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RESPONSE OF WHEAT CROP TO NITROGEN SOURCES AND APPLICATION TIMES UNDER SALINE SODIC SOIL CONDITIONS.

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ABSTRACT

Efficient nitrogen fertilizer management is being critical for the improved production of wheat and can be achieved through source and timing of N application.

In order to identify the effects of different N fertilizer sources and timing of application on growth, yield and its components of wheat, a field experiment was carried out at the Research Farm of El-Karada – Kafrelshiekh during 2012-2013 and 2013-2014 seasons. The experiment was conducted in saline sodic soil. The used variety was Sakha 93 wheat Varity as salt tolerant verity. The experiment was designed as a split-plot with four replications. The N sources; ammonium nitrate (AN), ammonium sulpahte (AS), Urea (U) and calcium nitrate (CN) were assigned in the main plots. The sub-plots consisted of three timing of N applications, T1= full N dose at sowing, T2= 1/2 N at sowing + 1/2 N at 30 days from sowing, T3= 1/3 N at sowing + 1/3 N at 30 days from sowing + 1/3 N at 60 days from sowing.

Results indicated that:-

The differences traits of growth, yield components, grain yield and harvest index (HI) in the both sources and timing of N application were significant. Ammonium nitrate increased flag leaf area and chlorophyll content but urea increased dry matter production. Ammonium sulphate increased yield components, grain yield and HI as compared to the other N sources.

Split N application especially at sowing, 30 days after sowing and 60 days after sowing had increased all parameters compared to full dose in 2012 and 2013 seasons.

The interaction between sources and timing of N application was significant for flag leaf area, dry matter production, spike length, panicle weight, No. of grains/spike, biological yield, grain yield and HI.

It was concluded that split application of ammonium sulphate or ammonium nitrate performed better than full dose application and the other N sources for improved wheat productivity and thus, is recommended for general practice in saline sodic soil conditions. Furthermore, the ammonium sulpahte application is better than other N- sources under current conditions as chemical amendment since it sulfur bearing fertilizer.

Keywords;wheat, N-sources, time of application, saline sodic soils.

INTRODUCTION

Wheat is strategic crop in Egypt, whereas it is grown under wide varied spectrum areas. Wheat is grown under different environments and soil fertility. Wheat is characterized as salt moderately tolerant since its salinity critical limit is 5.8 dSm^{-1}. Yield of wheat under salt affected soils is lower than those under normal soil indicating more additional and special management hast to be develop for wheat. Therefore, in soils affected by salts, increasing yield of wheat is an option to decrease wheat grain import. In Salt affected soils; the proper use of N fertilizers, particularly the N form and timing application applied to plants may influence plant-nutrient-salinity relationships (Martinez and Cerda, *1989*) and increase wheat yield with low inputs. Plants can take up N in two ionic forms, NH_4^+ or NO_3^- (Traore and Maranville, *1999*). The N form taken up by plants depends on the available N form, soil characteristics and plant species, variety and age. Nitrogen availability to plants differs with N form as a result of differences in mobility of each form in soil solution. Nitrogen form can also affect the availability of other nutrients such as phosphorus. Addition of NH_4^+ increased the capacity of plant roots to take up P from soils (Hofmann *et al., 1994*). Ammonium uptake by plants decreases soil pH in the rhizosphere because of release of H^+ from roots (Gahoonia *et al., 1992*). Nitrate nutrition can cause an increase in the rhizosphere pH through OH^- and HCO_3^- release which can enhance mobilization of soil P in acidic soils (Gahoonia *et al., 1992*). Under non-saline conditions, most plant species exhibit preference for NO_3^- compared to NH_4^+ nutrition ,where Compared to NH_4−N, NO_3−N nutrition increased the uptake of cations such as Ca^{2+}, Mg^{2+} and K^+ (Mahmood and Kaiser, *2003*) also, they found that nitrogen uptake can therefore play an important role in enhancing the availability of nutrients in soils and the uptake of nutrients, and hence the salt tolerance of plants. Also, compared to NH_4^+, NO_3^- nutrition increased plant uptake of Ca^{2+}, Mg^{2+}, K^+ and N and plant biomass at EC 10 dS m^{-1} induced using NaCl. Moreover, in a solution with EC 15 dS m^{-1}, NO_3−N uptake by barley increased with increasing concentration of Ca^{2+} salts (Ward *et al., 1986*). Additionally with salinity induced by NaCl up to 150 m*M*, equivalent to 15 dS m^{-1}, with 2 m*M*N for wheat (Al-Mutawa and El-Katony, *2001*) .Although most crops can grow on either N form, supplying plants with mixtures of NO_3^- and NH_4^+ in hydroponics with EC 8 dS m^{-1} (Ali *et al., 2001*) and in a loamy sand soil with EC_e 12.1 dS m^{-1} (Irshad et al. *2002*) often results in better vegetative growth and enhanced nutrient accumulation than either form alone. Mohammad and khan (2000) stated that types of N fertilizer (ammonium sulphate and ammonium nitrate had no significant effect on spike population, number of grains and 1000 grain weight.

Most studies of N form affect on plant growth under saline conditions have been conducted in hydroponics (Ali *et al., 2001*), where nutrients and Na^+ salts are in solution and completely available to plants. . Elgharably et al.(2009) indicated that soil salinity was highest with N addition as NO3−N and decreased in the following order: NO3−N > NH4−N > NH4NO3−N. Addition of greater than N50 as NO3−N, compared to NH4−N or NH4−NO3, increased soil salinity and reduced micronutrient uptake both of which likely limited plant growth. It can be concluded that in saline soils addition of 100 mg N kg^{-1} as NH4−N or NH4NO3−N is beneficial for wheat growth yield components and yield, whereas NO3−N can cause growth depression.

Applying the recommended nitrogen in proper dose at certain wheat growth under saline soil might be improved yield and overcame the nutrient problem under salt stress. Ayoub *et al.*(1994) stated that split N application had little effect on yield, but decreased lodging and spikes population, while grain weight increased. Split dose of fertilizer at sowing and vegetative stages or at vegetative and booting stage significantly increased grain weight, number of grains per spikes. Tariq et al. (2007)found that nitrogen splitting significantly increased the 1000 grain weight than those of single application. Also, yield and No. of grains per spike and were increased by split application. They also indicated that both types of N fertilizers were comparable in yield and its components. Mohammad et al. (2010) found that Split N at sowing, tillering and booting stage had increased the biological yield.

Therefore, the aim of the present study was to assess the effect of N added as NH_4^+, NO_3^- or NH_4NO_3 and application time on wheat growth in a saline clay soil.

MATERIALS AND METHODS

Tow field experiments were performed at El Karada Water Research Station, water management and research station, Sakha - Kafr El-Shiekh Egypt during 2012-2013 and 2013-2014 seasons. The salinity and pH levels of experiment sites were 9.5 and 9.0 dSm^{-2}&8.53 and 8.61 in the first and second seasons, respectively (Table 1).

Table1: Chemical analysis of experimental site during 2012-2013 and 2013-2014 seasons.

Season	pH	ECdS/m	ESP	OM%	Bulk density t/m^3	Soil texture
2012-2013	8.53	9.5	23.7	0.73	1.62	Clayey
2013-2014	8.60	9.0	23.3	0.81	1.66	Clayey

Sakha 93 wheat Varity as salt tolerant verity was used. The experiment was conducted to find out the optimum nitrogen sources and application timing for wheat under saline sodic soils. The statically design of the trials was split plot design with four replications. The tested nitrogen sources were ammonium nitrate (AN)33%, ammonium sulphate(AS) 20%, urea(U) 46%and calcium nitrare (15.5%), whereas, they were distributed in the main plots. The sub- plots were occupied by timing of application, T1= full N dose at sowing, T2= 1/2 N at sowing + 1/2 N at 30 days from sowing, T3= 1/3 N at sowing + 1/3 N at 30 days from sowing + 1/3 N at 60 days from sowing. The recommended phosphorus and potassium was applied in the form of calcium super phosphate (15.5KgP2O5) and potassium sulphate(24kg K2O), respectively. The above-mentioned nitrogen sources were applied in the rates of 75 kg N. The phosphorous in the form of calcium super phosphate was applied in the rate of 15 kg $P_2O_5fed^{-1}$. The seed was drilled in rows with spacing of 20cm between rows each other. The plot area was 1.2m wide and 4.5m length (5.4m^2).

At heading date, chlorophyll leaf content was assessed using SPAD value meter. Flag leaf area and dry matter production m^{-2} were also estimated at heading stage. Ten spikes were randomly taken at harvest to determined spike characteristics. The four inner rows were harvested, dried, and threshed, biological and grain yield of wheat were determined.

The obtained data were statically analyses according to Gomez and Gomez (1984). Least significant of difference (LSD) method was used to test the difference between treatment means at 5% level of probability as described by Snedecor and Cochran (1980).

RESULTS

Growth characters:-

Chlorophyll content (SPAD value), flag leaf area (cm^{-2}), and dry matter production (gm^{-2}) were affected by sources of nitrogen, however were increased with split applications of N sources (Table2). Differences in chlorophyll content, flag leaf area and dry matter production were significant for nitrogen sources and timing of N application. Application of ammonium nitrate (AN) had the highest chlorophyll content and flag leaf area compared to the other N sources in 2012-2013 and 2013-2014 seasons. While, the highest dry matter production was obtained with urea application in both seasons of study. Data in (Table 2) revealed that the split application of N had increased chlorophyll content, flag leaf area and dry matter production compared to full dose, however, two split application of N had increased flag leaf area, but three split of nitrogen application gave the highest values of chlorophyll content and dry matter production in 2012-2013 and 2013-2014 seasons.

The interaction between N sources and timing of nitrogen application was significant for flag leaf area and dry matter production (Table 2). The split application of N i.e. 1/2 at the first irrigation and other 1/2 at second irrigation had higher flag leaf area than all other N application with ammonium nitrate (AN) in 2012-2013 and 2013-2014 seasons. Meanwhile, the highest value of dry matter production was produced with AN when it is added on three equal doses in the first season, while the highest dry matter production was obtained with the combination of urea and three split application without any significant differences with AN in 2013-2014 season.

Table 2: chlorophyll content (SPAD value), flag leaf area (cm^{-2}) and dry matter production (gm^{-2}) as affected by sources and timing of nitrogen application during 2012-2013 and 2013-2014 seasons.

Characters	Chlorophyll content (SPAD value)		Flag leaf area (cm^{-2})		Dry matter production ($g\ m^{-2}$)	
Treatments	**2012-2013**	**2013-2014**	**2012-2013**	**2013-2014**	**2012-2013**	**2013-2014**
N source						
AN	50.58	50.32	34.62	33.10	1870.8	1796.3
AS	49.18	49.25	33.15	31.57	1831.9	1945.0
U	50.43	48.67	34.13	31.54	1879.9	1955.0
CN	50.67	49.20	30.40	32.81	1649.1	1752.9
F test	*	**	**	**	**	**
LSD at 0.05	1.19	0.82	1.72	0.56	115.8	41.6
N time						
T1	49.76	48.85	31.72	30.41	1684.3	1778.4
T2	50.23	49.31	34.59	33.43	1831.0	1874.1
T3	50.64	49.91	32.92	32.92	1885.7	1934.4
F test	*	*	**	**	**	**
LSD at 0.05	0.75	0.66	1.36	0.47	114.7	65.7
Interaction	NS	NS	**	**	**	**

NS, * and **: Non significant, significant at the 5% and 1% probability level, respectively.
AN= ammonium nitrate, AS= ammonium sulphate, U= Urea, CN= calcium nitrate, T1= full N dose at sowing, T2= 1/2 N at sowing + 1/2 N at 30 days from sowing, T3= 1/3 N at sowing + 1/3 N at 30 days from sowing + 1/3 N at 60 days from sowing.

Yield components:-

spike length, spike weight, number of grains $spike^{-1}$ and 1000-grain weight as affected by N sources and timing of application showed in Table 3. The N sources and timing of application had a significant effect on all yield components parameters, also, the interaction between N sources and timing of application had significant effect on all yield components except 1000-grain weight in Table 3.

Ammonium sulphate (AS) had the highest values of spike length, spike weight, number of grains/spike and 1000-grain weight as compared to the other N sources in both seasons of study.

The split application of N i.e. 1/3 at the first irrigation, 1/3 at 30 days from sowing and 1/3 at 60 days from sowing had higher spike length, spike weight, number of grains/spike and 1000-grain weight than all other N application strategies. However, N split application at sowing and 30 days after sowing increased these parameters as compared to full N application at sowing (Table 3).

The interaction between N sources and timing of nitrogen application was significant for spike length, spike weight and number of grains $spike^{-1}$ (Table 3). Generally, the split application of N had increased the spike length and spike weight as compared to full dose of N application. More specifically, the application of N in three split doses had increased spike length and spike weight especially with AS (Table5). The highest number of grains $panicle^{-1}$ were observed with the combination of AS with the split application of N i.e. 1/3 N at sowing, 1/3 N at 30 days after sowing and 1/3 N at 60 days after sowing (Table 6).

Table3: Some yield components as effected by sources and timing of nitrogen application during 2012-2013 and 2013-2014.

Characters	spike length cm^{-1}		spike weight g^{-1}		No. of grains $spike^{-1}$		1000-grain weight g^{-1}	
Treatments	**2012-2013**	**2013-2014**	**2012-2013**	**2013-2014**	**2012-2013**	**2013-2014**	**2012-2013**	**2013-2014**
N sourse								
AN	11.44	11.52	4.21	4.32	62.31	62.10	42.32	42.23
AS	11.99	12.02	4.38	4.42	65.56	65.20	42.36	42.20
U	11.38	11.47	4.06	4.38	61.21	61.00	41.53	42.13
CN	11.36	11.76	4.03	4.22	58.19	59.33	41.90	40.82
F test	**	**	**	**	**	**	**	**
LSD at 0.05	0.28	0.14	0.25	0.06	2.77	1.08	0.56	0.52
N time								
T1	10.96	11.10	4.02	4.20	59.59	59.75	41.69	41.15
T2	11.62	11.77	4.04	4.34	60.07	61.65	42.19	42.18
T3	12.05	12.21	4.44	4.48	65.79	64.33	42.20	42.21
F test	**	**	*	**	**	**	*	*
LSD at 0.05	0.26	0.12	0.20	0.06	2.02	0.49	0.39	0.80
Interaction	*	**	**	**	**	**	NS	NS

NS, * and **: Non significant, significant at the 5% and 1% probability level, respectively. AN= ammonium nitrate, AS= ammonium sulphate, U= Urea, CN= calcium nitrate, T1= full N dose at sowing, T2= 1/2 N at sowing + 1/2 N at 30 days from sowing, T3= 1/3 N at sowing + 1/3 N at 30 days from sowing + 1/3 N at 60 days from sowing.

Yield:-

Biological yield, grain yield t fed^{-1} and Harvest index (HI) are presented in Table 4. N sources had significant effect on these parameters, however, the nitrogen source of AN gave the highest biological yield t fed^{-1} in both seasons, while the highest grain yield t fed^{-1} and HI were recorded with Ammonium sulphate (AS), as well as, ammonium nitrate (AN) recorded the second rank in grain yield without any significant differences with AS in 2012-2013 and 2013-2014 seasons.

Biological yield and grain yield t fed^{-1} and HI were affected by timing of nitrogen application (Table 4). Split of N increased biological and grain yield, however, split of nitrogen to three equal doses gave the highest biological and grain yield t fed^{-1} as compared with the other treatments in 2012-2013 and 2013-2014 seasons.

The interaction between N sources and timing of N application was significant for biological yield, grain yield and HI (Table 4). The combination of AS with three split application of nitrogen recorded the highest value of grain yield without any significant differences with AN in two seasons of study as compared with the other combinations.

Table 4: Biological, grain yield (t fed^{-1}) and harvest index (HI) as affected by sources and timing of nitrogen application during 2012-2013 and 2013-2014 seasons.

characters	Biological yield t fed^{-1}		Grain yield t fed^{-1}		HI	
Treatments	**2012-2013**	**2013-2014**	**2012-2013**	**2013-2014**	**2012-2013**	**2013-2014**
N source						
AN	2.75	2.73	1.065	1.090	0.388	0.399
AS	2.64	2.61	1.089	1.10	0.410	0.419
U	2.74	2.69	0.990	1.005	0.362	0.374
CN	2.74	2.72	1.014	1.047	0.371	0.385
F test	**	**	**	**	**	**
LSD at 0.05	0.06	0.02	0.041	0.012	0.014	0.015
N time						
T1	2.46	2.50	0.973	1.015	0.395	0.406
T2	2.79	2.76	1.015	1.047	0.362	0.379
T3	2.90	2.82	1.134	1.120	0.391	0.397
F test	**	**	**	**	**	**
LSD at 0.05	0.08	0.06	0.021	0.008	0.014	0.013
Interaction	**	**	**	**	**	**

NS, * and **: Non significant, significant at the 5% and 1% probability level, respectively.
AN= ammonium nitrate, AS= ammonium sulphate, U= Urea, CN= calcium nitrate, T1= full N dose at sowing, T2= 1/2 N at sowing + 1/2 N at 30 days from sowing, T3= 1/3 N at sowing + 1/3 N at 30 days from sowing + 1/3 N at 60 days from sowing.

Table 5: Effect of the interaction between sources and timing of nitrogen application on flag leaf area, dray matter production, spike length and spike weight during 2012-2013 and 2013-2014 seasons.

	Flag leaf area (cm^{-2})		Dry matter production (g m^{-2})		spike length (cm)		spike weight (g)	
	2012-2013	**2013-2014**	**2012-2013**	**2013-2014**	**2012-2013**	**2013-2014**	**2012-2013**	**2013-2014**
AN*T1	29.98	29.18	1516.4	1637.5	10.78	10.90	4.01	4.12
AN*T2	37.43	35.50	1799.0	1688.8	11.53	11.72	4.14	4.30
AN*T3	36.46	34.62	2297.2	2062.5	12.03	11.95	4.49	4.55
AS*T1	34.84	30.08	1815.1	1807.5	11.78	11.88	4.41	4.20
AS*T2	33.83	33.06	1865.3	1965.0	11.98	11.87	4.00	4.39
AS*T3	30.79	31.53	1814.0	2062.5	12.24	12.30	4.71	4.66
U*T1	32.14	30.06	1860.6	1975.0	10.55	10.75	3.49	4.20
U*T2	34.99	32.10	2000.1	2087.5	11.35	11.36	4.21	4.35
U*T3	35.28	32.46	1689.2	1802.5	12.24	12.30	4.49	4.60
CN*T1	29.92	32.30	1545.1	1693.8	10.75	10.88	4.20	4.26
CN*T2	32.14	33.06	1659.8	1755.0	11.64	12.11	3.83	4.30
CN*T3	29.15	33.08	1742.5	1810.0	11.70	12.30	4.05	4.10
LSD 0.05	2.72	0.93	229.5	131.3	0.52	0.23	0.40	0.11

AN= ammonium nitrate, AS= ammonium sulphate, U= Urea, CN= calcium nitrate, T1= full N dose at sowing, T2= 1/2 N at sowing + 1/2 N at 30 days from sowing, T3= 1/3 N at sowing + 1/3 N at 30 days from sowing + 1/3 N at 60 days from sowing.

Table 6: Effect of the interaction between sources and timing of nitrogen application on no. of grains spike^{-1}, biological yield, grain yield and harvest index during 2012-2013 and 2013-2014 seasons.

	No. of grains spike^{-1}		Biological yield (t fed^{-1})		Grain yield (t fed^{-1})		Harvest index (HI)	
	2012-2013	2013-2014	2012-2013	2013-2014	2012-2013	2013-2014	2012-2013	2013-2014
AN*T1	56.97	58.80	2.46	2.49	0.978	1.043	0.398	0.419
AN*T2	63.40	64.00	2.90	2.87	1.058	1.080	0.365	0.376
AN*T3	66.58	63.50	2.89	2.84	1.121	1.148	0.402	0.397
AS*T1	68.64	63.50	2.32	2.38	1.017	1.042	0.439	0.437
AS*T2	58.04	65.20	2.99	2.76	1.064	1.083	0.356	0.392
AS*T3	69.98	66.90	2.60	2.70	1.159	1.157	0.438	0.428
U*T1	55.08	57.50	2.51	2.53	0.891	0.957	0.355	0.377
U*T2	59.45	58.90	2.62	2.67	0.929	0.987	0.354	0.369
U*T3	69.10	66.60	3.09	2.86	1.149	1.071	0.378	0.374
CN*T1	57.69	59.20	2.56	2.58	0.995	1.016	0.388	0.393
CN*T2	59.39	58.50	2.65	2.73	0.996	1.029	0.375	0.377
CN*T3	57.50	60.30	3.02	2.84	1.050	1.097	0.348	0.385
LSD 0.05	4.04	0.99	0.16	0.12	0.042	0.016	0.028	0.017

AN= ammonium nitrate, AS= Ammonium sulphate, U= Urea, CN= calcium nitrate, T1= full N dose at sowing, T2= 1/2 N at sowing + 1/2 N at 30 days from sowing, T3= 1/3 N at sowing + 1/3 N at 30 days from sowing + 1/3 N at 60 days from sowing.

DISCUSSIONS

The form in which N is supplied to plants growing under osmotic stress can be important (Martinez and Cerda, 1989). In the present study, under saline conditions, chlorophyll content and flag leaf area were increased with AS compared to other N sources. The positive effect of NH_4 compared to NO_3 on plant growth under saline conditions could be due to the reduced energy requirement for utilization of NH_4^+ in protein synthesis (Cox and Reisennauer, 1973) and enhanced uptake of nutrients, particularly micronutrients, and increased root growth. The greater dry matter production with urea can be attributed to the adequate N availability (Malhi *et al.,* 2006) which resulted in increased photosynthetic activities (Habtegebrial *et al.,* 2007), vigorous plant growth (Kibe *et al.,* 2006) and thus ultimately increased the productive tillers. Nitrogen application at vegetative stage improved the plant growth (Jan and Khan, 2000) and thereby increased productive tillers.

The split application might have fulfilled the plant N requirement due to greater availability of nitrogen for prolonged time (Singh and Bhan, 1998) and thus might increase the growth parameters.

The longest spike, heaviest spike weight, number of grains/spike and heaviest 1000-grain weight due to ammonia N might be attributed the greater availability of N due to NH_4-N compared to NO_3-N in cereals. In addition, the application of NH_4 SO_4 might be acting as soil conditioner and reclamation. Also, application of NH_4 SO_4 as N form was apparently improved chlorophyll content and flag leaf area resulted in improving current photosynthesis lead to improving spike characteristics. Our results are in agreement with finding of Kelley and Sweeney (2005). Split application of N had increased the available N (Lopez-Bellido *et al.,* 2006 and Huang *et al.,* 2007) particularly at sowing that enhanced the plant vegetative stage, or at boot stage that is accountable for improving the reproductive stage and thus increased the grains per spike since wheat had the longest period of grain filling and ensure an adequate amount of N supply during this period resulted in an improvement of yield components and ultimately wheat yield.

In the present study, sources of N had affected the grain yield, the highest grain yield were obtained with AS without any significant differences between AN in both seasons of study, the possible reason might be that both NH4-N and NO3-N fulfilled the crop requirements in similar fashion and thus might have resulted in non-significant differences for grain yield. Our results were further confirmed by Westerman *et al.* (1994). Improved grain weight might be associated with plant performance (Herrera *et al.,* 2006), improved plant photosynthetic capability (Benziger *et al.,* 1994) or improved leaf area (Kibe *et al.,* 2006).

The split application of N had improved the N uptake efficiency (Lopez-Bellido, 2006) or recovery efficiency (Davies *et al.,* 1979) and thus increased the grain weight. The other possible reason for improved crop yield due to split N application might be the enhanced uptake of N (Limon-Ortega *et al.,* 2000) and thereby increased crop performance (Houles *et al.,* 2007) and ultimately grain yield. The findings were at the same line with those reported by Ayoub et al. (1994), Mohammed and Khan (2000) Tariq et al.(2007),and Mohammad et al.(2010).

CONCLUSIONS AND RECOMMENDATIONS

Application of Ammonium sulphate (AS) and Ammonium nitrate (AN) had improved yield and yield components of wheat compared to Urea (U) and Calcium nitrate (CN). In general, Ammonium sulphate (AS) performed better than the other N sources. Split application of N had performed better than full dose of N application. Keeping in view the above facts that productivity of wheat can be increased by using AS or AN in three splits applications under saline sodic soil conditions.

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REFERENCES

Ali, A.; T.C.Tucker; T.L.Thompson; M. Salim (2001) Effects of salinity and mixed ammonium and nitrate on the growth and nitrogen utilization of barley. J Agron. Crop Sci., 186:223–228.

Al-Mutawa, M.M. and T.M. El-Katony (2001). Salt tolerance of two wheat genotypes in response to the form of nitrogen. Eur. J. of Agron., 21:259–266

Ayoub, M.; S. Guertin; S. Lussier and D.L. Smith (1994).Timing and level of nitrogen fertility effects onspring wheat yield in eastern Canada. Crop Sci., 34:748-756.

Banziger, M.; B. Feil and P. Stamp (1994). Competition between nitrogen accumulation and grain growth for carbohydrates during grain filling of wheat. Crop Sci., 34(2):440-446.

Cox, J.W. and H.M. Reisennauer (1973). Growth and ion uptake by wheat supplied with nitrogen as nitrate, ammonium, or both. Plant Soil, 38:363–380.

Davies, D. B.; L. V. Vaidyanathan, J. S. Rule and R. H. Jarvis (1979). Effect of sowing date and timing and level of nitrogen application to direct drilled winter wheat. Expt. Husb., 35: 122-131.

Elgharably,A.; P. Marschner and P. Rengasamy (2009). Wheat growth in a saline sandy loam soil as affected by N form and application rate. Plant and soil, 328(1-2): 303-312.

Frechilla, S.; B. Lasa; L. Ibarretxe; C. Lamsfus and P. Aparicio-Tejo (2001). Pea responses to saline stress is affected by the source of nitrogen nutrition (ammonium or nitrate). Plant Growth Regul, 35:171–179.

Gahoonia, T.S.; N. Claassen and A. Jungk (1992). Mobilization of phosphate in different soil by ryegrass supplied with ammonium or nitrate. Plant and Soil, 140:241–248.

Gomez, K. A. and K. S. Gomez (1984). Statistical procedures for agricultural research. 2nd Ed., John Wiley and Sons.

Habtegebrial, K.; B. R. Singh and M. Haile (2007). Impact of tillage and nitrogen fertilization on yield, nitrogen use efficiency of *tef* (Eragrostis tef (Zucc.)Trotter) and soil properties. Soil and Tillage Res., 94:55-63.

Herrera, J. M.; P. Stamp and M. Liedgens (2006). Inter-annual variability in root growth of spring wheat at low and high nitrogen supply. Eur. J. of Agron., 26:317-326.

Hofmann, C.; E. Ladewing; N. Claassen and A. Junk (1994). Phosphorus uptake of maize as affected by ammonium and nitrate nitrogen: measurements and model calculations.Z Pflanzerernahrung Bod., 157:225–232.(C.F. Computer Search)

Houles, V.; M. Guerif and B. Mary (2007). Elaboration of a nitrogen nutrition indicator for winter wheat based on leaf area index and chlorophyll content for making nitrogen recommendations. Eur. J. of Agron., 27: 1-11.

Huang, B.; W. Sun; Y. Zhao; J. Zhu; R. Yang; Z. Zou; F. Ding and J. Su (2007). Temporal and spatial variability of soil organic matter and total nitrogen in an agricultural ecosystem as affected by farming practices. Geoderma, 139: 336-345.

Irshad M.; T. Honna; A.E. Eneji and S. Yamamoto (2002). Wheat response to nitrogen source under saline conditions. J. Plant Nutr., 25:2603–2612.

Jan, M. T. and S. Khan (2000). Response of wheat yield components to type of N fertilizer, their levels and application time. Pakistan J. Biol. Sci., 3(8): 1227-1230.

Kelley, K. W. and D. W. Sweeney (2005). Tillage and urea ammonium nitrate fertilizer rate and placement affects winter wheat following grain sorghum and soybean. Agron. J., 97: 690-697.

Kibe, A. M.; S. Singh and N. Kalra (2006). Water-nitrogen relationships for wheat growth and productivity in late sown conditions. Agric. Water Manage., 84:221-228.

Limon-Ortega, A.; K. D. Sayre and C. A. Francis (2000). Wheat nitrogen use efficiency in a bed planting system in northwest mexico. Agron. J., 92: 303-308.

Lopez-Bellido, L.; R.J. Lopez-Bellido and F. J. Lopez-Bellido (2006). Fertilizer nitrogen efficiency in durum wheat under rainfed Mediterranean conditions: effect of split application. Agron. J., 98 : 55-62.

Mahmood, T. and W.M. Kaiser (2003). Growth and solute of the salt-tolerant kallar grass [*Leptochloa fusca* (L.) Kunth] as affected by nitrogen source. Plant Soil., 252:359–366.

Malhi, S. S.; R. Lemke; Z.H. Wang and B.S. Chhabra (2006). Tillage, nitrogen and crop residue effects on crop yield, nutrient uptake, soil quality and greenhouse gas emissions. Soil and Tillage Res., 90:171-183.

Martinez, V. and A. Cerda (1989). Influence of nitrogen source on rate of Cl, N, Na and K uptake by cucumber seedlings grown in saline conditions. J. Plant Nutr., 12:971–983.

Mohammad, T. J. and S. khan (2000). Response of wheat yield components to types of N-fertilizer, their levels and application time. Pakistan J. of biological Sci., 3(8):1227-1230.

Mohammad, T. J.; M. J. Khan.; A. Khan; M. Arif; M. Shafi and Farmanullah (2010) Wheat nitrogen indices response to nitrogen source and application time. Pakistan. J. Bot., 42(6): 4267-4279

Singh, S. and V. M. Bhan (1998). Response of wheat (Triticum aestivum L.) and associated weeds to irrigation regime, nitrogen and 2,4-D. Indian J. Agron., **.**43 (4):662-667.

Snedecor, G. W. and W. G. Cochran (1980). *Statistical Methods,* 7th ed. Ames: Iowa State University Press. SO7p.

Tariq, J.; T. J. Mohammad; M. Arif; H. Akbar and S. Ali (2007). Response of wheat to source, types and time of nitrogen application. *Sarhad J. Agric., 23 (4):871-880*

Traore, A. and J.W. Maranville (1999). Effect of nitrate/ammonium ratios on biomass production, N accumulation and use efficiency in Sorghums of different origins. J. Plant Nutr., 22:813–825.

Ward, M.R.; M. Aslam and R.C Huffaker (1986). Enhancement of nitrate uptake and growth of barley seedlings by calcium under saline conditions. Plant Physiol., 80:520–524.

Westerman R. L.; R.K. Boman; W.R. Raun and G.V. Johnson (1994). Ammonium and nitrate nitrogen in soil profiles of long-term winter wheat fertilization experiments. Agron. J., 86 (1): 94-99.

استجابة محصول القمح لمصادر ومواعيد أضافة السماد النيتروجينى تحت ظروف الأراضي الملحية.

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تعتبركفاءة إستخدام السماد النيتروجينى ضرورية لتحسين انتاجية القمح متمثلة فى مصادر ومواعيد إضافة السماد النيتروجينى تحت ظروف الأراضي الملحية. ولمعرفة تأثير مصادرالسماد النيتروجينى ومواعيد الإضافة على نمو ومكونات المحصول ومحصول القمح أقيمت تجربة حقلية فى المزرعة البحثية بالقرضا –معهد بحوث إدارة المياة –كفر الشيخ خلال موسمين ٢٠١٢/٢٠١٣ و ٢٠١٣/٢٠١٤م لدراسة هذا الغرض تحت ظروف الأراضي الملحية الصودية, واستخدم الصنف سخا٩٣ في
هذة الدراسة.وكان التصميم المتبع فى هذه التجربة هو القطع المنشقه مرة واحده فى أربعة مكررات حيث وضعت مصادر النيتروجين (نترات الأمونيوم ٣٣%N, سلفات الأمونيوم ٢٠%N, اليوريا ٤٦%N ونترات الكالسيوم ١٥.٥%N)بمعدل ٦٩ وحدة أزوت للفدان فى القطع الرئيسية بينما وضعت مواعيد الإضافة فى القطع المنشقة (١- عند الزراعة, ٢- ٢/١ عند الزراعة+٢/١ بعد ٣٠ يوم من الزراعة ,٣- ٣/١ عند الزراعة+٣/١ بعد ٣٠ يوم من الزراعة+٣/١ بعد ٦٠ يوم من الزراعة).

أوضحت النتائج أن صفات النموالمحصول ومكوناته ودليل الحصاد إختلفت معنويا مع مصادر ومواعيد إضافة النيتروجين حيث أعطت نترات الأمونيوم أعلى قيمة لمساحة ورقة العلم وأعلى محتوى من الكلوروفيل بينما أعطت اليوريا أعلى قيمة للمادة الجافة وقد أعطت سلفات الأمونيوم أعلى محصول حبوب وأعلى مكونات محصول وأعلى محصول حبوب ودليل حصاد بالمقارنة بمصادر النيتروجين الأخرى.
وبصفة عامة تقسيم السماد النيتروجينى وخصوصا على ثلاث دفعات أدى الى زيادة فى كل الصفات المدروسة بالمقارنة بإضافته مرة واحدة.

وكان هناك تأثير للتفاعل بين مصادر ومواعيد إضافة النيتروجين على مساحة ورقة العلم والمادة الجافة المتكونة وطول السنبلة ووزن السنبلة وعدد الحبوب فى السنبلة والمحصول البيولوجى ومحصول الحبوب ودليل الحصاد حيث أعطت سلفات النشادر عند إضافتها على ثلاث دفعات أعلى القيم لمعظم هذه الصفات.

ويمكن التوصية بإضافة سلفات الأمونيوم أو نترات الأمونيوم على ثلاث دفعات أودفعتين للحصول على أعلى إنتاجية من القمح تحت ظروف هذه التجربة أو ما يماثلها من أرض ملحية.