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Investigations on growth and yield responses of date palms (*Phoenix dactylifera* L.) to nitrogenous nutrition

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Abstract: The study was conducted at Al-Bakheet village, Karima Locality, Northern State, Sudan. The aim of this study was to investigate the growth attributes, yield and fruit physical traits of 'Barakawi' date palm cultivar to urea (46%N) applications. The selected trees were of uniform growth and size. Urea treatments were 0 (control), 50, 100, and 150 g/palm applied in the first season only. Their extended effects were also considered in the succeeding season. The randomized complete block design was used with 4 replicates. The results showed that the urea applications were enhancive for both vegetative growth and yield, and in particular the 100g urea/palm was the most satisfactory treatment. Such finding is indicative of the importance of application of even small amounts of nitrogen to increase yield of date palms.

Key words: Date palm; Urea; Growth; *Phoenix dactylifera*; Yield.

Introduction:

Date palm (*Phoenix dactylifera*) is one of the most important tree crops in desert areas of Northern Africa, Southern Asia and the Middle East (Hodel and Pittenger, 2003).In Sudan, dates cultivation is a major economical activity in the Northern State (Dirar, 2003). This crop is produced along the banks of the Nile where under-ground water table is sufficient to meet dates water requirements and the banks are fertile enough to provide the nutritional needs. The annual flood of the river renews these supplies; a situation that rendered a common concept among dates growers that dates are of no need for fertilizers or irrigation. Nevertheless, yield declined, due to continuous mono-cropping cultivation, diseases and pests' outbreaks and climatic fluctuations within the two last decades, and this necessitates yield enhancing research (Idris *et al*., 2006).

Barakawi is one of the most famous dry cultivars grown in the Sudan (Mohammed, 1984) and constitutes about 70% of the Northern State dates exports (Idris *etal*., 2006). Due to the low moisture content, dry dates can be kept for a whole year without loss of quality and are easy to store and transport under ambient conditions (Dawoud and Ahmed, 2006).

Nitrogen is considered a master element in plant nutrition and it plays an important role in all physiological growth processes of plant as stimulation of plant growth, yield and chemical constituents. In arid and semi-arid regions nitrogen and phosphorus are the most limiting nutrients to plant growth (Idris *et al*., 2012).The use of nitrogen by plants is related to the forms and levels of nitrogen, the cultivars and the physico-chemical properties of the soil (Li *et al.,* 2007). The form of nitrogen applied can play a significant role in plant growth and productivity (Sady *et al.,* 2008). Ammonium (NH4 +), nitrate (NO3 -) and urea are the forms of nitrogen generally applied. The responses of a large number of fruit trees to the application of different nitrogen forms has been reported previously (Saleh *et al.,* 2000). Kassem. (2012) found that applied nitrogen in different forms alone or in combination with potassium, phosphorus and sulfur increased fruit flesh and fruit pulp weights. Nitrogen is a major element required by all plants and adequate nitrogen is essential for tree growth, leaf cover, blossom formation, and fruit set and fruit size. (Sharma, 2016).Using chemical fertilization can improve plant ability to uptake mineral nutrients. Improving plant uptake reflects in increasing vegetative growth and consequently improves efficiency for absorption and utilization of nutrients (Mangle and Kirkby, 1978). N application significantly increased plant height, number of branches, number of leaves, stem and root dry weights and ripe fruit yield (number and weight) (Ayodele *et al*., 2015). Elamin *et al*. (2017) reported that the main fruit quality and fruit yield were strongly affected by fertilizers application of N, P, K and organic manure on "Khenazi" date palm. Ezz *et al*.(2010) concluded that the application of 500g of both nitrogen and potassium fertilization per palm could be suitable for increasing palm yield and improving date quality of "Zaghloul" and "Hallway". Fatima and Dawoud (2016) found that the effects of 1000g total N per palm increased the fruit yield of "Barhi" date palm. El sadig *et al*. (2017) showed that combination (N, P, K) treatments and organic manure significantly affected fruit weight, flesh weight, fruit volume, moisture content and fruit TSS. Dialami and Mohebi (2010) reported that application of proper amounts of nitrogen, phosphorus and potassium caused the best yield and fruit quality of "Sayer" date palm in Khuzestan province. Application of N fertilizer to mango tree markedly increased the number of fruit tree-1, pulp content as well as fruit quality (Satapathy

and Banik, 2002).Urea and sulfur singular or combined affects the number of leaves in lime and orange. Also increased branches number in the orange trees, while the combination of urea and sulfur (N/S) increased the number of branches (compared to urea (N) and sulfur (S) treatment) in lime (Husseen, 2007). Idris *etal*. (2016) observed that fertilizer dose (30kg organic + 0.50kg N_{15} P_{15} K_{15} %) per palm increased greatly the fruit weight over the control of 'Barakawi' date palm. Abou Sayed-Ahmed *etal*. (2005) studied the influence of N,P, and K fertilize application on yield of "Amry" date palm grown in sandy soil and found that 0.40 kg N/tree was the best application to increase the yield.

Therefore, the aim of this study was to investigate the effect of urea soil application at different levels on growth attributes, yield and fruit physical characteristics of Barakawi date palm cultivar grown under Al-Bakheet condition, Sudan.

Materials and methods:

The study was accomplished during seasons 2013 and 2014 at Al-Bakheet village, Karima locality, Northern State, Sudan. The aim of this study was to investigate the effect of urea on growth attributes, yield and fruit physical traits of 'Barakawi' date palm cultivar (*Phoenix dactylifera* L.). The palms were about 30 years old and the selected trees were of uniform growth and size. Urea treatments were: 0 (control), 50, 100, and 150 g/palm) applied in the first season only by direct application to soil, 50 cm away from the trunk, and irrigation followed immediately by direct water pumping from the Nile. The randomized complete block design was used with 4 replicates. Physical and chemical analyses of soil are shown in Table (5). Data were collected at harvest time in September, season 2013 and the extended effects of the treatments were also determined in the succeeding season i.e. September 2014. The parameters studied were: Number of leaves/palm; number of leaflets/leaf; length of leaf (cm); length of leaflet (cm); length of strand (cm); number of fruits/strand; fruit length (cm); fruit width (cm); pulp thickness (mm); fruit weight (g); seed length (cm); seed weight (g); number of bunches/palm; bunch weight (kg); yield/palm (kg). The data collected for the different parameters were subjected to analysis of variance and means were separated by Duncan's multiple range test (DMRT) at P =0.05 with the aid of Mstat-C computer program.

Results:

Vegetative growth attributes:

Table (1) illustrates the results of urea applications on vegetative growth attributes of Barakawi date palm in two successive seasons. In both seasons, all urea treatments increased the number of leaves per palm significantly compared to the control. Urea treatments performed alike and shared the top rank. The leaf length increased in both seasons with the increase of urea dose. In both seasons the 100 g urea dose ranked second with significant difference from the control. The lowest urea dose did not differ statistically from the control despite the increase of value over the control. The number of leaflets per leaf increased significantly over the control by all urea treatments at an equal statistical level in the first season, while they equaled the control statistically in the second season. However, in both seasons the length of leaflets was not affected by urea applications.

Table (1) Impact of urea applications on vegetative growth attributes of 'Barakawi' date palm cultivar at Al-Bakheet site, Sudan, season 2013 and 2014.

Urea (g/palm)	Number of leaves/ palm		Leaf length (cm)		Number of leaflets/leaf		Leaflet length (cm)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
0	48.0 b	81.0 b	291 c	293 c	171.0 b	187 a	41.8 a	42.3 a
50	71.0 a	97.2 a	302 bc	308 bc	185.8 a	194 a	44.8 a	48.0 a
100	71.2 a	94.7 a	325 b	328 b	187.0 a	195 a	45.0 a	46.0 a
150	74.0 a	98.0 a	350 a	354 a	183.3 a	190 a	45.3 a	48.3 a
C.V %	11.74	5.18	4.64	4.97	5.52	5.08	8.93	11.71

* Means with the same letter (s) in the same column are not significantly different according to DMRT p= 0.05.

Yield components:

As shown in Table (2), all urea treatments equally increased the number of bunches per palm with significant difference from the control in the first season. In season 2, only the 100 and 150g urea treatments were the best bunch producers with significant increase compared to the control. The difference between the 50g urea treatment and the control was not significant. The length of fruiting strand was increased significantly by urea treatments in the first season compared to the control and the best length was recorded for the 50g treatment. In the second season, the best length was obtained from the 100g treatment with significant difference from the only control. The other treatments ranked intermediate. Regarding the impact on the number of fruits per strand, the values of this parameter increased with increase of urea dose. All urea treatments increased bunch weight significantly over the control but without significant difference among them in the first season. In the second season, only the 100g and 150g urea treatments, that shared the top rank, were best enhancers of bunch weight.

Table (2) Impact of urea applications on yield components of 'Barakawi' date palm cultivar at Al-Bakheet site, season 2013 and 2014.

Urea (g/palm)	Number of bunches/palm		Length of strand (cm)		Number of fruits/ strand		Bunch weight (kg)	
	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
0	3.00 b	2.75 b	31.0 c	25.7 b	14.5 c	16.5 b	2.73 b	2.50 b
50	7.75a	3.50 ab	40.7 a	28.2 ab	16.5 bc	18.0 ab	3.89 a	2.64 b
100	8.25 a	4.25 a	38.7 ab	35.2 a	18.7ab	19.2 a	4.01 a	4.88 a
150	8.00 a	4.00 a	37.0 b	32.5 ab	21.5 a	20.5 a	4.13 a	4.62 a
C.V %	12.10	17.81	5.77	15.80	14.26	8.34	6.84	17.68

* Means with the same letter (s) in the same column are not significantly different according to DMRT p= 0.05.

Yield:

Substantial increase in yield was equally recorded for all urea treatments compared to the control in the first season. In the second season, the highest values were recorded for both 100g and 150g urea treatments that ranked top, while significant yield increase was also reported for the 50g treatment compared to the control (Figure 1).

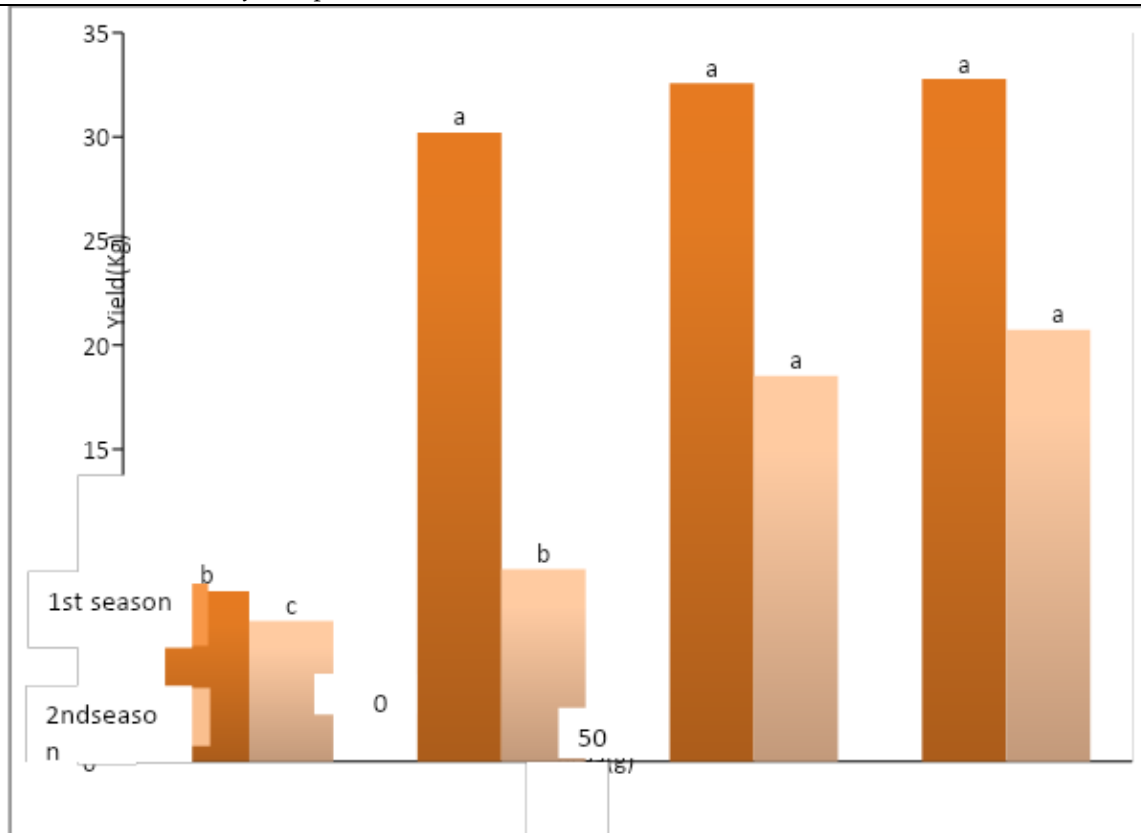

Figure 1: Impact of urea applications on yield/palm of 'Barakawi' date palm cultivar at Al-Bakheet site, season 2013 and 2014.

Fruit physical characteristics:

Table (3) illustrates the impact of urea applications on fruit characteristics. Fruit length increased significantly by all urea treatments compared to the control in the first season; the best increase resulted from the 50g and 100 g treatments. In the second season all urea treatments equaled the control statistically. Significant increase in fruit width over the control in the first season was only achieved from the 50g urea treatment, while the other urea treatments ranked intermediate. In the second season, the 50g urea treatment increased fruit width significantly over the control and the 150g treatment. The pulp thickness was increased significantly by urea treatments without significant differences between them in the first season. In the second season only the 100g urea treatment was the best enhancer of this character compared to the control. The heaviest fruits resulted from the 50g and 100g treatments in the first season, while no significant differences were obtained from urea treatments compared to the control.

Table (3) Impact of urea applications on fruit physical characteristics of 'Barakawi' date palm cultivar at Al-Bakheet site, season 2013 and 2014.

Urea (g/palm)	Fruit length (cm) 1st Season	2nd Season	Fruit width (cm) 1st Season	2nd Season	Pulp thickness (mm) 1st Season	2nd Season	Fruit weight (cm) 1st Season	2nd Season
0	3.765 c	4.270a	1.465 b	1.655 b	0.125b	0.320 b	5.568b	6.188a
50	4.390 a	4.870a	1.575 a	1.800 a	0.175a	0.365ab	7.536a	7.878a
100	4.285 a	4.655a	1.565ab	1.770ab	0.185a	0.395 a	7.320a	6.983a

150	4.065 b	4.460a	1.495ab	1.640 b	0.180a	0.310 b	6.705ab	6.073 a
C.V %	4.71	9.45	4.36	4.65	12.80	12.10	11.58	17.18

* Means with the same letter (s) in the same column are not significantly different according to DMRT

Seed physical characteristics:

As depicted in Table (4), all urea treatments increased seed length significantly over the control in the first season. The longest seeds resulted from the 50g and 100lg urea treatments. In the second season, only the 50 g urea treatments resulted in significant increase for seed length compared to the control. As for seed weight, urea treatments increased this parameter significantly compared with the control in the first season; the 50g and 10g treatments shared the top rank. The seed weight was also influenced by urea applications in the second season. The best seed weight was recorded for the 5g treatment, but without significant difference from the 1000g treatment. However, the 150g urea treatment did not differ statistically from the control.

Table (4) Impact of urea applications on seed physical characteristics of 'Barakawi' date palm cultivar at Al-Bakheet site, season 2013 and 2014.

Urea (g/palm)	Seed length (cm) 1st Season 2nd Season		Seed weight (g) 1st Season	2nd Season
0	2.220 c	2.605 b	0.7385 c	0.7845 c
50	2.575 a	2.935 a	0.8662 ab	0.9578 a
100	2.570 a	2.665 b	0.9320 a	0.8915 ab
150	2.420 b	2.685 b	0.8375 b	0.8235 bc
C.V %	1.74	4.73	5.47	5.93

* Means with the same letter (s) in the same column are not significantly different according to DMRT

Discussion:

Vegetative growth attributes:

Application of nitrogen in the form of urea (46% N) as shown in Table (1) caused significant increase in number of leaves, length, and number of leaflets. Using chemical fertilization can improve plant ability to uptake mineral nutrients. Improving plant uptake reflects on increasing vegetative growth and consequently improves efficiency of absorption and utilization of nutrients (Mangle and Kirkby-, 1978). These results are in agreement with those obtained by Idris *etal.*2012) on "Barakawi" date palm, Husseen (2007) on lime and orange, and Sharma (2016) on apple. Also in line with Abou Sayed-Ahmed *etal.* (2005) on "Amry" date palms. This effect of low doses of nitrogen may be due to synergistic effect of nitrogen with other elements in the soil to enhance these attributes.

Yield and Yield components:

The application of nitrogen in the form of urea (46% N), shown in figure (1) and table (2), caused significant increase in yield. The increment in yield by application of urea was due to increasing the number of bunches and bunch weight. These results are in agreement with those obtained by Ezz *et al*. (2010) who found that application of 500g nitrogen and potassium fertilization from each per palm, increased palm yield and improved date quality of "Zaghloul" and "Hallway". Moreover, Elsadig *etal.* (2017) showed that application of different fertilization treatments significantly affected yield components of fruit, number of fruits/strand, fruit number/bunch, fruit set percent and total fruit yield/

palm, on "Khenazi" date palm, Fatima and Dawoud (2016) on "Barhi" date palm, and Dialami and Mohebi (2010) reported that application of proper amounts of nitrogen, phosphorus and potassium caused the best yield.

Fruit and seed physical characteristics:

Fruit length, Fruit width, pulp thickness, fruit weight seed length and seed weight:

Application of nitrogen in the form of urea (46% N) presented in table (3) and (4), caused significant improvement in fruit length, fruit width fruit weight pulp thickness and seed length. These improvements may be due to the efficient uptake and metabolism of N under this soil conditions. The increments in fruit traits by adding N may be due to the fact that nitrogen is the basic protein building unit and protein is the basic cell building unit and involved in many physiological processes (Idris *etal*., 2012). These results are in line with the finding of Kassem (2012) who found that applied nitrogen in different forms alone or in combination with potassium, phosphorus and sulfur increased fruit flesh and fruit pulp weights. Similar results were reported by Dialami and Mohebi (2010) on "Sayer", Elamin *etal*. (2017) on "Kenazy" date palm, and Idris *etal*. (2016) on "Barakawi" date palm.

According to this study, date palm grown in Al-Bakeet site, need 100g urea (46 %N) per palm/year to increase growth, yield components, and enhance fruit physical characteristics under this soil condition compared to the control

Table (5) Physical and chemical analysis of Al-Bakheet soil.

Site	Depth cm	pH	ECe ds/m	Soluble cations (meq/l)			SAR	Soluble anions (meq/l)				Sand %	Silt %	Clay %
				Na	Ca+Mg	K		CO3	HCO3	Cl	SO4			
AL Bakheet	0--30	7.8	1.8	9.9	8	0.5	5	Nil	5.2	7	6.2	76	6	18
AL Bakheet	30-60	8.2	1.5	5.8	7.7	0.1	3	Nil	2.9	3.2	7.5	60	12	28
AL Bakheet	60--90	7.8	1.4	5.8	7.4	0.1	3	Nil	2.7	2.3	8.3	28	20	52

Site	Depth Cm	Exchangeable cations Meq/L			P ppm	N %	ESP	SP %	CEC Meq/100g	CaCO3 %
		Na	Ca+Mg	K						
AL Bakheet	0--- 30	6.16	17.715	0.125	3.9	0.02	26	51	24	2
AL Bakheet	30—60	13.64	12.86	0.5	5.3	0.01	51	54	27	5
AL Bakheet	60---90	11.132	26.618	0.25	2.1	0.03	29	43	38	4

P: Saturation percentage **ESP:** Exchangeable Sodium Percentage **SAR:** Sodium Adsorption Ratio.

References:

[1]. Abou Sayed-Ahmed, T. A., Abdalla, K.M., EL-Makhtoum, F. B. and Aly, M.A (2005) Influence of some fertilization treatments on yield and fruit quality of "Amry" date palms grown in sandy soil. *Zagazig J. Agric.Res*, Vol: **32**. pp: 1475-1499.

[2]. Ayodele, O.J., Alabi, E.O. and Aluko, M. (2015). Nitrogen fertilizer effects on growth, yield and chemical composition of hot pepper (Rodo) *International Journal of Agriculture and Crop Sciences*. Available on line at www.ijagcs.com IJACS/2015/8-5/666-673 ISSN 2227-670X ©2015 IJACS Journal

[3]. Dawoud, D.H. and Ahmed, F.A. (2006). Date palm culture and production technologies in Sudan. Zakat Printing Press, Khartoum. pp.123

[4]. Dialami, H. and Mohebi, A.H. (2010). Increasing yield and fruit quality of date palm "Sayer" with application of nitrogen, phosphorus and potassium optimum levels. Members of scientific staff at date palm and tropical fruits research institute of Iran. nashwan57new@gmail.com.

[5]. Dirar, A.M. (2003). Economics of date's culture in the Northern State, Sudan. *Proceedings of the Regional workshop on Date Palm Problems in Sudan*.29-30 Dec. 2003. pp. 165-171, Khartoum. Sudan.

[6]. Elamin, A. H.B., Elsadig, E.H., Aljubouri, H.J. and Gafar, M.O. (2017). Improving fruit quality and Yield of "Khenazi" date palm (*Phoenix dactilifera L.*) grown in sandy soil by application of nitrogen, phosphorus, potassium and organic manure. *International Journal of Development and Sustainability* ISSN: 2186-8662 – *www.isdsnet.com/ijds* Volume **6** Number **8** (2017): Pages 862-875 ISDS Article ID: IJDS17080601.

[7]. Elsadig, E.H., Aljubouri, H.J., Elamin, A. H.B. and Gafar, M.O. (2017). Impact of organic manure and combination of N P K S, on yield, fruit quality and fruit mineral content of "Khenazi" date palm .*JournalofAgriculture*2017,1:335346.do10.25081/isa.201.v1.**848**. http://updatepubmdex. Phpjaournals /index.phpjsa.

[8]. Ezz, T.M., Kassem, H.A. And Marzouk, H.A. (2010). Response of date palm trees to different nitrogen and potassium application rates, *Acta Hortic*., Vol.**882**,pp.761-768.

[9]. Fatima, A.A. and Dawoud, H.D. (2016). Effect of different nitrogen sources on Barhi date palm growing under heavy alkaline soil. 2nd International Conference for date palm (ICDP 2016) in Qassim, Kingdom of Saudi Arabia, from 10-12 October, pp: 49-60.

[10]. Hodel, D.R., Pittenger, D.R. (2003). Studies on the establishment of date palm (*Phoenix dactylylifera*) off shoots. Part1. Observations on root development and leaf growth. *Palms* 2003, **47**, 201–205.

[11]. Huseen, F.A. (2007). Effect of nitrogen and sulfur fertilizers on growth and leaf oil content of lime (*Citrus aurantifolia*) and Orange (*Citrus sinensis*=). M.Sc. in Horticulture. Sudan University of science and Technology.College of Graduate Studies.

[12]. Idris, H.A. and Elsadig,E.H.(2016).Effects of fertilization and irrigation on yield components of date palm (*phoenix dactylifera* L.) under Northern Sudan condition. *University of Dongola Journal for Scientific Research.* Sixth year issue No: **10**-January 2016.

[13]. Idris, T.I.M., Ibrahim, A.H. and Taha, A.K. (2006). A survey study on growth, yield, pests and diseases of date palms in the Northern State, Sudan. Technical report, Sudan Univ. of Sc. & Technology in collaboration with the Ministry of Agric., (Northern State), *ARC and University of Dongola*. Sep- Nov. 2006. pp85.

[14]. Idris, T.I.M., Khidir, A.A. and Haddad, M.A. (2012). Growth and yield responses of a dry date palm (*Phoenix dactylifera* L.) cultivar to soil and foliar fertilizers, *International Research Journal of Agricultural Science and Soils*, Vol. **2** No. **9**, pp. 390-394.

[15]. Kassem, H.A. (2012). The response of date palm to calcareous soil fertilization. *Journal of soil science and plant Nutrition*, **12** (**1**), 45- 58.

[16]. Li, H. R. G., Lada, R., Asiedu, S., Goodyear, N. (2007). Development of high plant population seeding technology: Double-row direct seeding for Brassica vegetables. Abstract of Atlantic Agricultural Science and Communication Work shop. Truro, NS: **18**.

[17]. Mangle,K and Kirkby,E.A.(1978). *Principle of plant Nutrition*. Int. Potash Ins. Berne, 419-431.

[18]. Mohammed, A.A. (1984). Date palm culture development and date production improvement in the Northern State (Technical Report).

[19]. Mstat-C, 1990.A micro computer program for Design, Management and Analysis of Agronomic Research Experiments, Michigan State University.

[20]. Sady, W., Rozek, S., Domagala-Swiatkiewicz, I., Wojciechowska, R. and Kolton, A. (2008). Effect of nitrogen fertilization on yield, NH_4^+ and NO_3^- content of white cabbage. *Acta Sci*. Pol., Hortorum Cultus, **7**: 41-51.

[21]. Saleh, M. M.S., Abou-Rayya, M. S., Kassim, N.E. (2000). A comparative study on the effect of fast and slow-release nitrogen fertilizers on nutrition .*J. Agric. Sci Mansoura Univ.,* **25**(**4**): 2189-2196.

[22]. Satapathy, S.K., and Banik, B.C. (2002). Studies on nutritional requirement of mango cv. Amrapali.Orissa *J. Horticulture*, **30**(**1**): 59-63.

[23]. Sharma, L.K. (2016), Effect of nutrients sprays on growth, yield and fruit quality of apple under cold desert condition of Himachal Pradesh, *Journal of Applied and Natural Science*, Vol. **8** No. **1**, pp: 297-3.