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Effects of Rye Green Manure Application in Soil Physical and Chemical Characteristics in Maragheh Dryland Condition Zone

S. B. Mosavi[1] , A. A. Jafarzadeh, M. R. Nishabouri, Sh. Ostan[2] and V. Feiziasl[3]

[1] - Soil Science Department, Agricultural Faculty, university of Maragheh, Email: Mosavi@mhec.ac.ir

[2] - Soil Science Department, Agricultural Faculty, University of Tabriz

[3] - Scientific member of Dryland Agricultural Research Institute (DARI)

ABSTRACT

In order to study of green manure application effects on soil physical and chemical characteristics in dryland condition, this project was carried out with 4 rye green manure treatments along with nitrogen factors included; 0, 26, 103 and 337 kg N.ha^{-1} from urea fertilizer plus check (without green manure) treatment in 3 rotation system (green manure-wheat) in RCBD desigin with 4 blocks at 1999-2007 in Maragheh Dryland Research Station. Results showed that, althrough treatment effects on dryland wheat grain yield was not significant, but maximum grain yield with 2484 kg.ha^{-1} obtained from application of rye green manure along with 26 kg N.ha^{-1}. This grain yield was 442 kg.ha^{-1} (22 percentage) more than check (without green manure) treatment. Application of green manure without nitrogen factors increased soil pH, T.N.V.% and E.C (dS.m^{-1}), but decreased O.C%, P (av.), Fe (av.), Cu (av.), Mn (av.), Zn (av.), saturation% and sand% in soil. With application of nitrogen factors along with green manure increased saturation%, clay%, E.C (dS.m^{-1}) in soil, but decreased O.C%, P (av.), Cu (av.), Mn (av.), Zn (av.) sand% in soil. Soil moisture decreased 8% in green manure application treatment without nitrogen applicalion in 0-20 cm depth, but with nitrogen application along with rye green manure, soil moisture increased 6% compare to check. It can be concluded that, green manure application is useful in long term along with nitrogen fertilizer application. Green manure application in addition to increasing of soil moisture content, increase dryland wheat grain yield. Green manure application changes soil characteristics for example, increasing of soil T.N.V%. This problem is decreased of availability of some essential nutrient for dryland wheat, therefore in this condition dryland wheat fertilizer requirments must estimate via soil testing.

Key words: Rye green manure, soil physical and chemical characteristics, dryland condition

INTRODUCTION

For the long term productivity soil organic mater has great importance. Cultivation is expletive and reduces the content of organic matter. This decline is aggravated if follow is included in the rotation where the soil is cultivated to ensure no plant growth or where crop residues are removed (Brady, 1999; Feizisal and *et al.* 2005). Application of green manures in soils is considered as a good management practice for increasing soil organic matter. Such practice can increase cropping system sustainability by reducing soil erosion and ameliorating soil's physical and

chemical properties (McGuire *et al*. 1998), by increasing organic matter and fertility level (Melero *et al*. 2006) and increases nutrient retention (Kapland and Estes, 1985).

It was reported that green manure increases soil water storage in dry lands by increasing water infiltration rate, declining evaporation and by soil structure amendment (Triplett *et al.* 1968; Zerega *et al.* 1995). Soil water storage is one of the important factors to crop production in arid and semiarid zones (Anger and McCala, 1980).

This project was fulfilled in Maragheh dry land condition zone to investigate the effects of Rye green manure with different nitrogen fertilizer levels on soil physical and chemical properties.

MATERIAL and METHOD

The study was conducted in research station of dryland agriculture research institute in Maragheh. The soil of the field experiment was a Clay loam (Fine Mixed Active, Mesic Typic Calcixerepts). Combined soil sampling before green manure cultivation derived from (0-25 cm) depth and general soil chemical and physical analysis measured in laboratory. Winter type Rye (*Secale cereale*) was cultivated in autumn and in spring Rye's green residues was added to soil along with nitrogen factors included: 0, 26, 103 and 337 kg N/ha from urea fertilizer plus check (without green manure) treatment. This level of N was added synchronous with Rye residue additional to soil. This study carried out in 3 rotation system (green manure –wheat) in PCBD design with 4 blocks at 1999 – 2007.

Soil water content measured (weigh moisture method) in wheat Growth stage (GS) by direct sampling from field experiment in two (0-20 cm and 20 -40 cm) soil depths.

Randomized 30 samples picked up from wheat field experiment and measured in laboratory For Plant characteristics observations. Statistical analysis of total data from this project carried out with Genstat software.

RESULTS

Dryland Wheat Yield

Mean comparison of for plant characteristics indicated that green manure application without N decreased biological yield, grain yield and straw yield respectively 10%, 14%, 7% in respect to the control. also this treatment decreased T.K.W, harvest index, productivity degree, Head Length, number of head m^{-2} and plant height respectively 15%, 5%, 6%, 3%, 8% and 8%. Whereas green manure application without N increased number of head and fertile tiller respectively 5% and 17% (table 1).

Application of green manure with nitrogen use in all level increased biological yield and grain yield

respectively 5% and 12% respect to control. This treatment effect's on straw yield wasn't significant (Table1).

The highest grain yield 2484 kg.ha^{-1} present for green manure + 26 kg.ha^{-1} N (from urea) treatment and the lowest grain yield 1757 kg.ha^{-1} obtained from green manure without N use treatment. But this lowest grain yield from green manure treatment had 22% increase respect to control (table1). According to Fageria *et al.* (1991) it is important regarding to next plant production after green manure application. Pilipenko and Savoshchenko (1998) reported that application of green manure had not significant effect on barely production whereas Triplett *et al.* (1980) believed that organic matter application increase soil water content and plants grain production level progressively.

Table 1: Mean comparison for green manure treatment effects on wheat plant characteristic

Treatment	Biological yield	Grain yield	Straw yield	T.K.W	Harvests Index	Productivity degree	Spike length	No of head .m-^{2}	No of seed per spike	Plant height	No. of tillers
	(kg.ha^{-1})			(gr)			(cm)			(cm)	
Control	5944	2042	3901	40.9	0.336	41.6	5.9	422	19.6	72.2	1.40
0	5368	1757	3611	34.8	0.318	39.0	5.7	387	20.5	66.1	1.64
26	6645	2484	4161	42.1	0.406	49.7	7.5	444	18.9	73.2	1.57
103	6522	2282	4240	37.9	0.354	44.2	5.5	466	17.8	70.5	1.35
337	5540	2107	3433	41.7	0.414	49.1	6.2	438	20.9	74.0	1.74
LSD5%	1560.2	542.2	1117.1	8.3	0.08	8.3	2.1	94.8	7.1	11.2	0.29

Soil Physical and Chemical Characteristics

The statistical analysis of 3 period of wheat cultivation (green manure-wheat) showed that the effect of year was significant ($P<0.01$) on soil pH , %O.C, Fe, Cu, Mn, Zn, %sand, %clay and %silt (table 2).

And also the effects of treatment was significant on soil P, %SP, EC and on the $\%CaCO_3$ ($P<0.05$) table 2.

Table 2 shows that in the first year of experiment $\%CaCO_3$, Fe, Mn and Zn increased respectively 80%, 48%, 18% and 20% whereas P and Cu decreased respectively 8 % and 7%.

In the second year $\%CaCO_3$, Fe, Mn increased respectively156%, 35% and 23 % whereas P and Cu decreased respectively 14% and 4%.

In the third year $\%CaCO_3$, Fe, Mn and Zn increased 82%, 26%, 20% and 5% respectively whereas O.C decreased grain yield 19%.

However mean comparison of three years experiment in comparison with previous experiment showed that in the different treatments of green manure $\%CaCO_3$, Fe, Mn and Zn uptake increased 105%, 48%, 31% and 16% respectively whereas O.C, P and Cu decreased them 7%, 8 % and 3% respectively (table 3).

This result doesn't confirm Biswas and Mukherjee (1991) who is reported that green manure application increased soil O.C% and available P.

Mean comparison between different green manure treatments with control showed that application of green manure without nitrogen increased soil pH, $\%CaCO_3$, %Clay and EC 2%, 138%, 3% and 2% respectively. Whereas this treatment decreased %OC, P, total N, Fe, Cu, Mn and Zn 11%, 20%, 12%, 3%, 6%,13%, 5%, 2% and 5% respectively.

Mean comparison between different green manure + N treatments with control showed that these treatments increased %CaCO3, %SP and EC_e 72%, 3%, 6% and 24% respectively Whereas these treatments decreased %OC, P, total N, Cu, Mn, Zn and %sand 6%, 18%, 4%, 4%, 5%,3% and 10% respectively.

Table 2: The effects of Year on soil characteristics in 0-20 cm depth

	pH	O.C	P (av.)	Total N	T.N.V	Fe (av.)	Cu (av.)	Mn (av.)	Zn (av.)	SP	Clay	Sand	Silt	EC
		(%)	($mg.kg^{-1}$)	(%)	(%)	($mg.kg^{-1}$)					(%)			($dS.m^{-1}$)
first	7.94	0.617	14.7	0.062	4.0	7.1	2.10	13.9	0.60	58	44	13	43	0.77
second	7.68	0.634	13.7	1.089	5.7	6.5	2.16	14.5	0.50	59	21	23	56	0.68
third	7.89	0.511	15.8	0.575	4.0	7.8	2.33	17.9	0.64	63	31	20	49	0.66
LSD5%	0.12	0.05	2.60	0.05	1.61	0.59	0.10	1.8	0.05	1.9	2.2	4.1	3.4	0.13

Table 3: Combined analysis of variance for soil characteristics in different green manure treatments

		Mean square													
S.O.V	d.f	pH	O.C	P (av.)	Total N	T.N.V	Fe (av.)	Cu (av.)	Mn (av.)	Zn (av.)	SP	Clay	Sand	Silt	EC
Year	2	0.376**	0.090**	23.032ns	10.547**	19.89*	9.13**	0.28**	91.7**	0.104**	5.1ns	5273.0**	1046.5**	1621.80**	0.08ns
Residual	9	0.027	0.006	13.253	0.004	5.08	0.68	0.02	6.4	0.005	6.0	8.3	28.7	19.68	0.03
Treatment	4	0.033ns	0.017ns	27.900**	0.011ns	15.08*	0.28*	0.04ns	11.5ns	0.004ns	29.8**	4.6ns	9.7ns	5.09ns	0.39**
Year*Treatment	8	0.033ns	0.011ns	2.350ns	0.006ns	0.53ns	0.96ns	0.01ns	1.6ns	0.004ns	20.4ns	7.5ns	8.9ns	23.80ns	0.14**
Residual	36	0.028	0.019	3.216	0.006	5.09	0.50	0.03	7.1	0.005	10.5	7.4	11.0	10.57	0.02
C.V%	-	2.1	23.7	12.2	13.4	49.4	9.9	8.5	17.2	12.4	5.6	8.4	18.1	6.6	21.7

Soil Water Content

Combined soil moisture analysis of variance in each three years cultivation indicated tat there were significant effect of year, treatment, depth , effect of year × treatment and year × depth ($P<0.01$) whereas the effects of treatment × depth and year × treatment × depth was significant ($P<0.05$) (table 4).

Mean comparison of soil moisture for three years cultivation of wheat showed that the higher mean 28.7 % belong to third year and the lowest mean 12.5% related to first year of experiment.

Comparison of moisture (%) between second year and third year with first year showed increase of 74% that was significant.

It seems that increasing annual precipitation has important role on the soil moisture increase but this factor isn't parallel with annual precipitation in the second and third year of our experiment. Because increasing of soil moisture was 75% for second year and 130% respectively in comparison with first year. But the annual precipitation for these years was 104% for second year and 107% respectively for third year of experiment.

Although these results indicated 1% increase on annual precipitation between second and third year but increase in soil moisture was 32% among this years that confirm positive effect of green manure application on soil water (fig 1).

Mean comparison interaction effect treatment × sampling depth indicated moisture increasing 8% without N in green manure application comparison with control. Addition first level of N to green manure increased moisture 6% in the 0-20 cm depth. Whereas soil moisture variation had not significant effect between different levels of N + green manure treatments.

Application of green manure without N use decreased soil moisture (10%) in the 20-40 cm depth whereas use of N in all level decreased 6% in such depth comparison with control (fig 2).

These results indicated that application of Rye green manure with N use increased soil moisture in 0-20cm soil depth whereas decreased soil moisture in 20-40cm depth. These results agree with those of Trilett *et al* (1968), Black (1973), Zerega *et al*. (1995) and Pradit *et al.* (1993) who found that green manure application caused soil water content increase by increase of water infiltration rate, by decreasing evaporation rate and by improving soil physical characteristics.

Against these results Pikul *et al*. (1997) reported application of green manure has not increased soil water content.

Table4: Combined analysis of variance for soil moisture in different green manure treatments in two different depth 0-20 cm and 20-40 cm in wheat grain yield

S.O.V	d.f.	Sum of square	Mean square
Year	3	3266.9	1089.0**
Residual	4	57.4	14.4
T	4	46.9	11.7ns
Year*T	12	122.0	10.2ns
Residual	16	153.7	9.6
Depth	1	170.9	170.9**
Year*Depth	3	128.6	42.9**
T*Depth	4	14.3	3.6ns
Year*T*Depth	12	29.6	2.5ns
Residual	20	82.5	4.1
C.V%		10.5	

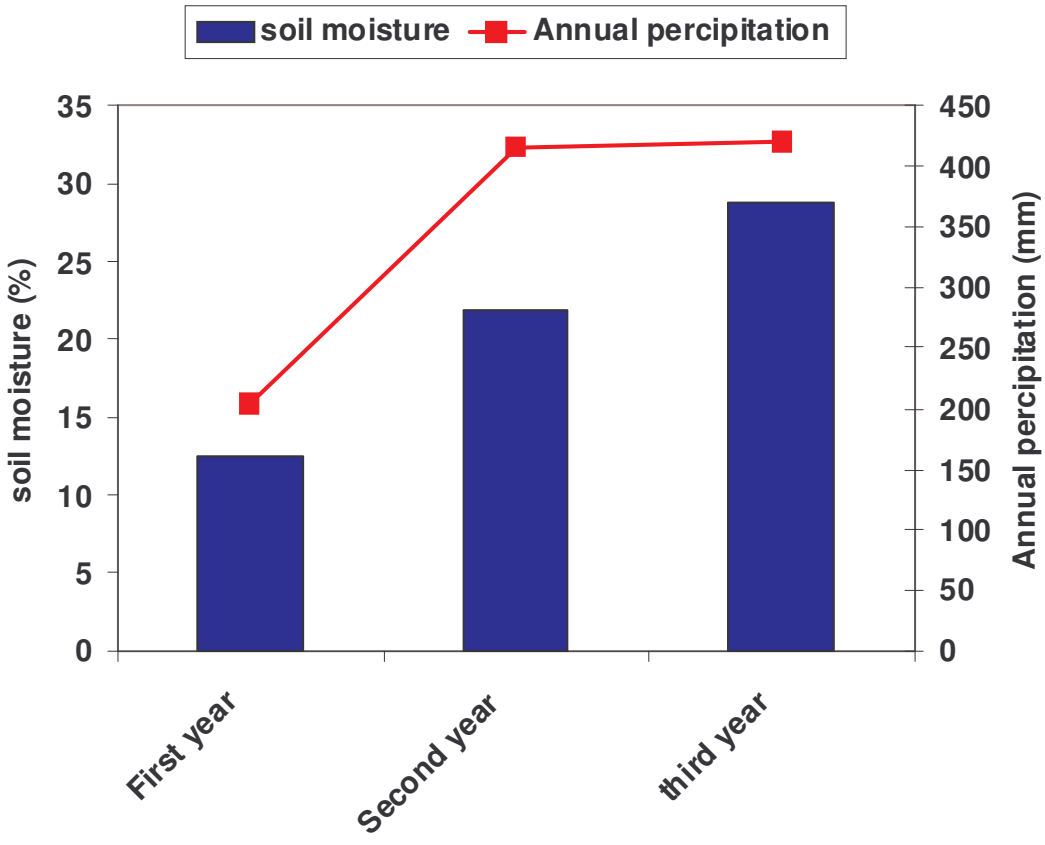

Fig 1: Variation of annual precipitation and soil moisture in 0-20 cm soil depth in three years in dray land wheat cultivation.

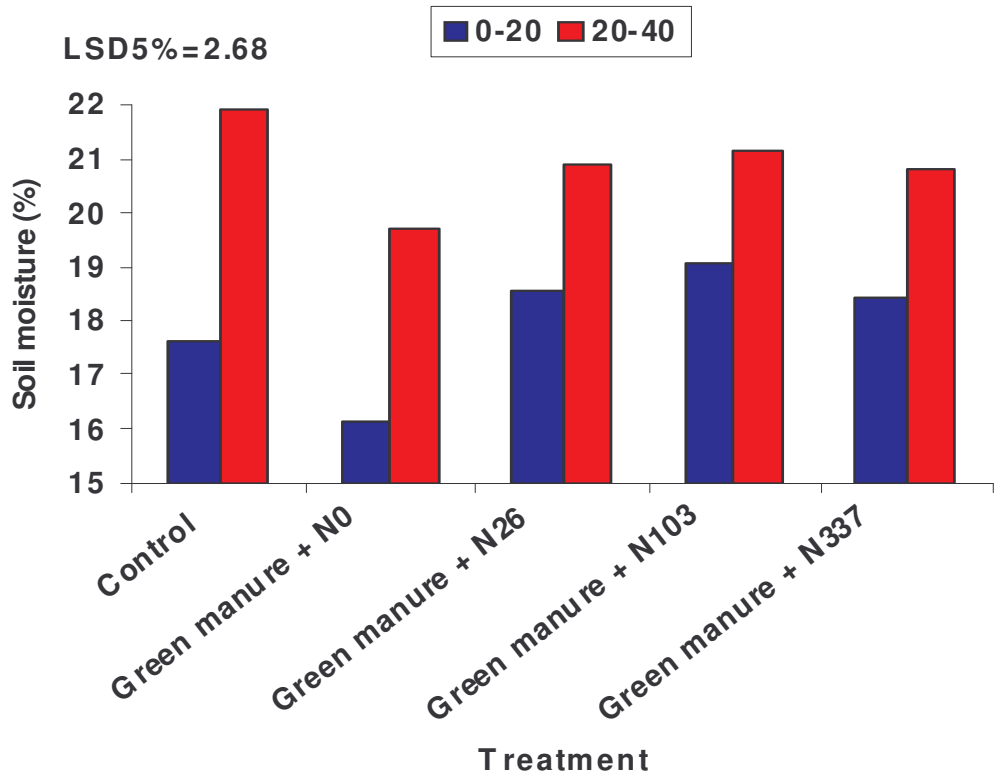

Fig 2: Mean soil moisture for average of three years in two different soil depths in wheat shooting stage.

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