295	488	477	472	501	513	485
Leaf Stage	6-7	6-7	6-7	7-8	7-8	7-8	7-8	7-8	7-8

InFurrow fertilizer treatment study

Table 3 Rooting at Early Plant Stage 25DAE No-Till vs. Strip-Till

N-S Direction Component Study … Midwest Hybrids completed observations

Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	
110RMD VT3 - No-Till			108RMD VT3 - No-Till			110RMD 72VT3 - Strip-Till			108RMD VT3 - Strip-Till			
11	9	7	11	9	11	11	11	11	13	11	13	Primary Roots
6	4	6	4	6	6	6	8	8	6	6	6	2nd Nodal Roots
0	0	0	0	0	0	3	4	5	0	2	1	3rd Nodal Roots
11.5	10	10	10.5	10	11	14	13.5	14	13	12	13	Plant Height (inches)
12	10	10	12	10.5	12.5	16	16	17.5	15	13.5	13	Root Depth(inches)
310	305	289	307	322	335	481	488	498	502	514	521	Linear Inches Roots
6	6	6	6	6	6	7	7	7	7	7	7	Leaf Stage(no.)

NOTES: All planted May 1st, 2009

Table 4. Rooting at Early Plant Stage 25DAE No-Till vs. Strip-Till two 113 RMD Corn Hybrids

N-S Direction Component Study ... Competitor Hybrids completed observations

Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	
Pioneer 113RMD Strip-Till			Pioneer 113RMD No-Till			Dekalb 113RMD Strip-Till			Dekalb 113RMD No-Till			
11	11	11	11	11	11	13	11	11	11	11	13	Primary Roots
8	6	8	6	8	6	8	8	8	8	8	6	2nd Nodal Roots
2	6	3	0	0	0	6	6	6	4	6	5	3rd Nodal Roots
16	15.5	15	10	12	12	14	15.5	17	14	15	15.5	Plant Height (inches)
17	16	16	12	13	11	16	16	17.5	15	16	14	Root Depth(inches)
489	494	490	432	441	435	502	489	498	451	465	459	Linear Inches of roots
7-8	7-8	7-8	7	7	7	7	7	7	6-7	7	6-7	Leaf Stage(no.)

All planted May 1st, 2009

Table 5. Rooting at Early Plant Stage 25DAE No-Till vs. Strip-Till with Hoegemeyer hybrid

N-S Row Direction Fertility Plots Corn Variety Hoegemeyer (108RMD)

Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	Plant 1	Plant 2	Plant 3	
Check 3gpa 'In-Furrow KQ1515			3gpa w/ In-furrow Strip-Till			3gpa w/ In-furrow No-Till			
11	11	9	13	13	11	11	9	9	Primary Roots
3	4	3	4	4	4	6	6	6	2nd Nodal Roots
0	0	0	0	0	0	0	2	0	3rd Nodal Roots
12	11.5	12	13	12	12	14	11.5	11	Plant Height (inches)
10	13	13	14	13	13.5	10	9	8	Root Depth(inches)
435	439	404	478	488	466	457	441	439	Linear Inches of roots
7	7	7	7	7	7	7	6	6	Leaf Stage(no.)
No pre-plant w/Strip-Till			All planted on May 1st, 2009						Notes:

Table 6. Root Dimension, Number, Depth of No-Till vs. Strip-Till Corn plots Lexington, NE 2009

Strip-Till vs.. Direct Seeding (No-Till) Root Studies at Orthman Research Farm

55DAE Root Observations made on July 10, 2009

Tillage Type	Seed Co.	Day Length	Max Rooting Depth(inches)	#Primary Roots	#2nd Node Roots	#3rd Node Roots	#4th Node Roots	#5th Node Roots	Total No. Roots
No-Till	Midwest	110	36	9	8	6	8	6	37
No-Till	Midwest	108	31	9	8	10	8	4	39
No-Till	Hoegemeyer	108	32	9	6	7	10	3	35
No-Till	Dekalb	113	35	11	6	8	8	10	43
No-Till	Pioneer	113	27	11	6	8	6	6	37
Strip-Till	Midwest	110	30	11	10	10	10	6	47
Strip-Till	Midwest	108	37	13	10	8	10	6	47
Strip-Till	Hoegemeyer	108	33	11	10	8	10	7	46
Strip-Till	Dekalb	113	39	13	12	8	10	10	53
Strip-Till	Pioneer	113	33	13	10	8	8	8	47

Table 7. Roots at 55DAE Fertility Study w/All Natural Fertilizer and Commercial Liquid Products

Treatment of Fert.	Maturity	Max root depth(in)	1st Nodal	2nd Nodal	3rdNodal	4thNodal	5thNodal	Total Root no.
BioGr 3gpa-IF: w/ PrePlant	108RMD	46	9	8	10	10	10	47
BioGr 5gpa-IF: w/ PrePlant	108RMD	47	11	10	8	10	10	49
Check no IF: w/ PrePlant	108RMD	33	9	8	8	8	6	39
Check No PrePlant: 6gpa IF Kugler	108RMD	40	9	6	8	8	12	43
Check No PrePlant: 2.8gpa IF Kugler	108RMD	31	11	8	6	6	8	39
PrePlant+ w/4gpa IF15-15 Kugler	108RMD	46	9	10	8	8	12	47
PrePlant + w/6gpa IF15-15 Kugler	108RMD	51	11	12	8	8	10	49

Table 8. Soybean Root Development at 110DAE fertilized with two kinds of InFurrow Fertilization

Treatment of Fert.	Maturity	Max rooting (in.)@55DAE	Max rooting (in.)@110 DAE	INCHES of Primary root	Depth 1st Lateral (in.)	Depth 2nd Lateral(in.)	Depth 3rd Lateral(in.)	# Pods/ plant	Avg.No. Branches/ plant	Yield - bpa
BioGr 3gpa IF	3.1	27"	46"	46"	4	10	18	108-132	5	81.6
BioGr 5gpa IF	3.1	31"	52"	52"	4	11	19	128-144	7	83.7
Kugler w/1515 4gpa	3.1	24"	47"	47"	3	8	16	98-138	7	78.9
Kugler w/1515 6gpa	3.1	30"	48"	48"	3	9	17	108-138	8	82.9

Discussion of the 25, 55 and 105 DAE Corn Root observations/data:

Our root observations provide us and our fertilizer partners a more full appreciation as to the effectiveness of fertilizer placement to get the crop off onto the right racing footpath. The intent of this study is to observe what occurs with In-Furrow fertilizers as to root number, depth of roots and length differences. Growers for numerous years have been using the methods to place nutrition 2x2 or 2x3 with predominantly the old standby 10-34-0. It has chemical characteristics to rightfully forecast with its high salt index of 104 to keep the young plant root system far enough away to avoid burn and setback. There are other products out on the market that have more efficacy, less salty, fast uptake and easy to use. Yes there is some rise in cost but our work shows significant benefits to early growth, vigor and health of the crop. So let's take a look.

At 25DAE roots are getting a good start and also require a reasonable feeding, that is setting the stage for the development of how the soil profile is changing, temperature-wise for root growth and depth. What we are looking for is a correlation of root number and second and third nodal roots developing. We are wanting to observe what develops off the first node to be a number larger than 8 to really gain the early advantages and anchoring of the crop. Then we saw from the second node and/or third, to observe 10 from the second and at least 2 to 8 from the third node. More comes in the next 20 days but to see a total of 18 and more, this offers a substantial clue we are well on our way. I am referring to a healthy corn plant in Figure 1 on page one of this document. In Tables 1 and 2 we used two differing hybrids but the change is obvious. The check plots without any ‘InFurrow’ fertilization ranged from 12 to 15 roots, at the four gallon per acre (gpa) rate of Kugler 15-15-2 the number of roots ranged from 17 to 20 and last the higher rate of 15-15 product at 6 gpa we observed 18 to 23 roots. That can be stated this way; from no fertilizer to 4gpa an increase in 5 roots and from 4 to 6 gpa 2 more roots. Or another look 37.1% increase in roots with the 4gpa rate and placed well over the check. The 6gpa rate then gave a 51.8% increase in roots added to the system over the check.

In tables 3, 4, &5 we observed at 25DAE what was occurring in the No-Till (NT-Direct Seeded) compared to Strip-Till (ST) system. The two Midwest Genetics; No-Till ranged from 13 to 17 roots in the 110 RMD variety compared to 15 to 17 roots in the 108RMD variety. Strip-Till, same varieties; 110RMD was 20 to 24 roots and the 108RMD was 19 to 20 roots. Both (NT and ST) had 4gpa of the Kugler 15-15 product added InFurrow. Strip-tillage demonstrates improved root production. In the Midwest 110 that is a 46% improvement. In the 108RMD Midwest, a 22% improvement in root numbers was obseerved. In Table 4 we compared two other seed corn companies at 113RMD still in the vein of No-Till compared to Strip-Till. The Pioneer No-Till averaged 18 roots compared to the strip-till having 22 roots on the average already showing. That is a 22.2% improvement of the number of roots on the strip-tilled corn plants compared to No-Till. Again, both are fertilized with 4gpa of Kugler InFurrow. With the Dekalb 113 RMD; we observed an average of 26 roots per plant in the strip-till and 24 in the No-Till. A change of 8.2% improvement with the strip-till which was fertilized as was the Pioneer. Early vigor shows here in the hybrids but tillage has its positive effects for a more healthy corn crop later. Last in Table 5 we looked at Hoegemeyer 108RMD variety with strip-till and No-Till. The No-Till and Strip-Till were the same at an average of 16 roots per plant, the check with no InFurrow averaged 13 roots. An definite improvement of 18.7% where we placed fertility.

Now how much is tillage and how much is the effect from InFurrow? Good question, we believe that can be demonstrated with the No-Till plots and Strip-Till plots. The No-Till was consistently observed with fewer roots with the same fertilizer rates when compared to strip-till except in the Hoegemeyer corn variety. The corn plants appeared greener, exhibited more leaves and larger diameter stalks from 25DAE to maturity in the strip-tilled corn across all varieties we grew.

At 55DAE the plant is shifting into high gear, it is gobbling upwards of 6.5 to 7.5lbs of N per day to head for the top speed production at silk-pollination and ear fill. Root growth is potentially growing now at a total rate of 250 to 400cm per day or 98 to 157 inches per day. That demands a lot of surface area to consume/obtain that amount of nitrogen to supply 6 to 7.5lbs of N per day. Sounds nearly unbelievable doesn’t it?

As you look in Table 6 where we conducted Strip-till compared to No-Till at the 55DAE period, the total root capacity (numbers) were obviously more by 19 to 27% with strip-till. This was across the board with the four different varieties. As observed at 25DAE the strip-till plants exhibited better vigor and health with increased number of roots at the 55DAE time period.

At 110 DAE (Table 9) we observed larger rooting volumes of the soil were explored with strip-till versus the No-till at same time. At ~110 DAE the corn has reached its maximum growth and the corn plant has usually sends a hormone that releases into the upper root cells a chemical that stops root cell development and roots begin to quickly die. That means no more nutrient uptake will move obtained sugars and nutrients into the seed. Leaves will go into senility and the plant goes into drying down mode, all eyes are on harvest to come.

With the Midwest Seeds varieties between No-Till and strip-till, the differences were small 30 and 45 more cubic inches of root-soil space with the strip till corn and 8 to 9 inches of maximum rooting depth achieved strip-till over the No-Till. With the Hoegemeyer variety, the differences were greater. Hoegemeyer NT was 625 cubic inches less but the maximum achieved depth was greater by 7 inches. The Dekalb corn was 500 cubic inches more with strip-till and was 1 inch less in maximum depth. The Pioneer variety was 865 more cubic inches of root zone area in the strip-till and 13 inches deeper compared to NT. In a general sense the strip-till had a larger root mass, deeper, and more numbers of roots being effective in absorbing water and nutrients in 2009. I will discuss yield differences in another section of this report a little later.

Table 9. Root Profile Data … Comparing Dimension with Yields 2009 Orthman Farm, Lexington, NE

2009 Final Root Report (110DAE) - OMI Research Farm -- Corn Plots

Corn Hybrid	Tillage Practice	RMD	Fertility Program	Total N Inputs	Root Width@ 12"	Root Width @24"	Root Width @36"	Root profile Dimension (cu.in.)	Vol. 1st 85% of roots-depth	Mature Rooting Depth (max.)	Yield (bpa)
Midwest 208-72	StripTill/N-Srows	108	10gpa KQ663+10gpa 32% + KQ1515 3gpa IF-105#N_pivot	164.0	19"	20"	16"	4445	22"	50	250.2
Midwest 210-57	StripTill/N-Srows	109	10gpa KQ663+10gpa 32% + KQ1515 3gpa IF-105#N_pivot	164.0	21"	18"	12"	4475	18"	59	240.8
Midwest 210-57	NoTill/N-S rows	109	10gpa KQ663+10gpa 32% + KQ1515 3gpa IF-105#N_pivot	164.0	19"	14"	13"	4330	17"	50	185.4
Midwest 208-72	NoTill/N-S rows	108	10gpa KQ663+10gpa 32% + KQ1515 3gpa IF-105#N_pivot	164.0	23"	18"	13"	4285	15"	58	201.5
Pioneer 33P83	StripTill/N-Srows	113	10gpa KQ663+10gpa 32% + KQ1515 3gpa IF-105#N_pivot	164.0	27"	20"	15"	5210	26"	64	258.3
Pioneer 33P83	NoTill/N-S rows	113	10gpa KQ663+10gpa 32% + KQ1515 3gpa IF-105#N_pivot	164.0	28"	14"	10"	4345	20"	51	213.9
Dekalb 63-42VT3	NoTill/N-S rows	113	10gpa KQ663+10gpa 32% + KQ1515 3gpa IF-105#N_pivot	164.0	21"	18"	11"	5010	24"	57	219.6
Hoegemeyer 5143	NoTill/N-S rows	108	10gpa KQ663+10gpa 32% + KQ1515 3gpa IF-105#N_pivot	164.0	20"	16"	15"	4400	19"	64	199.7
Hoegemeyer 5143	Still Chk N-S rows	108	20gpa KQ663+10gpa 32% No KQ1515 105#N-pivot	176.7	24"	16"	11"	5025	25"	57	229.6
Dekalb 63-42VT3	S.Till N-S rows	113	10gpaKQ663+ 10gpa32% + 3gpa KQ1515 IF 105#N pivot	164.0	20"	16"	13"	5510	30"	56	228.8
Hoegemeyer 5143	STill w/MMax	108	20gpa KQ663+10gpa 32% +MicroMax KQ1515 3gpa IF105#N pivot	181.7	24"	18"	14"	6265	30"	72	226.1
Hoegemeyer 5143	S.Till Chk N-S rows	108	10gpaKQ663+10gpa 32% No IF KQ1515 105#N pivot	158.9	22"	17"	3"	3785	16"	53	212.9
Hoegemeyer 5143	Still Chk N-S rows	108	No KQ663/32% + 5gpa KQ1515 IF 105#N_pivot	113.4	25"	20"	12"	5735	17"	57	229.8
Hoegemeyer 5143	S.Till N-S rows	108	10gpa KQ663+10gpa 32% + BioG 3gpa IF105#N pivot	159.8	26"	19"	13"	4920	33"	72	220.5
Hoegemeyer 5143	S.Till N-S rows	108	10gpa KQ663+10gpa 32% + BioG 5gpa IF 105#N pivot	159.8	29"	25"	23"	6530	26"	65	223.6
Pioneer 33P83	S.Till NW-SE rows	113	25gpaKQ663+ 15gpa32% + 5gpa KQ1515 IF 105#N pivot	203.6	27"	18"	12"	5530	17"	50	223.7
Dekalb 63-42VT3	S.Till NW-SE rows	113	25gpaKQ663+ 15gpa32% + 5gpa KQ1515 IF 105#N pivot	203.6	20"	16"	13"	5510	30"	56	222.4

Discussion of Soybeans…

In the soybean plots we observed some large root profiles which suggests that the plants were very healthy and were able to provide adequate water and nutrients that we fed and the plant obtained in the soil. The addition of In Furrow fertilization at planting time did help the yield potential, see Table 8. Previous years we have measured smaller statured soybean root volumes and maximum depth. In 2008 the soybean roots extended to 33 inches at 110DAE, this year 46 to 52 inches.

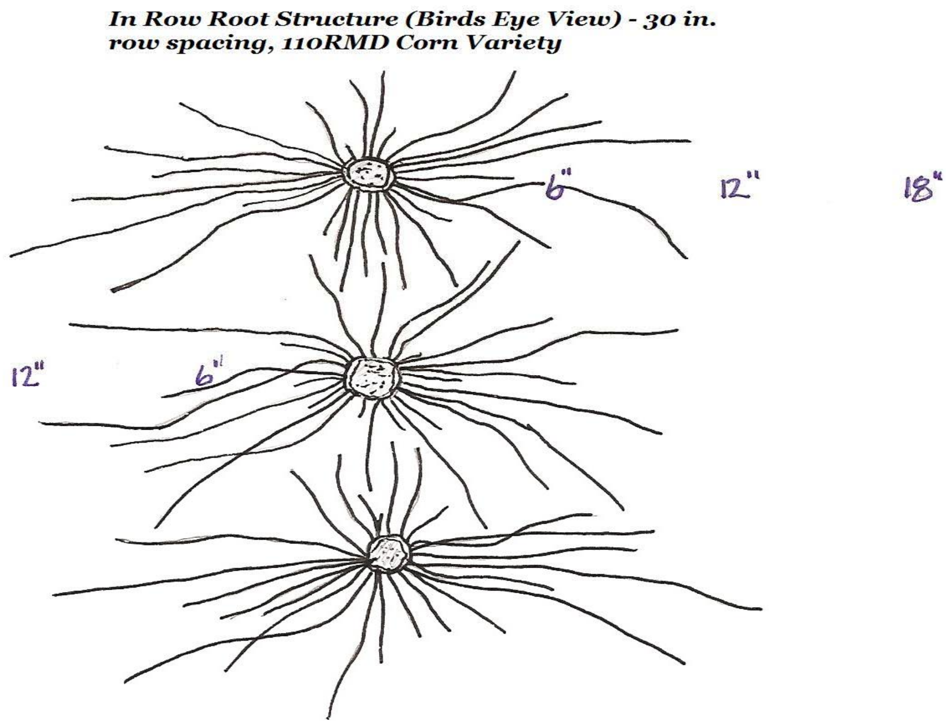

Figure 5. Root Diagrams [Birds eye view] at 55DAE in 30 inch rows, Strip-Till 110RMD Corn variety (*at end of each root at their full extension to the left or right of the stalk the root turns downward*)

Rooting Diagrams of Corn…

With these first two diagrams (Figures 5 & 6) I want to offer you and idea from a top down view what the roots look like when in the row and how the competition between plants and spacing of the plants dictate where the roots grow and far they may extend. Figure 5 is a viewpoint from the 55 DAE root dig. Roots do sense the neighboring plant and they will grow quite close to one another, when they actually touch they pull away or move to the side so to speak and grow downward to avoid the other. Some plant physiologists have believed that a chemical scent is released to tell the other root to move aside. When I have made my root digs and washed root crowns like I am depicting here I have observed just what the physiologists are writing about. Roots do not like to intertwine between adjacent or neighboring plants but they will. The rooting profile is much more rectangular in shape from the top down view. In wider row spacing and less intra-row population (spacing between plants is larger) the root system becomes much more box-like, nearly square.

When determining root profile dimension of 5025 cu. in. (for instance) volume, it is imperative that I gain the bird's eye view of the root system. This way I can provide you a picture of how much space does each corn plant root system take up in the soil. As root systems get squeezed in higher populations, either the roots must go deeper or spread out laterally. But much of that spreading out is determined by soil temperature changes, residue cover between rows, early season rains or irrigations, fertilizer placement, corn genetics, and tillage effects. We have observed with strip-tillage we can affect soil temperature, place fertility better, and gain deeper roots for crop growth and yield potential.   Table 8 offers you the reader data and information with size of the root system in the three columns of row width at depths of 12, 24 and 36 inches; then in column labeled "root profile dimension" is our best accounting of the root space in the soil profile during our root digs at 110DAE. This can indicate how well the plant rooted and extracted nutrients and water in the soil to take the crop to yield.

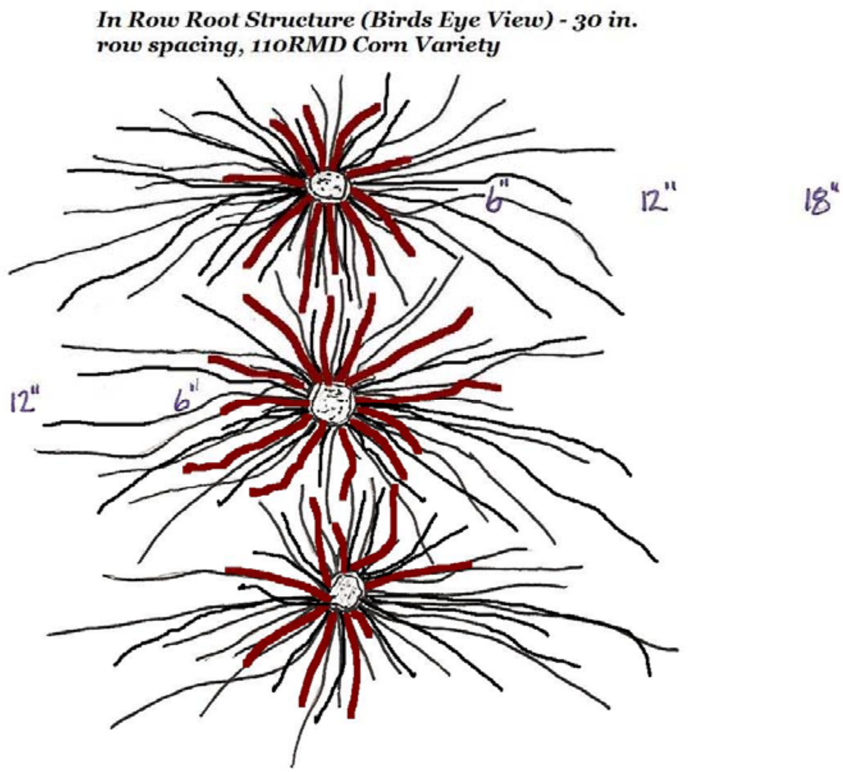

Figure 6. Root Diagrams [Birds eye view] at 110DAE in 30 inch rows, Strip-Till 110RMD Corn variety .. red colored lines depict adventitious roots (*at end of each root at their full extension to the left or right of the stalk the root turns downward*)

Conclusions/Remarks:

In 2009 the growing season was cool and wet long into October. Many growers in not only Nebraska struggled for their corn crop to reach black layer and fully developed kernels. Planting on May 1st and 2nd during the great window we were provided in Nebraska we observed our corn explode out of the ground in five days and reach the fertility very soon and establish well, getting a big root zone right away. As you have read in our two other reports prior to this third of four in the series and saw the diagrams of the rooting profiles, the strip-till corn plants out performed and expanded very good root systems [10 to 33% deeper] compared to the Direct Seeded corn on the Orthman Research Farm. Even in our moderately well to somewhat poorly drained soils on the farm for four to six weeks of the summer growing season (May-July period) we are gaining larger rooting zones than what we observed in 2007. The corn was then rooting to about 37 to 40 inches, now in 2009 57 to 72 inches deep and a larger soil volume.

We are gaining 200 on up to 835 cubic inches of soil-root volume more in the strip-till compared to the Direct Seeded corn. During the heat portion of the summer (what little we had) we observed much less wilting in the strip-till, we saw ears fill with kernel set all the way from the butt of the ear to its end. We observed very little tipback and loss of kernels in the strip-till. Many of the strip-till ears we counted were 700 to 725 kernels at finish stand population of 28,400 plants per acre and the Direct Seeded were 625 to 640 kernels per ear with same population. The rooting area that produced that, as seen in Table 9 was over 5000 up to 6000+ cubic inches of soil-root volume; Dekalb 113, Pioneer 113RMD, and Hoegemeyer 108RMD all exceeded expectations yield-wise. The Midwest Genetics hybrids were just under 4900 cu.in. and produced 240 to 250 bpa in the strip-till plots. In the previous year of 2008 we reported that the corn measured soil-root volumes of 3900 to 4300 cu. in. at best and yielded 188-192bpa. In our studies over an 8 year program that we at Orthman are associated with the Irrigation Research Foundation near Yuma in eastern Colorado, we have measured soil-root zone volumes of 8,700 to just over 10,250 cu.in. and 270 bpa corn yields. We know that corn root zones that can obtain another 1,000 cu.in. are able to access right at another gallon of water for the plant respiration. In 2009 we were gaining cubic inches to feed and water the crop. A rule of thumb is: the first bushel of corn takes 10 inches of soil water, every inch on top of those first 10 inches gains 16 to 22 more bushels. Now N-P-K fertilization is important to this equation but it takes water to grow a great corn crop, and we add a caveat – roots to access the water and nutrients.

Rooting profiles are very important to developing big yield corn crops even in the wet and cooler seasons like 2007, 2008, and 2009. Getting a quick start with fertility placed in multiple but precise locations for the corn crop to access is vital, and a top notch seedbed is crucial. With strip-till we are able to make that all happen. The roots when they reach the 55DAE time period are reaching 85-88% of the maximum depth with strip-till and more lateral root expansion to accomplish in the next 45 days since the soils are reaching maximum depth at 56°degrees F around 47 to 55 inches at 55DAE. To get roots to grow right with the warming front deep into the soil profile is a serious management style issue. We are able to make that happen with the Orthman 1tRIPr, create a 10 inch wide strip of darkened soil, clean, even seedbed with very little to no residue in the strip zone for top notch seed to soil contact. The soil will warm quickly and evenly getting the seed to germinate and come through the soil surface quickly. The strip zone is generally protected from harsh winds with the remaining crop residues moved between the rows that helps protect from drying the soil excessively or have a cutting action in sandy soils and cut the baby plant right to the ground. Replant is time consuming and quite costly with todays stacked varieties. Gaining rooting depth and expansion into the soil profile saves water that has to be applied when growers are in an irrigated scenario.

Did your corn root well? You purchased the best grades of seed from your preferred seed company, the 2009 season was wet and cooler than normal and the corn grew well, in spite of the lack of heat units. Did your corn perform as well as it could on your soils? Using the strip-till implements, top quality GPS guidance, precision placed nutrients and seed these all will set the corn gears in motion. Having a healthy crop that grows long and sturdy roots, expands into the soils requires the right methods – strip-tillage plays an important leading role. The grower should adopt a more aggressive stance with strip-till that can put him/her in the drivers seat and definite black ink on the ledger page.

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