COMPARISON OF SOIL ORGANIC MATTER ACCUMULATIONS UNDER VARIOUS SOIL MANAGEMENT SYSTEMS IN VETCH-WHEAT VERSUS WHEAT-WHEAT ROTAIONS IN CENTRAL ANATOLIA USING NUCLEAR TECHNIQUES

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ABSTRACT

With this research work the quantitative estimation of soil organic matter dynamics, water and nitrogen use efficiencies in wheat-wheat and vetch-wheat (where vetch is green manured at 10 % flowering stage) rotation systems will be compared by using ^{13}C and ^{15}N techniques. Specific objectives of this research work includes a) to find out the water and nitrogen use by wheat in vetch-wheat rotation, thus to find out the soil moisture conservation , b) to find out the influence of the soil organic matter by green manuring of vetch, c) to trace the quantitative soil carbon change in vetch-wheat rotation in the long run d) to find out the effects of different irrigation and N fertilization rates to wheat yields, water and nitrogen use efficiencies by using neutron probe water balance method and ^{15}N techniques, respectively, d) to find out the N_2-fixation (using isotope dilution method) of vetch in vetch-wheat rotation.

Significantly higher grain and stover wheat yields were obtained in the first year when irrigation was done and the N rate was increased. Nitrogen use efficiency of wheat increased with irrigation. Also, the N_2-fixation of vetch at 10 % flowering (just before plowing down into the soil) in vetch-wheat rotation had been quantified by using wheat as reference crop. As expected with higher N rates and no irrigation less N_2-fixation was obtained. Soil ^{13}C analysis were done by IAEA Seibersdorf laboratory on the soil samples taken from different depths.of all treatments for the first year experiments.

In the begining of the second year (October 2005) wheat was the only crop sown in both rotations. Soil moisture readings, were done every month and are still continuing. The harvest of wheat will be relaized in July 2006. Then we will have the wheat dry matter yields (both grain and stover), also the total nitrogen and ^{15}N analysis will be done on the wheat plant samples that will be taken at harvest, and thus we will have the second year data on nitrogen and water use of wheat. Also, soil samples will be collected from different depths for ^{13}C analysis. After all the data for the second year are obtained and analyzed the conclusions drawn will be reported.

1. SPECIFIC OBJECTIVES OF THE RESEARCH

In general, the soils of Ankara, which is located in the northern dry zone part of Central Anatolia, contain little organic matter (≤ 1.0 %) and have poor structure (Karaca et al., 1991, and Halitligil et al., 1996). Due to little vegetation in this region poor soil structure conditions, low water holding capacity of the soils and easily erodeable oil surface conditions occurs. Therefore, the management of these soils should be improved through the incorporation in rotations some means that contribute organic matter such as green manuring of legumes. One other contribution of legume-based rotations is the symbiotic nitrogen fixation during the legume phase, which contributes nitrogen to the system, which can be harvested by cereals. Research findings in the last decade had shown that wheat-vetch rotation could be suitable for this region (Karaca et al., 1991 and Halitligil et al., 1996). However, in these earlier researches soil organic matter accumulations were not investigated quantitatively.

Cropping systems that lessen or totally avoid tillage will reduce the organic matter loss and thus will cause an increase in the accumulation of a large fraction of organic matter near the soil surface. Robson and Taylor, 1987 indicated that it is not clear whether reduced or zero tillage in the fallow phase will slow the rate of organic matter loss or not and this must not be generalized because factors such as rainfall and temperature regimes, soil texture and responses to all of them are likely to be site and season specific. Therefore, the use of fertilizers and the rotations, which restore organic matter, are necessary for maintaining the crop productivity.

Soil organic matter is closely associated with soil quality. The definition of soil is linked to the effects of organisms and their residues, and it is the accumulation of organic matter that changes the deposits of sand, silt and clay into soil. Soil organic matter can be defined in terms of soil organic carbon. The amount of soil carbon and hence the changes in soil carbon can be determined by ^{13}C technique. Cropping systems such as

different tillage and crop rotations systems can change the soil organic carbon.

The objectives of this investigation are: a) to find out the nitrogen use efficiency and the nitrogen balance in vetch-wheat and wheat-wheat rotations by using ^{15}N labeled fertilizer, b) to find out the influence of the soil organic matter by green manuring of vetch, and to trace the quantitative soil carbon change in vetch-wheat rotation in the long run by using ^{13}C technique, c) to find out the effects of irrigation on wheat and vetch using neutron probe and the water balance method, and d) to find out the N_2-fixation of vetch in vetch-wheat rotation by using ^{15}N technique.

2. ACTIVITIES ACCOMPLISHED FROM THE START UPTO SEPTEMBER 2006

Field experiment was established at the Saraykoy Nuclear Research and Training Center (SNRTC) in Ankara in November 2004. Soil samples up to 90 cm depth, with 30 cm increments, were collected from the field just before planting and they were analysed for some physical and chemical properties (Table 1).

The field experiment was consisted of wheat-wheat (C_1) and vetch-wheat (C_0) rotations. They included rain fed (I_0), irrigation (I_1) treatments beside N_1 and N_2 N fertilizer rate treatments. (Nitrogen fertilizer rates used were N_1= 40 kg N/ha and N_2= 80 kg N/da for wheat and N_1= 10 kg N/ha and N_2= 20 kg N/ha for vetch). Each rotation was consisted of two blocks having 4 treatments (I_0N_1, I_0N_2, I_1N_1, I1N2) in split plot experimental design with 4 replications in which irrigation treatments was the main plots, and the N rates as the sub plot. Therefore, each rotation was consisted of 16 subplots with dimensions of 2.4 m x 3.0 m = 7.20 m^2 (Table 2). The field experimental layout was revised after the 1st RCM of CRP Number: D15009 in Vienna. The reason was to have 'No Till' and 'Till' treatments separately in the experiments. In the original plan these two treatments were included in both rotations so the numbers of plots were doubled, so the revision was done. Consequently, in the wheat-wheat rotation no tillage was done and the second wheat was planted, which was a 'No Till' treatment, however, in the vetch-wheat rotation vetch was plowed to a depth of 25 cm at 10 % flowering stage and also before planting wheat in November 2005 it was plowed one more time, which was a 'Till' treatment.

To the irrigation treatments (I_1) in each rotation, 100 mm of water was applied by drip irrigation half on May 15, 2005 and the other half on June 15, 2005.

In order to determine the soil moisture status at rain fed and irrigated conditions in the wheat-wheat and vetch-wheat rotations neutron probe access tubes were installed to only N_1 treatments. Neutron probe (Campell) readings at 30, 60 and 90 cm depths were taken monthly starting from planting to harvest. For the 0-30cm depth, soil samples were taken manually and soil moisture was determined gravimetrically. Total water storage values in the soil profile at planting and at harvest were used to calculate the Evapotranspration (ET, mm) values and hence the water use efficiency [WUE, yield (kg/ha)/ET mm] values.

Half of the ^{15}N labeled fertilizer (as 8.0 and 3 % ^{15}N a.e. ammonium sulphate for winter vetch (Hungarian Vetch) and Gerek-79 wheat, respectively) was applied at planting in November 2004 to the 3.60 m^2 isotope sub-plots in each plot. Unlabeled ordinary ammonium sulphate fertilizer was applied to the 3.60 m^2 yield plots. The other half of the N fertilizer was applied on April 15, 2005.

Hungarian Vetch was cut and plowed 25 cm into the soil when 10 % flowering was obtained in May 25, 2005 after weighing them and taking plant samples from each isotope sub-plots. In order to be able to calculate N_2 fixation by vetch, on the same date, the wheat plant samples from the adjacent isotope plots were taken, and both were analysed for % total N and % ^{15}N a.e.

Wheat was harvested on July 30, 2005. Plant (grain and straw) and soil samples (from 0-5, 5-10, 10-30 and 30-60 cm depths) were collected from every isotope - sub plots. 192 soil sample was sent to IAEA Seibersdorf Laboratory where % C and $d^{13}C$ ‰ analysis were made.

Wheat (Akça variety) was planted on October 30, 2005 in both wheat-wheat and vetch-wheat rotations. Again, half of the nitrogen fertilizer was applied at planting and the other half was applied on March 23, 2006. To the irrigation treatments (I_1) in each rotation, 150 mm of water was applied by drip irrigation half on May 25, 2006 and the other half on June 20, 2006. Wheat was harvested on July 27, 2006 Soil moisture determinations were done at planting and at harvest of wheat at 30, 60 and 90 cm depths.

All plant samples harvested were analysed for % total N, % ^{15}Na.e. , percent nitrogen drived from fertilizer (% Ndff,) N fertilizer yield and nitrogen use efficiency (% NUE) at SNRTC using NOI7 Optical Emission Spectrometer. Soil samples taken at harvest on July 27, 2006 will be sent to IAEA Seibersdorf Laboratory where % C and $d^{13}C$ ‰ analysis were made.

3. EXPERIMENTAL RESULTS OBTAINED UNTIL SEPTEMBER 2006
(Progress made with respect to the work plan)

a) Site characterization:

The field experiments were established in Saraykoy Nuclear Research and Training Center fields, which were under continuous wheat cropping for the last four years. Some physical and chemical properties of the soil is given in the Table 1.

Table 1. Some physical and chemical properties at different depths before the experiment established in Nov. 2004.

Soil Depth (cm)	Sand %	Clay %	Silt %	Texture Class	pH	$CaCO_3$ (%)	O.M (%)	N (%)	P_2O_5 (kg/ha)	Field Capacity (%)	Wilting Point (%)
0-30	11.1	41.2	47.7	Silty Clay	7,9	12,9	0,80	0,014	4,86	34,3	17,6
30-60	11.4	37.9	50.7	Silty Clay Loam	7,7	13,7	0,60	0,011	4,19	33,8	17,2
60-90	23.9	38.2	37.90	Clay Loam	8,0	15,8	0,47	0,010	4,56	32,3	15,4

Table 2. CRP (D1.50.09) - TUR/12984 REVISED FIELD EXPERIMENT LAYOUT
WHEAT-WHEAT ROTATION (C_1) VETCH-WHEAT ROTATION (C_0)

'No Till' Treatment (T_0) 'Tillage' Treatment (T_1)
* Neutron Probe Access Tubes

Factors:
Irrigation (I) : I_0 (No Irrigation), I_1 (Drip Irrigation)
N Rate (N) : N_1 (10 kg N/ha vetch; 40 kg N/ha for wheat), N_2 (20 kg N/ha vetch; 80 kg N/ha for wheat)

1	$I_1N_2R_1$	9	$I_1N_2R_2$	1	$I_1N_2R_1$	9	$I_1N_2R_2$
2	$I_1N_1R_1$	10	$I_1N_1R_2$*	2	$I_1N_1R_1$	10	$I_1N_1R_2$ *
3	$I_0N_2R_1$	11	$I_0N_2R_2$	3	$I_0N_2R_1$	11	$I_0N_2R_2$
4	$I_0N_1R_1$	12	$I_0N_1R_2$ *	4	$I_0N_1R_1$	12	$I_0N_1R_2$ *
5	$I_1N_2R_4$	13	$I_1N_2R_3$	5	$I_1N_2R_4$	13	$I_1N_2R_3$
6	$I_1N_1R_4$	14	$I_1N_1R_3$	6	$I_1N_1R_4$	14	$I_1N_1R_3$
7	$I_0N_2R_4$	15	$I_0N_2R_3$	7	$I_0N_2R_4$	15	$I_0N_2R_3$
8	$I_0N_1R_4$	16	$I_0N_1R_3$	8	$I_0N_1R_4$	16	$I_0N_1R_3$

Replication ® : R_1, R_2, R_3, R_4
Each Plot Size : 2.4 m x 3.0 = 7.20 m^2 of which half is Isotope plot = 3.60 m^2 and the other half is Yield plot

Long-term yearly average precipitation in Ankara is 350 mm of which is obtained mostly in Fall and Spring. Ankara received 330, 375, and 335 mm of precipitation in 2004, 2005 and upto August 2006, respectively.

b) Plant and Soil Data obtained in 2005 but not presented in the first CRP Progress report due to the unfinished analysis at that time:

Grain, straw and total yields for wheat and buried fresh vetch biomass and the dry mater yields, N yield, N fertilizer yield and %NUE in wheat-wheat and vetch-wheat rotations in 2005 are given in Table 3.

The lowest grain, straw and total wheat yields and N fertilizer yields were obtained from rain-fed high N rate treatments (I_0N_2) and the highest were obtained from irrigated high N rate treatments (I_1N_2). Significantly

higher wheat yields and N fertilizer yields were obtained with increasing the N rate under irrigated conditions, however, under rain-fed conditions significantly lower wheat yields and N fertilizer yields were obtained with increasing N rate. As expected, significantly lower % NUE values were obtained when N rate was increased.

Higher fresh biomass and dry matter yields for vetch was obtained under irrigation and also when the N rate was increased. Although, there were no statistically significant differences in the amount of N fixed by vetch under rain-fed conditions when higher N rate is applied, the amount of N fixed by vetch significantly increased when N rate increased under irrigated conditions.

Table 3. Yield, N yield, Nfertilizer yield and %NUE in wheat-wheat and vetch-wheat rotations in 2005.

Year 2005 ROTATION		YIELD (kg/ha)			N YIELD (kg N/ha)			Weighted % Ndff	N Fertilizer Yield (kg N/ha)	% NUE
		Grain	Straw	Total	Grain	Straw	Total			
Wheat-Wheat (Gerek-79 variety)	I_0N_1	4432	4378	8810	74,1	28,9	103,0	25,1	25,6	64,0
	I_0N_2	4292	3983	8275	72,9	27,3	100,2	24,3	24.3	30,4
	I_1N_1	4572	5060	9832	76,0	33,4	109,4	29,8	32,5	81,3
	I_1N_2	4990	5352	10345	87,3	39,1	126,4	34.6	43,7	54,6
LSD(0.05)		140	189	325	1,32	1,11	2,43	0,53	1,1	3,5
C.V. (%)		22.3	23.7	23.0	20,8	21,2	21,0	19,6	20,3	21,7
		Total Fresh Vetch Biomas Buried (kg/ha)			Total D.M. Yield (kg/ha)	Total N Yield (kg N/ha)	% ^{15}N a.e. plant	% Ndff	% Ndfa	Fixed N (kg N/ha)
Vetch-Wheat (H.Vetch was buried at flowering)	I_0N_1	23038			6220	168,6	0,335	4,19	70,7	119,2
	I_0N_2	23500			6286	170,1	0,354	4,43	67,9	115,5
	I_1N_1	36032			9621	262,7	0,365	4,56	73,1	192,0
	I_1N_2	38313			9784	269,1	0,371	4,64	77.8	209.4
LSD(0.05)		451			263	18,6	0,013	0,17	4,85	6.98
C.V. (%)		19.8			18,3	17,9	14,67	15,90	17,8	16.7

*Each number is average of 8 replications

Table 4. %N and % ^{15}N a.e. at different soil depths in wheat-wheat and vetch-wheat rotations in 2005.

Year 2005 ROTATION		%N				% ^{15}N a.e.			
		Soil Depth, cm				Soil Depth, cm			
		0-5	5-10	10-30	30-60	0-5	5-10	10-30	30-60
Wheat-Wheat (Akça variety was grown)	I_0N_1	0,10	0,09	0,08	0,07	0,070	0,075	0,024	0,011
	I_0N_2	0,10	0,09	0,10	0,08	0,065	0,085	0,035	0,014
	I_1N_1	0,10	0,09	0,09	0,08	0.041	0,098	0.041	0,015
	I_1N_2	0.09	0,09	0,09	0.08	0,047	0,107	0.053	0,018
Vetch-Wheat (Hungarian vetch was buried in soil)	I_0N_1	0,09	0,09	0,10	0,08	0,064	0,046	0,016	0,008
	I_0N_2	0,10	0,10	0,10	0,08	0,058	0,065	0,024	0,011
	I_1N_1	0,11	0,10	0,09	0,08	0,087	0,066	0,035	0,009
	I_1N_2	0,12	0,10	0,10	0,08	0,093	0,073	0.046	0,010

Table 5. Applied nitrogen fate in wheat-wheat, vetch-wheat rotations at different N rates and Irrigation in 2005.

Year 2005 ROTATION		Amount of N fertilizer remained in soil (kg N/ha)					Plant Fertilizer N Uptake (kg N/ha)	Fertilizer N Lost (kg N/ha)
		Soil Depth, cm						
		0-5	5-10	10-30	30-60	Total		
Wheat-Wheat (Akça variety was grown)	I_0N_1	0,93	1,00	0,32	0,15	2,40	25,60	12,00
	I_0N_2	1,73	2,27	0,93	0,37	5,30	24,30	50,40
	I_1N_1	0.55	1,31	0,55	0,20	2,61	32,50	4,48
	I_1N_2	1,25	2,85	1,41	0,48	5,99	43,70	30,31
Vetch-Wheat (Hungarian vetch was buried in soil)	I_0N_1	0,08	0,06	0,02	0,01	0,17	7,06	2,77
	I_0N_2	0,15	0,16	0,03	0,03	0,37	7,54	12,91
	I_1N_1	0,11	0,08	0,04	0,01	0,24	11,98	7,78
	I_1N_2	0,23	0,18	0.12	0,03	0,56	12,49	6,95

Table 6. Growing season rainfall, irrigation, soil moisture contents in the soil profile at planting and at harvest, ET and WUE data in wheat-wheat and vetch-wheat rotations in 2005.

Year 2005 ROTATION		Soil moisture (mm) in 0-90 cm profile					
		(A) Growing season Rainfall, mm	(B) Irrigation, mm	(C)* At planting in Nov. 2004	(D)* At harvest in July 2005	ET = (C-D)+A+B	WUE (Total D.M. yield/ET)
Wheat-Wheat (Gerek-79 variety was grown)	I_0N_1	369	-	346	297	418	21,1
	I_0N_2	369	-	-	-	-	-
	I_1N_1	369	100	363	231	601	16,4
	I_1N_2	369	100	-	-	-	-
Vetch-Wheat (Hungarian Vetch was grown)	I_0N_1	115	-	353	302	166	37,5
	I_0N_2	115	-	-	-	-	-
	I_1N_1	115	50	345	305	205	46,9
	I_1N_2	115	50	-	-	-	-

* Each number is average of four replication

The growing season rainfall, irrigation, soil moisture contents in the soil profile at planting and at harvest, ET and WUE data in wheat-wheat and vetch-wheat rotations in 2005 are given in Table 4.

With irrigation ET values increased due to the higher yield obtained which resulted in higher transpiration from the plant leaves. Lower WUE values are obtained with irrigation compared to rain-fed conditions due to the higher ET values obtained with irrigation which is expected.

Table 7. Average % C, % O.M. and $d^{13}C$ ‰ in wheat-wheat and vetch-wheat in 2005. (Each value is average of 24 observation)

			0-5cm			5-10 cm			10-30cm		
			%C	% O.M.	$d^{13}C$ ‰	%C	% O.M.	$d^{13}C$ ‰	%C	% O.M.	$d^{13}C$ ‰
		N1	0,67	1,06	-23,49	0,66	1,03	-23,55	0,58	0,92	-23,44
	No Irr.	N2	0,63	0,99	-23,13	0,64	1,00	-23,09	0,61	0,97	-23,32
		N1	0,68	1,07	-23,37	0,64	1,01	-23,47	0,62	0,97	-2309
w-w	Irr.	N2	0,65	1,02	-23,32	0,64	1,01	23,59	0,59	0,92	-23,18
		N1	0,63	1	-23,49	0,65	1,02	-23,34	0,61	0,96	-23,43
	No Irr.	N2	0,67	1,06	-23,57	0,67	1,05	-23,58	0,63	0,99	-23,42
		N1	0,68	1,06	-23,47	0,66	1,05	-23,53	0,65	1,02	-23,51
v-w	İrr.	N2	0,66	1,05	-23,46	0,67	1,05	-23,58	0,64	1,01	-23,48

c) Data obtained upto Augsut 2006 and due to the unfinished analysis some are not presented here.

Table 9. Yield N yield, Nfertilizer yield and %NUE in wheat-wheat and vetch-wheat rotations in 2006.

Year 2006 ROTATION		YIELD (kg/ha)			N YIELD (kg N/ha)			Weighted % Ndff	N Fertilizer Yield (kg N/ha)	% NUE
		Grain	Straw	Total	Grain	Straw	Total			
Wheat-Wheat (Akça Wheat was grown)	I_0N_1	3114 *	3067	6181	79.7	22.7	102.4	18.3	18.7	46.7
	I_0N_2	3071	2936	6007	85.4	22.6	108.0	17.5	18.9	23.2
	I_1N_1	5118	5423	10541	140.2	36.3	176.5	22.3	34.3	85.6
	I_1N_2	5980	6286	12260	174.6	56.6	231.3	24.5	56.7	70.5
LSD(0.05)		175	243	418						
C.V. (%)		25.3	24.9	25,6						
Vetch-Wheat (Akça Wheat was grown)	I_0N_1	3248	3190	6438	90.6	33.8	124.4	20.5	25.5	63.8
	I_0N_2	3233	3194	6427	95.7	38.6	134.3	19.8	26.7	32.6
	I_1N_1	4748	5200	9948	137.2	55.1	179.1	21.3	38.1	95.4
	I_1N_2	5821	6092	11913	172.3	75.5	247.8	24.3	60.2	75.3
LSD(0.05)		163	249	479	1,58	1,43	2,98	0,44	0,8	3,7
C.V. (%)		22.3	22.9	23.3	23,6	22,2	21,7	18,7	21,6	20,6

*Each number is average of 8 replications

Table 10. %N and % ^{15}N a.e. at different soil depths in wheat-wheat and vetch-wheat rotations in 2006.

Year 2006 ROTATION		%N				% ^{15}N a.e.			
		Soil Depth, cm				Soil Depth, cm			
		0-5	5-10	10-30	30-60	0-5	5-10	10-30	30-60
Wheat-Wheat (Akça variety was grown)	I_0N_1								
	I_0N_2								
	I_1N_1								
	I_1N_2								
Vetch-Wheat (Akça variety was grown)	I_0N_1								
	I_0N_2								
	I_1N_1								
	I_1N_2								

Table 11. Applied nitrogen fate in wheat-wheat, vetch-wheat rotations at different N rates and irrigation in 2006.

Year 2006 ROTATION		**Amount of N fertilizer remained in soil (kg N/ha)**					**Plant Fertilizer N Uptake (kg N/ha)**	**Fertilizer N Lost (kg N/ha)**
		Soil Depth, cm						
		0-5	5-10	10-30	30-60	**Total**		
Wheat-Wheat (Akça variety was grown)	I_0N_1							
	I_0N_2							
	I_1N_1							
	I_1N_2							
Vetch-Wheat (Akça variety was grown)	I_0N_1							
	I_0N_2							
	I_1N_1							
	I_1N_2							

* Each number is average of four replications

Table 12. Soil moisture, ET and WUE data in wheat-wheat and vetch-wheat rotations in 2006

Year 2006 ROTATION		Soil moisture (mm) in 0-90 cm profile					
		(A) Growing season Rainfall, mm	(B) Irrigation, mm	(C)* At planting in Nov. 2005	(D)* At harvest in July 2006	ET = (C-D)+A+B	WUE = Total Yield, kg/ha / ET, mm
Wheat-Wheat (Akça variety was grown)	I_0N_1	286	150	321	270	487	12.7
	I_0N_2	286	150	-	-	-	-
	I_1N_1	286	150	333	231	538	19.6
	I_1N_2	286	150	-	-	-	-
Vetch-Wheat (Akça variety was grown)	I_0N_1	286	150	323	210	549	11.7
	I_0N_2	286	150	-	-	-	-
	I_1N_1	286	150	332	235	533	18.7
	I_1N_2	286	150	-	-	-	-

4. WORK PLAN FOR THE COMING YEARS

Under our experimental soil conditions, in order to get a better planting conditions, we decided to plough the 'No Till' treatments once every two years. This kind of operation was also suggested by other researchers (Wortmann and Mamo, 2006). Therefore, after the wheat harvest in July 2006 we ploughed all the experimental are including the 'No Till' treatments. In November 2006 wheat will be planted in wheat-wheat rotation and Hungarian vetch will be planted in vetch-wheat rotation. ^{15}N labeled nitrogen fertilizer rates of N_1= 40 kg N/ha and N_2= 80 kg N/da for wheat and N_1= 10 kg N/ha and N_2= 20 kg N/ha for vetch will be applied to the isotope sub plots, also unlabeled nitrogen fertilizer will be applied to yield-sub plots. Half of the fertilizers will be applied at planting and the other half in Spring 2007. Irrigation will be done at two times in Spring of 2007 according to the plant development stage conditions. Vetch will be ploughed into 25 cm soil depth at 10 % flowering stage and at this time plant samples both from vetch and reference crop wheat will be taken for determining the amont of N_2 fixed by vetch. In July 2007, wheat will be harvested in wheat-wheat rotation and plant samples beside soil samples will be collected. Total N, % ^{15}Na.e. analysis in these samples will be done by using NOI7 Optical Emission Spectrometer in SNRTC and % Ndff, N fertilizer yield and % NUE values will be calculated. Aslo, the soil samples that will be taken at different depths at harvest July 2007 will be sent to IAEA Seibersdorf Laboratory where % C and $d^{13}C$ ‰ analysis.

In November 2007, wheat will be planted in both rotations and they will be fertilizer and irrigated accordingly in Fall 2007 and Spring 2008. In July 2008, wheat will be harvested and plant and soil samples will be collected accordingly and the required plant and soil analysis will be performed. Thus two cycles of the rotations will be accomplished and overall evaluations of the all results will be done and general results will be reported.

5. REFERENCES

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