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WHEAT PRODUCTIVITY IN SANDY SOIL AS AFFECTED BY PLANT RESIDUES, IRRIGATION AND NITROGEN RATES USING NUCLEAR TECHNIQUES

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ABSTRACT

Two field experiments were conducted in the Experimental Farm at Inshas, Nuclear Research Center, Atomic Energy Authority through 1997 / 1998 and 1998 /1999 .growing seasons whereas, wheat(Triticum aestivum L.) c.v. Sakha-69 was investigated in sandy soil to investigate: 1- The effect of different plant residues, i.e., corn ash and casourina leaves whose treated before the addition of its to the sandy soil at the rate of 10 ton / Fed. In a circle lines, 30 cm. depth and 60 cm. apart around irrigation system (sprinkler). 2-Two different irrigation levels named, Irrigation after 50 and 70 % loss in sandy soil water holding capacity (SWHC) whereas, the irrigation based on moisture depletion measured by the Neutron Moisture Gauge. 3-Two nitrogen rates as ammonium sulphate, i.e., 60 and 120 kg..N /Fed., as well as the control. Nitrogen were applied through a five equal splitting doses started 15 days after planting using a fertigation technique. The fives splitting doses was applied as ammonium sulphate N-15 labelled 3.33% atom excess in micro-plots. The experiments were achieved in a split-split plot design. The observed results indicated that the application of both plant residues to sandy soil increased *wheat plant growth as indicated by dry matter and economic yield. The application of 60 kg.N/ Fed. was more effective in yield more than 120 kg. N/ Fed. as shown by N- utilized. Also the irrigation afetr 50 % loss in soil water holding capacity (SWHC) gave the best result compare to the irrigation 70 % loss in SWHC.*

Key wards*:*

plant residues, corn ash , casouarina, wheat , N-15 and drip Irrigation.

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INTRODUCTION

Increasing population in Egypt become the major problem for agricultural production. The Egyptian Governoment must face that by increasing the land use efficiency with lower coasts and in short time.

The best way for increasing land use efficiency is the addition of organic matter after special treating to the sandy soil to face law water, and large portion of the applied fertilizer is leashed or volatilized.

The use of organic matter is considered as a good tool maximizing soil fertility. Most of the farmers are interested with the effective use of crop residues and other recycled organic activities. The role of plant residues in modern agricultural systems have become topic of major interest in the scientific research and agricultural authorities through improving water use efficiency (Sallam *et al* 2002) and both better aireation and increasing water holding capacity (Im 1982).

Research work on crop residues has provided new concepts on the interaction between crop residues and soils whereas, the application improved onion bulbs dry matter production significantly as a result of increasing water, nitrogen and phosphorus requirements in soil (Abdalla and Battah 2002 , and Abdalla 2002). The presence of organic matter in the soil effectively decreased the phosphorus fixation by the soil through the acidifying mechanism, Freney and Simpson (1983). Moreover, Olsen (1986) has reviewed research work including that a stable supply of ammonium (as organic matter) is essential for achievement of high yields.

A high significant correlation between soil organic matter (carbon) and the lowering in bulk density percentage (khaleel . *et al .;* 1981.; Jenkinson and Johnson .; 1977 ; and Avimelech . et al.; 1971) . On the other side the fast decomposition of organic matter leads to a high rate of nitrogen release only when the crop residues is rich in nutrients (it means low C / N and C / P). The decomposition of crop residues depends on the application rate and time which would have an effect on the rate of nutrients release.

The familiar C / N ratio is a useful guide to the peridiction of nitrogen mineralization is about between 25 / 1 to 30 / 1 , (khaleel *et al* ., 1981; Rynk.,1992 ; Biddlestone *et al* .,1994 ; and Rechegl ; 1995).

It could be concluded that the main and the effective factor affecting soil fertility especially in sandy soil is the organic matter content.

So the main objectives of the present study are ; The application of crop residues as a source of organic matter to sandy soil incorporated with different nitrogen and water levels for maximizing the input use efficiency and as well the output of wheat yield.

MATERIALS AND METHODS

The present study was conducted in the Experimental Farm at Inshas, Nuclear Research Center, Atomic Energy Authority through the two growing seasons of 1997 / 1998 and 1998 / 1999 whereas, wheat (*Triticum aestivumL.*) C. V. Sakha- 69 was planted in the two field experiments in sandy soil having the following characteristics presented in Table (A).

Table (A): Mechanical and chemical characteristics of the upper 30 cm. depth sandy soil in the two growing seasons.

Mechanical characters			Chemical characters		
Characters	97/98	98/99	characters	97/98	98/99

Sand %	93.3	93.3	pH (1: 25) soil/water	7.9	7.9
Silt %	4.5	4.7	0rganic matter %	0.1	0.1
Clay %	2.5	2.3	CaCO3 %	o.15	0.23
Bulk density	1.72	1.72	Nitrogen %	o.o11	0.08
SWHC %	7.98	7.86	Phosphorus %	0.005	0.004
Wilting point	1.99	2.01	Potasium %	0.057	0.052

The experiments were confirmed to study the effect of the following three main factors of:

I Plant residues treatments.
II Irrigation levels.
III Different nitrogen rates.

I- PLANT RESIDUES TREATMENTS:

Plant residues , i.e.; corn ash and casourina leaves locally available were grounded with a suitable mill and then mixed by (100 kg. dust +30 kg. ammonium sulphate + 5 kg calcium superphosphate) per one ton of both plant residues, according to Edward and Nabilla (1993) and then applied one months before planting at the rate of 10 tons / Fed. to sandy soil in both growing seasons based on the final C / N ratio of 14/1. To observe that C / N ratio, corn ash treated with 1 kg. chicken manure (C / N = 3.4 / 1) per 1 kg corn ash. Plant residues were mixed in a circle lines , 30 cm. depth and 60 cm apart around the irrigation source, (sprinkler) whereas , the soil stil wetted till planting .

II- IRRIGATION TREATMENTS

Two irrigation treatments were investigated whereas, the first one (W 1) was the irrigation after 50 % loss of soil water holding capacity (SWHC) and the second (W2), was the irrigation after 70 % loss of SWHC, using sprinkler irrigation system prepared especially for this purpose. The moisture content was determined by using Neutron moisture gauge for monitoring changes of soil water status within the plant rooting zone during growth at two depths, i.e.; 15 and 30 cm.

Irrigation based on moisture depletion measured by Neutron moisture gauge as well as soil water content data depending on the depletion down to 50 and 70 % of the available water contents. The irrigation treatments started one month after planting.

III- FERTLIZATION LEVELS

Two nitrogen rates as ammonium sulphate, i.e.; 60 and 120 kg./ N / Fed. were studied as well as the unfertilized treatment (control) in both growing seasons. The ammonium sulphate (21.2 % N) were applied through a five equal splitting doses started, 15 days after planting (DAP) using fertigation technique . The five splitting doses were applied by using ammonium sulphate (21.2 %) N-15 labelled of 3.33 % N-15 atom excess in a micro plot (1.4 m .long x 0.6 m. apart to be 0.84 m^2

The harvested plant samples (88 DAP) were dried for 48 hrs. at 70C ^{0}, grounded and passed through a 0.2 mm sieve for total nitrogen- isotope analysis using emission spectrometer model No. 1-5, as described by Buresh et al., (1982).

EXPERIMENTAL DESIGN AND ANALYSYS

The present experiment was achieved in a split - split plot design in three replicates whereas ,the irrigation treatments has been arranged in the main plots while, the plant residues occupied the sub -plot as well as the nitrogen rates in the sub -sub plot in both growing seasons. Data observed were statistically analyzed according to Snedecor and Cochran (1987) and the least significant differences were made.

The following characteristics were determind:

1- Plant height (cm.) 88 DAP.

2- Dry weight of shoots (g.) 88 DAP.
3- Spikes number / m² and grains number / spike.
4- Spike weight (g).
5- Flag leaf area (cm ²).
6-Grains yield kg. / Fed.
. 7-Water use efficiency (WUE) expressed as kg. grains /m3 water
8- Nitrogen use efficiency expressed as N- utilized % according to Buresh et al. (1982)

RESULTS AND DISCUSSION

1- Effect of plant residues, irrigation and nitrogen on growth characters:

Wheat plants cultivated in sandy soil applied with both corn ash and casourina residues as well as received 60 and / or 120 kg. N / Fed. improved significantly the growth of plant as compared to those cultivated in sandy soil only as indicated by plant height and shoots dry matter. The increments in dry matter resulted in were: (48.5 and 77.0 %) and (47.5 and 61.9 %) for casourina and corn ash fertilized with 120 and 60 kg. N / Fed. respectively as shown in Table (1 and 2). Moreover , plants cultivated in sandy soil treated with plant residues and did not fertilized were significantly affected in its plant height and shoots dry matter content compared to those planted in sandy soil only in both growing seasons as indicated in Tables (1 , 2 and Fig. 1). On the other side, plants fertilized and received more water (irrigated after 50 % loss in SWHC) were longer than those received less water (irrigated after 70 % loss in SWHC) in the two growing seasons as well as the same trend was noticed on shoots dry matter percentages. Meanwhile, plants in sandy soil which did not fertilized and irrigated after 70 % loss in SWHC were shorter and less in its dry matter than those unfertilized and received more water in both growing seasons as shown in Tables (1 and 2) and Fig.(1).

It could be concluded that the application of plant residues and nitrogen to sandy soil as well as the early irrigation were more effective in fertilizer and water use efficiency which reflected on plant height and shoots dry matter production 88 DAP.

The increments in both plant height and its dry matter may be attributed to the significant increase in flag leaf area which significantly increased as a result of irrigation (50% SWHC loss) compared to the untreated sandy soil and irrigation after 70 % loss in SCWH as shown in Table (3) and Fig. (2).

Table (1): Plant height (cm.) 88 DAP as affected by plant residues , nitrogen rates and irrigation levels.

Irr. Level	Plant residues treatments (PR) and nitrogen rate (N) kg/Fed.												W. av
	Sandy soil				Sandy soil + Corn ash				Sandy soil + Casourina				
	0	60	120	av.	0	60	120	av.	0	60	120	av.	
W1	28	63	85	58	74	82	90	82	77	88	87	84	74.7
W2	21	46	59	42	49	56	67	58	51	61	67	60	53.3
PR mean	50.0				78.5				72.0				

LSD at 0.05 for :

PR	N	W	PR .N	PR.W	N.W	PR.N.W
2.71	2.16	4.87	3.74	3.84	3.05	5.29

Nitrogen Av.

0	60	120
49.6	66.3	71.0

2-Effect of plant residues, water loss and nitrogen on wheat yield components

Yield components , i.e., spikes number / m², grains number /spike and spike weight (g) at harvest were significantly affected as a result of plant residues application whereas, the increments in spike numbers reached 36.5 and 32.5 % for both casourina and corn residues in sandy soil irrigated after 50 % SWHC loss as well as that increments were significantly higher than that irrigated after 70 % SWHC loss in both growing season respectively. In this concern plants which irrigated after 50 % loss planted in both sandy soil treated with plant residues and fertilized with 60 and 120 kg. N / Fed. having higher number of spikes / M^2 , grains number / spike and having a heavier Spike weight compared to the control (Tables 4, 5, and 6) and Fig .(3, 4, and 5).

Irrigation after 70 % loss in its SWHC decreased significantly wheat yield components compared to the irrigation after 50% loss in sandy soil WHC.

The higher efficiency of the applied plant residues in preventing nitrogen an wate and then maximizing its utilization by plants.Olsen (1986) and Khaleel et al., (1981) are similar to those occurred in present study.

Table (2): Dry weight of shoots (g) 88 DAP as affected by plant residues , nitrogen rates and irrigation levels during 1997/1998 growing season.

Irrig. Levels (W)	Plant residues treatments (PR) and nitrogen rates (N) kg./Fed.												W av
	Sandy soil				Sandy soil + Corn ash				Sandy soil + casourina				
	0	60	120	av.	0	60	120	av.	0	60	120	av.	
W1	129	396	512	346	447	625	815	629	374	725	813	637	537
W2	90	292	420	267	352	490	560	467	343	493	571	469	400
PR mean			306.5				548.0				535.0		

L S D A at 0.5 for:

PR	N	W	PR.N	PR.W	N.W	PR.N.W
22.8	21.2	52.1	36.7	32.2	29.9	51.9

Nitrgen average

0	60	120
289	503	615

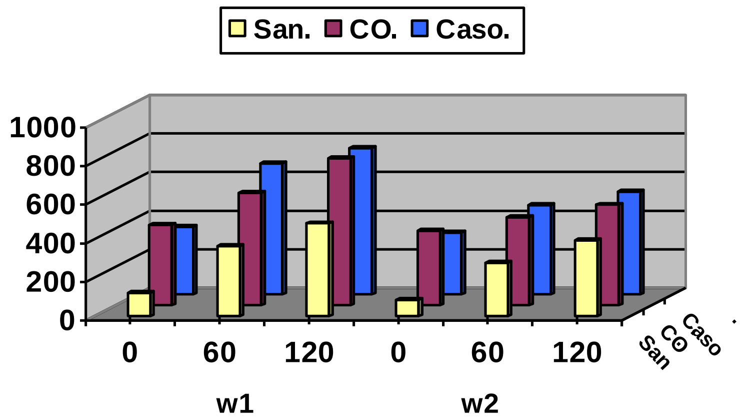


Fig. (1): Dry weight of shoots (g/m^2) 88 days after planting during 1998/1999 growing season.

Table (3): Flag leaf area (cm²). 88 DAPas affected by plant residues, nitrogen rates and irrigation levels during 1997/1998 growing season.

Irrig. Levels	Plant residues treatments (PR) and nitrogen rate (N) kg. / Fed.												W
	Sandy soil				Sandy soil + Corn ash				Sandy soil + casourina				av.
	0	60	120	av.	0	60	120	av.	0	60	120	av.	
W1	2.9	27.1	44.8	24.9	20.5	46.2	50.3	39.0	19.5	48.1	51.1	39.5	34.5
W2	2.3	15.6	27.3	15.1	14.1	28.2	35.8	26.0	12.8	28.0	33.0	24.6	21.9
PR mean	20.0				32.5				32.1				

LSD at 0.05 for:

PR	N	W	PR.N	PR.W	N.W	PR .N .W
1.55	0.82	1.24	1.42	2.20	1.16	2.01

Nitrogen av.

0	60	120
11.9	32.2	40.4

Table (4): Spikes numbers / m² as affected by plant residues, nitrogen rates and

Irrigation levels during 1997/1998 growing season.

Irrig. Levels	Plant residues treatments (PR) and nitrogen rates (N) kg. / Fed.												W av.
	Sandy soil				Sandy soil + Corn ash				Sandy soil + casourina				
	0	60	120	av.	0	60	120	av.	0	60	120	av.	
W 1	137	203	252	197	245	256	283	261	230	273	306	269	242
W 2	94	203	225	174	215	245	254	238	212	267	288	255	222
PR mean	185.5				249.5				262.0				

LSD at 0.05 for:

PR	N	W	PR.N	PR.W	N.W	PR.N.W.
11.1	9.2	13.6	15.9	15.7	12.9	22.4

Nitrogen average

0	60	120
180	241	267

Table (5): Grains number / spike as affected by plant residues, nitrogen rates and Irrigation levels during 1997/1998 growing season.

Irrig. Levels	Plant residues treatments (PR) and nitrogen rate (N) kg. / Fed.												W av.
	Sandy soil				Sandy soil + Corn ash				Sandy soil + casourina				
	0	60	120	av.	0	60	120	av	0	60	120	av	
W 1	6	23	36	21	16	39	42	32	17	40	43	33	28.6
W 2	3	16	22	13	10	23	28	20	11	26	30	22	18.3
PR mean	17.0				26.0				27.5				

LSD at 0.05 for:

PR	N	W	PR.N	PR.W	N.W	PR.N.W
0.99	1.36	1.81	2.36	1.4	1.93	3.35

Nitrogen average

0	60	120
10.3	27.6	33.3

Table (6): Spike weight (g) 88 DAP as affected by plant residues, nitrogen rates And irrigation levels during 1997/1998 growing season.

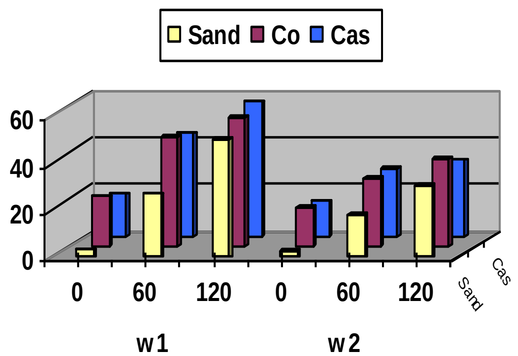
Irrig. Levels	Plant residues treatments (PR) and nitrogen rates (N) KG. / Fed.												W
	Sandy soil				Sandy soil + Corn ash				Sandy soil + casourina				av.
	0	60	120	av.	0	60	120	av.	0	60	120	av.	
W 1	1.29	1.69	2.15	1.40	1.35	2.53	2.40	2.03	1.16	2.23	2.58	1.99	1.81
W 2	0.23	1.64	1.71	1.19	0.63	1.72	1.86	1.40	0.61	1.59	1.91	1.39	1.32
PR mean	1.30				1.72				1.68				

LSD at 0.05 for:

PR	N	W	PR . N	PR.W	N.W	PR.N.W
0.42	0.48	0.74	0.08	0.59	0.06	0.11

Nitrogen average

0	60	120
0.72	1.86	2.10



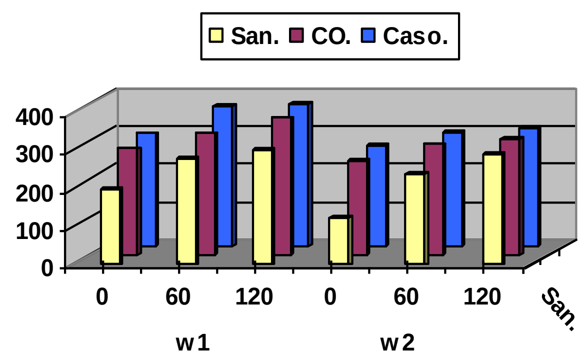


Fig. (2): Flag leaf area (cm^2) 88 DAP 1998/1999 growing seasons.

Fig. (3) : Spikes number / m2 at harvest during 1998/1999 growing season.

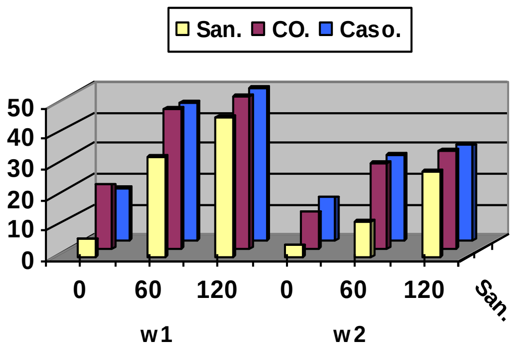


Fig. (4): Grains number / spike at harvest
during 1998/1999 growing season.

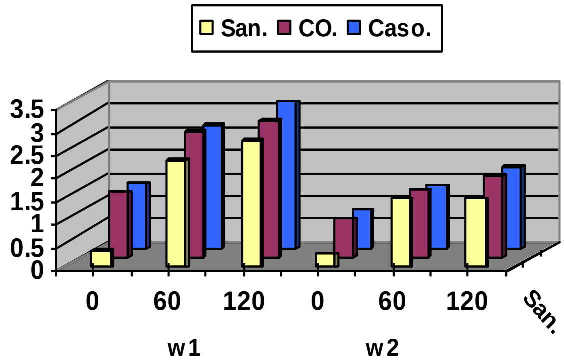


Fig. (5): Spike weight / gm. at harvest time during 1998/1999 growing season.

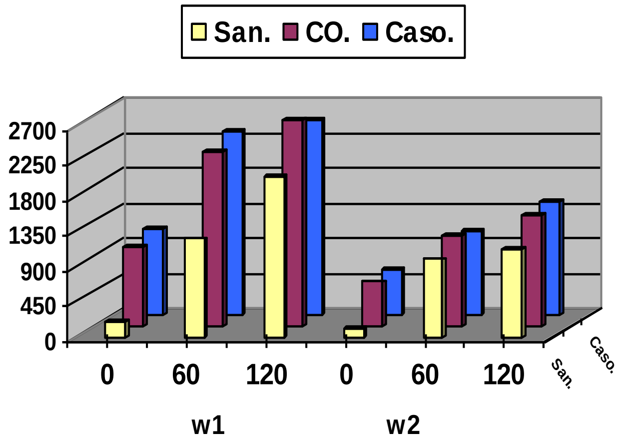


Fig: (6): Grains yield kg / Fed. Through 1998/1999 growing season.

3-Effect of plant residues, water and nitrogen on wheat yield.

Wheat grains (kg. / Fed.) increased significantly as a result of plant residues applicated to sandy soil whereas ,it could be concluded that the increments reached (68.8 and 80.1 %) and (65.5 and 81.9 %) for the soil applicated with both casouarina and corn ash when irrigated after 50 and 70 % of SWHC loss respectively.

Addition of nitrogen is very important in sandy soil. On the other side, application of nitrogen in presence of plant residues improved significantly wheat N-utilized applied whereas, the sandy soil applicated with both casourina and corn ash when fertilized with 60 and 120 kg. N / Fed. produced higher grains kg. / Fed. as indicated in Table (7) and Fig. (6). whereas, the increments reached (22.0 and 89.2 %) and (22.5 and57.1 %) for corn ash and casourina plant residues fertilized with 120 and 60 kg. /Fed. respectively.

It could be noticed that addition of 120 kg. N / Fed. was more effective than the 60 kg. N / Fed. in the first and the second growing seasons as indicated in Table (7). The resulted increase, in grains yield could be attributed to the increments produced in yield components which reflected on the total yield such as number of tillers. The increase in total chlorophyll in flag leaves occurred an increments in biological yield produced as a result of plant residues, irrigation and nitrogen interactions as shown in Tables (7, 8 and 9).

Table (7): Grains yield (kg. / Fed.) as affected by plant residues, nitrogen rates and irrigation levels during 1997/1998 growing season.

Irrig. Levels	Plant residues treatments (PR) and nitrogen rates (N) kg. /Fed.												W av.
	Sandy soil				Sandy soil + Corn ash				Sandy soil + casourina				
	0	60	120	av.	0	60	120	av.	0	60	120	av.	
W 1	135	969	1824	979	775	1951	2118	1615	778	2029	2137	1648	1413
W 2	87	563	799	483	595	957	1084	879	577	977	1075	870	744
PR mean	730				1247				1259				

LSD AT 0.05for:

PR	N	W	PR. N	PR. W	N.W	PR.N.W	Nitrogen average		
							0	60	120
23.6	50.6	33.6	87.5	46.0	71.5	123.8	487.6	1241	1506

4- Water and nitrogen use efficiency as affected by plant residues, irrigation and nitrogen applied.

The application of sandy soil with both plant residues induced high significant increase in water use efficiency whereas, the increments in water use efficiency (WUE) were 98.0 and 94.1 for casourina and corn ash after irrigation at 50 %WHC loss as well as 167.7 and 170.9 after irrigation at 70 % WHC loss in the first season as shown in Table (8).

The increments in WUE as a result of fertilization with 60 Kg. N/ Fed. were similar relatively to the higher rate of nitrogen (120 kg. N / Fed.) compared to the unfertilized and fertilized plants planted in pure sandy soil. It could be noticed that more irrigation (after 50 % loss in SWHC) increased nitrogen use efficiency (NUE) and WUE by 32.0 and 27.3 % relatively to lower irrigation (after 70 % loss in SWHC) On the other side, the utilization from nitrogen applied increased as a result of plant residues applicated in sandy soil whereas, the increment was higher with the more irrigation than the lower as presented in Tables (8 and 9).

Table (8) : Water use efficiency (kg. grains / m³ water) as affected by plant residues, nitrogen rates and irrigation levels during 1997/1998 growing season.

Irrig. Levels	Plant residues (PR) and nitrogen rates (N) kg. / Fed.												W av.
	Sandy soil				Sandy soil + Corn ash				Sandy soil + casourina				
	0	60	120	av.	0	60	120	av.	0	60	120	av	
W 1	0.07	0.5	0.95	0.51	0.47	1.19	1.30	0.99	0.48	1.24	1.31	1.01	0.48
W 2	0.06	0.37	0.52	0.31	0.57	0.91	1.03	0.84	0.53	0.93	1.30	0.83	0.66
PR means	0.41				0.92				0.92				

LSD at 0.05 for :

PR	N	W	PR.N	PR.W	N.W	PR.N.W	Nitrogen av.		
							0	60	120
0.02	0.05	0.04	0.07	0.04	0.05	0.09	0.36	0.86	0.91

Table (9): Fertilizer use efficiency expressed as N-utilized % as affected by plant residues, nitrogen rates and irrigation levels during 1997/1998 growing season.

Irrig. Levels	Plant residues treatments (PR) and nitrogen rate(N) KG. / Fed.												W av.
	Sandy soil				Sandy soil + Corn ash				Sandy soil + casourina				
	0	60	120	av.	0	60	120	av.	0	60	120	av	
W 1	-	7.2	10.0	8.6	-	31.3	30.9	31.1	-	32.4	31.7	32.1	23.9
W2	-	6.25	8.9	7 58	-	21.7	22.3	22.0	-	24.1	25.3	24.7	18.1
PR means	6.7	9.45	-		-	26.5	26.6	-		28.3	28.5	-	

Nitrogen av.		
0	60	120
--	20.5	21.5

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