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EFFECT OF ORGANIC FERTILIZERS TYPES AND LEVELS ON YIELD AND QUALITY OF POTATO TUBERS (Nicola var.) AT HARVEST AND DURING STORAGE

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ABSTRACT: *A field experiment was conducted during successive autumn season (2010 & 2011) at Horticulture Research Station farm at El-Kanater district and Fruit Handling Research Department, Horticulture Research Institute, Agricultural Research Center (ARC), Giza, Egypt, to study the effect of application of two different organic fertilizers (compost) types and levels on yield, yield component and quality of potato tubers (Nicola var.) at harvest and during storage. There were 7 treatments viz. the recommended NPK minerals fertilizer (control), two types of compost the first one is plant-animal residues(a)and the second is plant residues (b) each type was applied at three levels of nitrogen(80, 120 and 160 kg N fed^{-1}) equal used (6, 7), (9, 10.5) and (12, 14) ton fed^{-1} from compost a and b, respectively. At harvest (after 110 days), tubers were transported directly to the laboratory where, cured and stored (at room temperature 32±2^{o}C and 65% RH or at 8°C and 4°C and 90:95 % RH). Physical and chemical studies were done monthly for tubers where stored at room temperature and 45 days for cool temperature. The obtained results indicated that, application of high level of organic fertilizers (160 Kg N fed^{-1}) in both compost types recorded no significant differences as compared to control treatment at yield (tubers ton fed^{-1}) as well as NPK content on tubers. On contrary, Nitrate and Nitrite concentrations in plants received various N-organic fertilizers levels produced in significantly reduce values as compared to treatment received recommended NPK mineral fertilizers(control). These results also, cleared that, potato tubers which stored at low temperature (8 and/or 4°C) had a long storage period and less weight loss during the two seasons as compared to treatments stored at room temperature (32±2^{o}C). Also application of organic fertilizers led to increasing dry matter percentage, specific gravity (g/cm^{3}) and TSS% in tubers. Moreover, storage potato tubers at 8 and/or 4°C led to increase its shelf life. In generally, application of different two types of organic fertilizers (compost a & b) led to obtain tubers had higher quality, storability and gave healthy product.*

Key words: *Potato tubers- fertilizers-compost types- storage-mineral fertilizers- tubers quality*

INTRODUCTION

Potato (*Solanum tuberosum L.*) is one of the majority important vegetable crops of the world. It is considered one of the fourth important energy crops of the world, it has a great potential to provide nutritious food in diversity of environments for increasing hungry world and ranks after Wheat, Rice and Maize for human consumption (Ewing, 1997). Potato is Egypt's largest horticulture export; it plays an important role in the economy of the country as a food as well as a cash crop. It is a major source of inexpensive energy; it contains high levels of carbohydrate, significant amount of vitamins B, C and minerals. Moreover, potato is use in many industries such as French fries, chips, starch and alcohol production (El-Saiid, 2011). Among the materials used in agriculture, fertilizers one the most widely used. Based on the production process, it can be roughly categorized into three types, chemical, organic and biofertilizers, each type of fertilizer has advantages and disadvantages, these advantages need to be integrated in order to achieve optimum performance by each fertilizer type and realize balanced nutrients management of

crop production (Chen, 2008). Organic fertilizers (compost) become the alternative solution for reducing the chemical fertilizers, keeping on higher plant uptake minerals and saving environment. In the other side, compost amendments maintain and enhance the fertility and productivity of agricultural soil, allowing a sustainable land use (Piqueres *et al.,* 2006). Little information is available concerning the efficiency of organic fertilizers on growth, yield, yield components, quality, storability and chemical analysis on potato crop under Egyptian soils conduction. Therefore, the target of this study is to investigate the effect of various types and different levels of N-organic fertilizers (compost) on the yield, yield components, quality and storability of potato tubers.

MATERIALS AND METHODS

A field experiment at two consecutive seasons (2010 and 2011) at the Experimental Research of Fruit Handling Research Department, Horticulture Research Institute, ARC. to study the effect of application of organic fertilizers (compost) on yield, yield components, quality and storability of potato tubers. The seed tubers (*Nicola va*r.) were cultivated during autumn season of 2010 and 2011 at the Farm of the El-Kanater El-Khairia Station Research. The potato tuber seeds were cured and planted at 0.25m apart in rows 3.5m in long and 0.75m in width. The plot area was about 10.5m^2 consisting of 4 rows. Some mechanical, physical and chemical analyses of soil (clay loam in texture) used are shown in Table (1), according to Jackson, 1973. Two types of compost i-e, plant animal residues (a) and plant residues (b), were used at three levels of nitrogen application as follows, 1) 80 kg N fed^{-1}, 2) 120 kg N fed^{-1} and 160 kg N fed^{-1}, equal (6, 7), (9, 10.5) and (12, 14) ton fed^{-1} for compost a and b respectively. Table (2) show some physical and chemical characteristic of the two compost types.

Table (1): The mechanical, physical and chemical analyses of the studied soil.

analysis	value
Mechanical analyses :	
Lime sand%	27.75
Silt %	31.83
Clay %	28.31
Texture	Clay loam
Chemical analysis:	
pH	7.43
E.C. dsm^{-1}	2.9
O.C. %	0.75
O. M %	1.31
Total N %	0.19
WHC %	51.33
Anions and Cat ions (mg/L^{-1})	
HCO_3^-	7.5
Cl^-	12.73
SO_4^{--}	18.43
Ca^{++}	10.51
Mg^{++}	3.11
Na^+	25.81

Table (2): Physical and chemical analyses for the two types of compost.

Character	Compost (a) (Animal-Plant Residues)	Compost (b) (Plant Residues)
Bulk density "kg m^{3}"	725	618
Moisture %	29	27
pH	7.91	7.55
E.C. dsm^{-1}	3.84	2.14
Total N %	1.35	1.13
Total C %	20.05	18.39
O. M %	34.93	31.99
P %	0.71	0.67
K %	0.93	0.87
Ash %	71	73
C / N ratio	1:18	1 :19
Nematode (worm)	Nil	Nil
Total E. coli	Nil	Nil
Weed seed	Nil	Nil

NPK mineral fertilizers were used at the recommended doses (160, 96 and 50 kg fed^{-1} of N, P and K, respectively). Seven treatments were applied as follows :1- Control treatment where potato plants received 100% of recommended NPK mineral fertilizers; 2– Potato plants received 80 kg N fed^{-1}(6 or 7 ton fed^{-1} from compost a or b); 3- Potato plants received 120 kg N fed^{-1} (9 or10.5 ton fed^{-1} from compost a or b) and 4-Potato plants received 160 kg N fed^{-1} (12 or 14 ton fed^{-1} from compost a or b).

All treatments were replicate three times with using Randomized Complete Block Design (RCBD) system. At harvest, (after approximately 110 days from planting) plants that produced from the three inner ridges of each plot were harvested to determine tubers yield ton fed^{-1}.

Laboratory studies:-

A representative sample of 10 healthy tubers from each plot was selected to obtain yield component which marketable potato tubers had been given a 10 day curing period after harvest, heaped under a thick layer of rice straw for healing wounds and bruises date: 1) tubers yield ton fed^{-1}, 2) tubers NPK and concentrations (%) and 3) tubers Nitrite and Nitrate concentrations (ppm), where determined as described by A.O.A.C. (2003).

Storage studies:-

Tubers were storage at three degrees as follows: 1) storage tubers at room temperature (32±2ºC) for three months and RH 65%. , 2) storage tubers at 4 ºC and RH 90:95 % and 3) storage tubers at 8 ºC and RH 90: 95 %, up to 135 days . Data of weight loss (%); dry weight (%); specific gravity (g/cm^{3}) and total soluble solids(TSS%) were estimated monthly at room temperature and 45 days at 4 and 8ºC during storage period where determined according to A.O.A.C. (2003).

The obtained results were subjected to analysis of variance according to Snedecor and Cochran (1989), and the significant differences among the variance treatments were comparing using L.S.D. values at 5%.

RESULTES AND DISCUSSION

1-Yield and yield components.

1-1- Yield:

Concerning the effect of application of the two compost types (a&b) at different levels on yield of potato tubers. The results in Table (3) clearly showed that plants received recommended NPK mineral fertilizers doses recorded the higher tubers yield (15.7 and 16. ton fed^{-1}) for the first season and the second season, respectively. No significant difference was found as compared to treatments which received higher amount (120 and 160 kg N^{-} fed^{-1} of the two compost types a&b), moreover, treatment received 160 kg N fed^{-1} of compost (a) gave the highest tubers yield (17.6 ton fed^{-1}) at the second season. However, no significant differences were found between the two compost types (a & b) used, but among levels of compost a or b, treatments received 120 and 160 kg N^{-} fed^{-1} recorded significant differences as compared to treatment which received 80 kg N^{-} fed^{-1} at the two seasons. These results are in line with those obtained by Barzegar *et al.*,2002; Boliglowa and Glen, 2003; Carter *et al.*, 2004 and Cerný *et al.*, 2010, they demonstrated that, organic fertilization increased potato tubers yield. They added also that, organic fertilization increased potato tuber contents of N, P and K at harvest. Moreover, these results are in agreement with those mentioned by Boliglowa and Dzienia, 1996 and Grzeskiewiez and Trawezynski, 1997, they illustrated that, organic fertilizers into soil increased the quality of potato tubers. On the other side, these results confirmed with those obtained by Alam *et al.*, 2007 who mentioned that, the vegetative growth and yield of potato increased gradually and significantly with increasing the used of vermicompost levels(2.5, 5, 10 t/ha) to reach the highest yield at 10 t/ha.

Table (3): Effect of different levels and types of organic fertilizer on yield, N, P, K, NO_3 and NO_2 in potato tubers at harvest in the two growing seasons (2010 & 2011).

Parameter	Yield Ton/fed		N %		P %		K %		Nitrate ppm		Nitrite ppm	
Types / Levels	First season											
	a	b	a	b	a	b	a	b	a	b	a	b
control	15.7	15.7	2.6	2.6	0.44	0.44	3.90	3.90	289.5	289.5	99.0	99.0
80Kg N fed^{-1}	11.0	9.5	2.3	2.1	0.36	0.34	3.58	3.40	127.2	121.6	0.39	0.35
120Kg N fed^{-1}	14.0	12.4	2.6	2.3	0.41	0.39	3.75	3.68	130.4	125.5	0.42	0.38
160Kg N fed^{-1}	15.3	14.6	2.6	2.5	0.44	0.41	3.84	3.79	148.2	138.3	0.44	0.41
Mean	14.0	13.05	2.5	2.4	0.41	0.40	3.77	3.69	173.8	168.7	25.1	25.0
L.S.D at 0.05												
A(compost type)	n. s		n. s		n. s		n. s		n. s		n. s	
B(compost level)	2.27		0.34		0.033		0.23		8.61		4.44	
C (A * B)	n. s		0.38		n. s		n. s		n. s		n. s	
Second season												
control	16.0	16.0	3.1	3.1	0.47	0.47	4.05	4.05	294.8	294.8	95.3	95.3
80 Kg N fed^{-1}	12.5	9.7	2.34	2.1	0.39	0.36	3.65	3.56	129.9	124.6	0.38	0.36
120Kg N fed^{-1}	15.4	13.4	2.72	2.45	0.44	0.41	3.86	3.77	135.5	131.2	0.42	0.39
160Kg N fed^{-1}	17.6	15.5	3.13	2.71	0.47	0.44	3.99	3.85	153.5	142.1	0.44	0.41
Mean	15.4	13.7	2.81	2.58	0.44	0.42	3.89	3.80	178.4	173.1	24.12	24.10
L.S.D at 0.05												
A(compost type)	n. s		n. s		n. s		n. s		n. s		n. s	
B(compost level)	2.27		0.38		0.039		0.22		8.61		2.39	
C (A * B)	n. s		n. s		n. s		n. s		n. s		n. s	

a= Compost (plant animal residues)
b= Compost (plant residues)

1-2- Potato tubers N%, P% and K% concentration:

Data present in Table (3) illustrated that application of mineral NPK fertilizers gave the highest N% of potato tubers among all test treatments at the two seasons and no significant differences were found as compared to treatments which received various types compost used. The significant differences were found among various levels of the two compost types application to potato tubers. The highest tubers N% content was recorded (3.13%) at treatment received compost (a) at level 160 kg N^{-} fed^{-1} in the second season. Regarding the two different compost (a&b) used and recommended NPK mineral fertilizers treatment data obtained (Table 3), revealed that potato tubers content of phosphor (P%) and potassium (K%) had no significant differences among all tested treatments at the two seasons. As seen in Table (3), significantly differences were found at various levels of two compost types (a&b) at two seasons. Generally, by increasing compost levels P and K concentration (%) increase at two seasons. These data are in agreement with Biomy (2012) who reported that in respective of organic or mineral fertilization, phosphor and potasium content significantly increased in potato tubers.

1-3- Potato tubers Nitrite and Nitrate concentrations (ppm):

Higher values of NO_2 and NO_3 were recorded (99; 289.4 and 95.3; 294.8 ppm for the first season and the second season, respectively by application of recommended NPK mineral fertilizers (Table 3). The two compost types (a or b) and various its levels led to a reduction in both No_2^- and No_3^- concentrations and scored significant difference as compared to NPK mineral fertilizers. On the other hand, no significant differences were found at No_3^- concentration among all tested treatments, which received compost (a) or (b) with different levels at both seasons. But in case of No_2^- there is no significant difference found between compost (a) and (b). In contract levels of compost (a) and (b) showed significant differences in No_2^- concentration. In this respect, Martin,1995 pointed out that nitrogen fertilization increased nitrogen, nitrate and nitrite contents in potato tubers. In this connection, Kolbe *et al.*,1995 and Calskan *et al.,* 2004 found that application of organic fertilization augmented dry matter and contained about 50% lower nitrate and nitrite contents compared with mineral fertilizers. Moreover, Helaly *et al.*, 2009 and Zelalem *et al.*, 2009 found that nitrate and nitrite concentrations were decreased significantly with decreasing mineral N fertilizer doses.

2- Storability Studies:

2-1- Weight Loss Percentage:

Data shown in Tables (4 & 5) clearly indicated that, weight loss percentage of potato tubers increased gradually and significantly with prolonging of storage period stored either at room temperature or at cooling conditions during the two seasons of this study. Moreover, data also showed that, tubers stored at 4°C significantly had less weight loss than those associated with those stored at 8°C during the two seasons of this study. Also from the same data we can conclude that, tubers produced from plants received plant compost had significantly weight loss higher than those produced from that received plant animal compost either stored at cooling or at room temperature during the second season in this study, while this trend was clear only in the case of tubers stored at cooling temperature during the first season but there was no significant effect related to organic fertilizers (compost) types in tubers stored at room temperature. On the other hand, these data also illustrated that, tubers produced from plants received organic fertilizer, regardless the used doses, had significantly less weight loss than those produced from that received mineral fertilizers and stored either at room temperature or at cooling during the two seasons of this study. Moreover, weight loss percentage of potato tubers increased gradually and significantly with increasing the used organic fertilizer

doses under storage at room temperature or at cooling during the two seasons in this study. Data also indicted that, there was a significant interactions among all studied factors in this investigation. These results are in line with those obtained by Ashiv and Singh, 2002 who found that, weight losses in potato tubers were increased from 7.5 to 13.7 percent and 11.0 to 21.0 percent, respectively between 90 and 120 days of storage. On the other hand, these results are in line with those found by Granstedt and Kjellenberg, 1997; Boligłowa and Glen, 2003 and Nowacki, 2007, they demonstrated that, the organic treatments resulted in a greater ability to tolerate stressful conditions and long term storage in comparison with the inorganic treatments. In addition, these results are in harmony with those mentioned by Chourasia and Goswami, 2001; Blenkinsop *et al.*, 2002 and Davids *et al.*, 2004. They demonstrated that, storage temperatures above 21°C increase respiration, weight loss, and prevent the accumulation of reducing sugars but cause spoilage. On contrast, storage temperatures below 5°C inhibit respiration, weight loss, but continued hydrolysis of starch leads to the accumulation of reducing sugars.

Table (4): Effect of different levels and types of organic fertilizer on weight loss (%) in potato tubers during storage at room temperature (32±2oc) in tow seasons (2010 & 2011).

parameters	Storage period (days)										
	0		30		60		90		Means		
Types / Levels	First season										
	a	b	a	b	a	b	a	b	a	b	Mean
control	0.0	0.0	10.15	10.15	12.60	12.60	16.30	16.30	9.76	9.76	9.76
80 KgN fed^{-1}	0.0	0.0	8.45	7.38	11.50	10.15	14.00	13.80	8.49	7.83	8.16
120Kg N fed^{-1}	0.0	0.0	8.03	8.80	10.88	11.68	13.86	14.43	8.19	8.73	8.46
160Kg N fed^{-1}	0.0	0.0	7.48	9.70	10.88	11.88	14.03	14.20	8.10	8.49	8.52
Mean	0.0	0.0	8.53	9.01	11.46	11.58	14.55	14.68	8.63	8.82	8.73
Mean	0.0		8.53		11.52		14.61		8.73		
L.S.D. at 5%	A = 0.33 B = 0.47 C = 0.47 AB = 0.67 AC = 0.67 BC = 0.94 ABC = 1.34										
Second season											
control	0.0	0.0	11.43	11.43	13.85	13.85	15.90	15.90	10.13	10.13	10.13
80 Kg N fed^{-1}	0.0	0.0	11.43	11.43	13.30	12.90	15.13	14.55	9.97	9.60	9.78
120 Kg N fed^{-1}	0.0	0.0	11.43	11.43	13.93	13.50	16.10	15.55	10.50	10.15	10.33
160 Kg N fed^{-1}	0.0	0.0	11.43	11.43	14.63	14.53	16.73	15.95	11.05	10.69	10.87
Mean	0.0	0.0	11.43	11.43	13.93	13.65	15.96	15.49	10.41	10.14	10.28
Mean	0.0		11.43		13.79		15.73		10.28		
L.S.D. at 5%	A = 0.19 B = 0.27 C = 0.27 AB = 0.38 AC = 0.38 BC = 0.53 ABC = 0.75										

A = compost type a= Compost (plant animal residues) b= Compost (plant residues)
B = compost level C=storage period

Table (5): Effect of different levels and types of organic fertilizer on weight loss (%) in potato tubers during storage at cool temperature (4 & 8 °C) in two seasons (2010 & 2011).

Parameters		Storage period (days)											
		0		45		90		135		Mean			
Types / Levels		First season											
		a	b	a	b	a	b	a	b	a	b	Mean	Mean
control	4ºC	0.0	0.0	6.50	6.50	6.90	6.90	8.50	8.50	5.48	5.48	5.48	6.63
	8 ºC	0.0	0.0	8.10	8.10	10.78	10.78	12.22	12.22	7.77	7.77	7.77	
80 Kg N fed^{-1}	4 ºC	0.0	0.0	6.25	6.40	7.38	7.75	8.25	8.45	5.47	5.65	5.56	6.22
	8 ºC	0.0	0.0	6.70	7.70	9.50	8.48	10.85	11.75	6.76	6.98	6.87	
120 Kg N fed^{-1}	4 ºC	0.0	0.0	6.10	6.60	7.65	8.00	8.56	9.28	5.58	5.97	5.77	6.43
	8 ºC	0.0	0.0	7.10	7.95	8.56	9.85	11.83	11.45	6.87	7.31	7.09	
160 Kg N fed^{-1}	4 ºC	0.0	0.0	6.13	7.75	7.45	9.10	9.10	10.08	5.67	6.73	6.20	6.44
	8 ºC	0.0	0.0	6.20	7.60	8.35	9.43	10.80	11.0	6.34	7.01	6.67	
Mean	4 ºC	0.0	0.0	6.25	6.81	7.34	7.94	8.60	9.08	5.55	5.96	5.75	6.43
	8 ºC	0.0	0.0	7.03	7.84	9.30	9.63	11.42	11.61	6.94	7.27	7.11	
Mean		0.0		6.98		8.55		10.18		6.43			
L.S.D. at 5%		A=0.21 B=0.21 C=0.29 D=0.29 AB=0.29 AC=0.41 AD=0.41 BC=0.41 BD=0.41 CD=0.58 ABC=0.58 ABD=0.58 ACD=0.28 BCD=0.82 ABCD=1.16.											
Second season													
control	4ºC	0.0	0.0	5.20	5.20	6.65	6.65	9.23	9.23	5.27	5.27	5.27	7.25
	8 ºC	0.0	0.0	9.95	9.95	12.90	12.90	14.10	14.10	9.24	9.24	9.24	
80 Kg N fed^{-1}	4 ºC	0.0	0.0	3.93	4.20	4.95	5.25	5.90	6.70	3.69	4.04	3.86	5.90
	8 ºC	0.0	0.0	6.95	7.20	11.30	10.60	13.38	14.00	7.91	7.95	7.93	
120 Kg N fed^{-1}	4 ºC	0.0	0.0	4.05	4.48	5.00	5.65	6.35	7.90	3.85	4.51	4.18	6.54
	8 ºC	0.0	0.0	8.13	8.43	12.30	12.88	14.48	15.03	8.73	9.08	8.91	
160 Kg N fed^{-1}	4 ºC	0.0	0.0	4.38	4.60	5.80	6.20	7.43	8.30	4.40	4.77	4.59	7.15
	8 ºC	0.0	0.0	9.25	9.58	12.83	13.45	15.95	16.63	9.51	9.91	9.71	
Mean	4 ºC	0.0	0.0	4.39	4.62	5.60	5.94	7.23	8.03	4.30	4.65	4.48	6.71
	8 ºC	0.0	0.0	8.57	8.79	12.33	12.46	14.48	14.94	8.85	9.05	8.95	
Mean		0.0		6.59		9.08		11.17		6.71			
L.S.D at 5%		A=0.09 B=0.09 C=0.13 D=0.13 AB=0.13 AC=0.18 AD=0.18 BC=0.18 BD=0.20 CD=0.26 ABC=0.26 ABD=0.26 ACD=0.36 BCD=0.36 ABCD=0.51.											

A = compost type a= Compost (plant animal residues)
B = compost level b= Compost (plant residues)
C = storage period
D = Degree of temperature

2-2- Dry Matter Percentage:

Data presented in Tables (6&7) clearly indicated that, dry matter percentage of potatoes tubers increased gradually and significantly with prolonging of storage period either storing at room temperature or at cooling during the two seasons of this study. Moreover, data also cleared that, tubers stored at 4°C significantly had less dry matter% than those associated with those stored at 8°C during the two seasons

of this study. Also from the same data, it is obvious that, tubers produced from plants received plant animal compost had significantly dry matter higher than those produced from that received plant compost stored either at cooling or at room temperature during the two seasons of this work. On the other side, these data also demonstrated that, tubers produced from plants received organic fertilizer, regardless the used doses, significantly had less dry matter% than those produced from that received mineral fertilizers stored either at room temperature or at cooling during the two seasons of this study. Moreover, weight loss percentage of potatoes tubers increased gradually and significantly with increasing the used organic fertilizer doses under storing either at room temperature or at cooling during the two seasons in this study. However, it is clear that, in most cases, these effects return to the effect of these preharvest treatments conditions.

Data also indicted that, there were a significant interactions among all studied factors during this study. These results are agreed with those found by Graña *et al.*, 2012, they obtained that, dry matter increased considerably towards the end of the storage period. On the other hand, these results agree with those found by Rivero *et al.*, 2003 who found that, the moisture of potato tubers remained constant for the first 6 weeks; afterwards; a significant decrease was observed.

Table (6): Effect of different levels and types of organic fertilizer on dry matter (%) in potato tubers during storage at room temperature (32±2 °C) in two seasons (2010 & 2011).

parameters	Storage period (days)										
	0		30		60		90		Means		
Types / Levels	First season										
	a	b	a	b	a	b	a	b	a	b	Mean
control	20.28	20.28	24.18	24.18	26.38	26.38	26.00	26.00	24.21	24.21	24.21
80 Kg N fed^{-1}	18.32	18.05	23.35	22.40	26.00	24.40	25.65	24.40	23.33	22.31	22.82
120 Kg N fed^{-1}	18.97	18.65	24.50	22.88	26.80	25.25	26.47	24.97	24.19	22.94	23.57
160 Kg N fed^{-1}	19.84	19.80	25.43	24.50	27.33	25.55	26.57	25.56	24.79	23.85	24.32
Mean	19.35	19.20	24.36	23.49	26.63	25.39	26.17	25.23	24.13	23.33	23.73
Mean	19.28		23.93		26.01		25.70		23.73		
L.S.D. at 5%	A = 0.37 B = 0.52 C = 0.52 AB = 0.74 AC = 0.74 BC = 1.01 ABC = 1.48										
Second season											
control	22.37	22.37	25.20	25.20	25.17	25.17	24.89	24.89	24.41	24.41	24.41
80 Kg N fed^{-1}	20.58	20.08	23.47	22.46	23.97	23.52	23.63	22.88	22.91	22.24	2258
120 Kg N fed^{-1}	21.66	20.97	25.10	23.98	26.18	25.83	25.12	24.12	24.52	23.73	24.13
160 Kg N fed^{-1}	23..19	22.49	24.98	25.45	26.69	26.18	26.25	25.13	25.28	24.81	25.05
Mean	21.95	21.48	24.69	24.27	25.50	25.17	24.97	24.25	24.28	23.80	24.04
Mean	21.72		24.48		25.34		24.61		24.04		
L.S.D. at 5%	A = 0.38 B = 0.53 C =0.53 AB = 0.76 AC = 0.76 BC = 1.07 ABC = 1.51										

A = compost type a= Compost (plant animal residues)
B = compost level b= Compost (plant residues)
C=storage period

Table (7): Effect of different levels and types of organic fertilizer on dry matter (%) in potato tubers during storage at cool temperature (4 & 8 °C) in two seasons (2010 & 2011).

Parameters		Storage period (days)											
		0		45		90		135		Means			
Types / Levels		First season											
		a	b	a	b	a	b	a	b	a	b	Mean	Mean
control	4ºC	20.28	20.28	21.29	21.29	23.94	23.94	25.08	25.08	22.65	22.65	22.65	23.62
	8 ºC	20.28	20.28	24.41	24.41	25.84	25.84	27.81	27.81	24.58	24.58	24.58	
80 Kg N fed^{-1}	4 ºC	18.32	18.05	19.15	18.30	22.21	19.63	24.30	21.63	21.00	19.40	20.20	20.70
	8 ºC	18.32	18.05	20.84	20.35	22.20	21.53	24.51	23.82	21.47	20.94	21.20	
120Kg N fed^{-1}	4 ºC	18.97	18.65	21.65	21.02	23.05	21.80	25.20	24.04	22.22	21.38	21.80	22.10
	8 ºC	18.97	18.65	23.05	20.83	23.47	22.92	26.27	25.13	22.94	21.88	22.41	
160 Kg N fed^{-1}	4 ºC	19.84	19.80	21.58	20.47	23.60	23.08	25.78	25.37	22.70	22.18	22.44	22.83
	8 ºC	19.84	19.80	23.40	22.23	24.40	23.80	26.22	26.09	23.46	22.98	23.22	
Mean	4 ºC	19.35	19.20	20.92	20.27	23.20	22.11	25.09	24.03	22.14	21.40	21.77	22.31
	8 ºC	19.35	19.20	22.92	21.96	23.98	23.52	26.20	25.71	23.11	22.59	22.85	
Mean		19.28		21.52		23.20		25.26		22.31			
L.S.D. at 5%		A=0.23 B=0.23 C=0.32 D=0.32 AB=0.32 AC=0.46 AD=0.46 BC=0.46 BD=0.46 CD=0.46 ABC=0.64 ABD=0.44 ACD=0.91 BCD=0.91 ABCD=1.29											
Second season													
control	4ºC	22.37	22.37	22.06	22.06	22.06	22.06	24.12	24.12	22.65	22.65	22.65	23.31
	8 ºC	22.37	22.37	24.31	24.31	24.31	24.31	24.85	24.85	23.96	23.96	23.96	
80 Kg N fed^{-1}	4 ºC	20.58	20.08	22.68	21.44	22.68	21.44	23.87	23.14	22.45	21.53	21.99	22.17
	8 ºC	20.58	20.08	22.97	22.33	22.97	22.33	24.19	23.31	22.68	22.01	22.34	
120Kg N fed^{-1}	4 ºC	21.66	20.97	23.45	22.53	23.45	22.53	24.46	23.75	23.26	22.45	22.86	23.03
	8 ºC	21.66	20.97	23.52	22.94	23.52	22.94	25.41	24.60	23.53	22.86	23.20	
160Kg N fed^{-1}	4 ºC	23.19	22.49	23.82	23.26	23.82	23.26	25.22	24.75	24.01	23.44	23.73	24.30
	8 ºC	23.19	22.49	25.77	24.86	25.77	24.86	26.50	25.44	25.31	24.41	24.86	
Mean	4 ºC	21.95	21.48	23.00	22.32	23.00	22.32	24.42	23.94	23.09	22.52	22.81	23.20
	8 ºC	21.95	21.48	24.14	23.61	24.14	23.61	25.24	24.55	23.87	23.31	23.59	
Mean		21.72		23.27		23.27		24.54		23.20			
L.S.D at 5%		A=0.20 B=0.20 C=0.28 D=0.28 AB=0.28 AC=0.39 AD=0.39 BC=0.39 BD=0.39 CD=0.56 ABC=0.56 ABD=0.56 ACD=0.79 BCD=0.79 ABCD=1.11											

A = compost type
B = compost level
C = storage period
D = Degree of temperature

a= Compost (plant animal residues)
b= Compost (plant residues)

2-3- Specific gravity:

Data illustrated in Tables (8&9) clearly indicated that, specific gravity of potatoes tubers increased gradually and significantly with prolonging of storage period either storing at room temperature or at cooling during the two seasons of this study. Moreover, data also cleared that, tubers stored at 4°C significantly had higher specific gravity than those associated with those stored at 8°C during the two seasons of this study. The same data, indicated also

that, tubers produced from plants, received plant animal compost had higher specific gravity than those produced from that received plant compost and stored either at cooling or at room temperature during the two seasons of this study. On the other side, these data also demonstrated that, tubers produced from plants received organic fertilizer, regardless the used doses, had less specific gravity than those produced from that received mineral fertilizers and stored either at room temperature or at cooling during the two seasons of this study. Moreover, specific gravity of potatoes tubers increased gradually and significantly with increasing the used organic fertilizer doses and stored either at room temperature or at cooling during the two seasons in this study. However, it is clear that, in most cases, these effects return to the effect of these pre-harvest treatment conditions. Data also indicted that, there were a significant interactions among all studied factors during this work. These results are in harmony with those obtained by Laza *et al.,* 2001, they reported that, specific gravity increased slightly throughout the storage period.

Table (8): Effect of different levels and types of organic fertilizer on specific gravity (g/cm^3) in potato tubers during storage at room temperature (32±2 °C) in two seasons (2010 & 2011).

parameters	Storage period (days)										
	0		30		60		90		Means		
Types / Levels	First season										
	a	b	a	b	a	b	a	b	a	b	Mean
control	1.05	1.05	1.11	1.11	1.13	1.13	1.18	1.18	1.12	1.12	1.12
80 Kg N fed^{-1}	1.05	1.04	1.06	1.08	1.09	1.12	1.13	1.15	1.08	1.10	1.09
120 Kg N fed^{-1}	1.09	1.04	1.07	1.08	1.09	1.11	1.13	1.14	1.10	1.09	1.10
160 Kg N fed^{-1}	1.10	1.05	1.05	1.09	1.08	1.08	1.14	1.16	1.09	1.10	1.10
Mean	1.07	1.05	1.07	1.09	1.10	1.11	1.14	1.16	1.10	1.10	1.10
Mean	1.06		1.08		1.11		1.15		1.10		
L.S.D. at 5%	A=0.011	B=0.016	C=0.016	AB=0.022	AC= 0.022	BC=0.031	ABC= 0.044				
Second season											
control	1.06	1.06	1.11	1.11	1.11	1.11	1.14	1.14	1.11	1.11	1.11
80 Kg N fed^{-1}	1.02	1.00	1.03	1.02	1.10	1.05	1.13	1.07	1.07	1.04	1.06
120 Kg N fed^{-1}	1.04	1.03	1.10	1.03	1.14	1.06	1.15	1.08	1.11	1.05	1.08
160 Kg N fed^{-1}	1.09	1.06	1.10	1.05	1.14	1.07	1.16	1.09	1.12	1.07	1.10
Mean	1.05	1.04	1.08	1.05	1.12	1.07	1.14	1.09	1.10	1.07	1.09
Mean	1.05		1.07		1.10		1.12		1.09		
L.S.D. at 5%	A = 0.014	B = 0.019	C = 0.019	AB = 0.027	AC= 0.027	BC= 0.038	ABC= 0.054				

A = compost type
B= compost level
C=storage period

a= Compost (plant animal residues)
b= Compost (plant residues)

Table (9): Effect of different levels and types of organic fertilizer on specific gravity (g/cm^3) in potato tubers during storage at cool temperature (4&8°C)in two seasons (2010 & 2011).

Parameters		Storage period (days)											
		0		45		90		135		Means			
Types / Levels		First season											
		a	b	a	b	a	b	a	b	a	b	Mean	Mean
control	4ºC	1.05	1.05	1.11	1.11	1.12	1.12	1.13	1.13	1.10	1.10	1.10	1.09
	8 ºC	1.05	1.05	1.08	1.08	1.11	1.11	1.10	1.10	1.08	1.08	1.08	
80 Kg N fed^{-1}	4 ºC	1.05	1.04	1.06	1.05	1.13	1.05	1.11	1.07	1.09	1.05	1.07	1.06
	8 ºC	1.05	1.04	1.05	1.04	1.00	1.04	1.12	1.08	1.05	1.05	1.05	
120 Kg N fed^{-1}	4 ºC	1.09	1.04	1.08	1.06	1.09	1.08	1.13	1.11	1.10	1.07	1.08	1.07
	8 ºC	1.09	1.04	1.05	1.04	1.06	1.06	1.10	1.09	1.07	1.06	1.06	
160 Kg N fed^{-1}	4 ºC	1.10	1.05	1.13	1.12	1.13	1.10	1.14	1.10	1.12	1.09	1.10	1.09
	8 ºC	1.10	1.05	1.12	1.07	1.10	1.08	1.11	1.09	1.11	1.07	1.09	
Mean	4 ºC	1.07	1.05	1.09	1.08	1.12	1.09	1.13	1.10	1.10	1.08	1.09	1.08
	8 ºC	1.07	1.05	1.07	1.06	1.07	1.07	1.11	1.09	1.07	1.07	1.07	
Mean		1.06		1.08		1.09		1.11		1.08			
L.S.D. at 5%		A=0.02 B=0.02 C=0.03 D=0.03 AB=0.03 AC=0.04 AD=0.04 BC=0.04 BD=0.05 CD=0.05 ABC=0.05 ABD=0.05 ACD =0.05 BCD=0.08 ABCD=0.11.											
Second season													
control	4ºC	1.06	1.06	1.10	1.10	1.03	1.03	1.13	1.13	1.08	1.08	1.08	1.08
	8 ºC	1.06	1.06	1.09	1.09	1.00	1.00	1.12	1.12	1.07	1.07	1.07	
80 Kg N fed^{-1}	4 ºC	1.02	1.00	1.07	1.06	1.11	1.06	1.14	1.11	1.09	1.06	1.08	1.07
	8 ºC	1.02	1.00	1.06	1.06	1.09	1.04	1.13	1.09	1.08	1.05	1.07	
120 Kg N fed^{-1}	4 ºC	1.04	1.03	1.09	1.04	1.11	1.09	1.13	1.12	1.09	1.07	1.08	1.08
	8 ºC	1.04	1.03	1.08	1.02	1.10	1.06	1.13	1.11	1.09	1.06	1.08	
160 Kg N fed^{-1}	4 ºC	1.09	1.06	1.10	1.07	1.12	1.11	1.14	1.12	1.11	1.09	1.10	1.10
	8 ºC	1.09	1.06	1.08	1.05	1.11	1.10	1.13	1.12	1.10	1.08	1.09	
Mean	4 ºC	1.05	1.04	1.09	1.07	1.09	1.07	1.13	1.12	1.09	1.08	1.08	1.08
	8 ºC	1.05	1.04	1.08	1.06	1.08	1.05	1.13	1.11	1.08	1.07	1.08	
Mean		1.05		1.08		1.07		1.13		1.08			
L.S.D at 5%		A=0.01 B=0.01 C=0.02 D=0.02 AB=0.02 AC=0.03 AD=0.03 BC=0.03 BD=0.04 CD=0.04 ABC=0.04 ABD=0.04 ACD=0.05 BCD=0.05 ABCD=0.08.											

A = compost type a= Compost (plant animal residues)
B = compost level b= Compost (plant residues)
C = storage period
D = Degree of temperature

2- 4- Total Soluble Solids Content (TSS) :

Data presented in Tables (10 & 11) cleared that, total soluble solid content increased gradually and significantly with prolonging of storage period either at room temperature or at cooling conditions during the two seasons of this study. Moreover, data also illustrated that, tubers stored at 4°C significantly had less total soluble solid

contents than those associated with those stored at 8°C during the two seasons of this study. The same data, showed that, tubers produced from plants received plant animal compost had higher total soluble solid content than those produced from that received plant compost stored either at cooling or at room temperature during the two seasons of this study. On the other hand, total soluble solid content of potatoes tubers increased gradually and significantly with increasing the used organic fertilizer doses and stored either at room temperature or at cooling during the two seasons in this study. Moreover, these data also demonstrated that, tubers produced from plants received the highest dose of organic fertilizer had higher total soluble solid content than those produced from that received mineral fertilizers either stored at room temperature or at cooling during the two seasons of this study. However, it is clear that, in most cases, these effects return to the effect of these pre-harvest treatment conditions. Data also indicted that, there were a significant interactions among all studied factors during this study. These results are in agreement with those demonstrated by Rivero *et al.*, 2003, and Hebeisen *et al.*, 2007 they demonstrated that, higher temperature resulted in more rapid changes in the different quality parameters (total soluble solids).

Table (10): Effect of different levels and types of organic fertilizer on TSS percentage (%) in potato tubers during storage at room temperature (32±2 °C) in two seasons (2010 & 2011).

parameters	Storage period (days)										
	0		30		60		90		Means		
Types / Levels	First season										
	a	b	a	b	a	b	a	b	a	b	Mean
control	5.55	5.55	6.40	6.40	6.93	6.93	7.20	7.20	6.52	6.52	6.52
80 Kg N fed^{-1}	4.80	4.60	6.13	5.90	6.48	6.20	6.75	6.50	6.04	5.80	5.92
120 Kg N fed^{-1}	5.00	5.00	6.33	6.05	6.65	6.53	7.03	6.78	6.25	6.09	6.17
160 Kg N fed^{-1}	6.00	5.40	6.98	6.75	7.23	6.98	7.63	7.23	6.96	6.59	6.78
Mean	5.34	5.14	6.46	6.28	6.82	6.66	7.15	6.93	6.44	6.25	6.35
Mean	5.24		6.37		6.74		7.04		6.35		
L.S.D. at 5%	A = 0.057 B = 0.080 C = 0.080 AB = 0.113 AC = 0.113 BC = 0.160 ABC = 0.226										
Second season											
control	4.85	4.85	5.45	5.45	6.45	6.45	7.53	7.53	6.07	6.07	6.07
80 Kg N fed^{-1}	4.65	4.33	5.18	5.00	5.80	5.48	6.85	6.65	5.62	5.37	5.50
120 Kg N fed^{-1}	5.10	4.85	5.70	5.43	6.13	5.65	7.03	6.75	5.99	5.67	5.83
160 Kg N fed^{-1}	5.38	5.15	6.30	6.15	5.00	6.43	7.20	6.88	5.97	6.15	6.06
Mean	5.00	4.80	5.66	5.51	5.85	6.00	7.15	6.95	5.91	5.82	5.87
Mean	4.90		5.59		5.92		7.05		5.87		
L.S.D. at 5%	A = 0.087 B = 0.123 C = 0.123 AB = 0.173 AC = 0.173 BC = 0.245 ABC= 0.347										

A = compost type a= Compost (plant animal residues)
B = compost level b= Compost (plant residues)
C=storage period

Table (11): Effect of different levels and types of organic fertilizer on total soluble solid (TSS) in potato tubers during storage at cool temperature (4 & 8 °C) in two seasons (2010 & 2011).

Parameters		Storage period (days)											
		0		45		90		135		Means			
Types / Levels		First season											
		a	b	a	b	a	b	a	b	a	b	Mean	Mean
control	4ºC	5.55	5.55	6.15	6.15	6.23	6.23	6.65	6.65	6.15	6.15	6.15	6.38
	8 ºC	5.55	5.55	6.55	6.55	6.90	6.90	7.46	7.46	6.62	6.62	6.62	
80 Kg N fed^{-1}	4 ºC	4.80	4.60	5.13	4.75	5.68	5.28	5.85	5.30	5.37	4.98	5.18	5.64
	8 ºC	4.80	4.60	6.35	6.18	6.68	6.35	7.13	6.63	6.24	5.94	6.09	
120 Kg N fed^{-1}	4 ºC	5.00	5.00	5.40	5.08	5.98	5.75	6.65	6.33	5.76	5.54	5.65	6.O1
	8 ºC	5.00	5.00	6.58	6.23	6.98	6.63	7.35	7.05	6.48	6.23	6.36	
160 Kg N fed^{-1}	4 ºC	6.00	5.40	6.75	6.28	6.73	6.53	7.20	7.00	6.67	6.30	6.49	6.70
	8 ºC	6.00	5.40	7.30	6.80	7.53	7.13	7.63	7.38	7.12	6.68	6.90	
Mean	4 ºC	5.34	5.14	5.86	5.57	6.16	5.95	6.59	6.32	5.99	5.74	5.87	6.18
	8 ºC	5.34	5.14	6.70	6.44	7.02	6.75	7.39	7.13	6.61	6.37	6.49	
Mean		5.24		6.14		6.47		6.86		6.18			
L.S.D. at 5%		A=0.05 B=0.05 C=0.08 D=0.08 AB=0.08 AC=0.11 AD=0.11 BC=0.11 BD=0.11 CD=0.15 ABC=0.15 ABD=0.15 ACD=0.21 BCD=0.21 ABCD=0.30											
Second season													
control	4ºC	4.85	4.85	5.83	5.83	6.50	6.50	6.75	6.75	5.98	5.98	5.98	6.04
	8 ºC	4.85	4.85	6.00	6.00	6.50	6.50	7.00	7.00	6.09	6.09	6.09	
80 KgN fed^{-1}	4 ºC	4.65	4.33	5.05	4.85	6.00	5.48	6.30	5.70	5.50	5.09	5.30	5.44
	8 ºC	4.65	4.33	5.88	5.35	6.13	5.80	6.43	6.00	5.77	5.37	5.57	
120 KgN fed^{-1}	4 ºC	5.10	4.85	5.50	5.35	6.18	5.68	6.58	6.13	5.84	5.50	5.67	5.81
	8 ºC	5.10	4.85	6.10	5.75	6.43	6.10	6.78	6.50	6.10	5.80	5.95	
160 KgN fed^{-1}	4 ºC	5.38	5.15	6.38	5.98	6.75	6.30	7.13	6.85	6.41	6.07	6.24	6.31
	8 ºC	5.38	5.15	6.53	6.33	6.83	6.63	7.13	6.95	6.47	6.27	6.37	
Mean	4 ºC	5.00	4.79	5.69	5.50	6.36	5.99	6.69	6.36	5.94	5.66	5.80	5.90
	8 ºC	5.00	4.79	6.13	5.86	6.47	6.26	6.84	6.61	6.10	5.88	5.99	
Mean		4.90		5.80		6.27		6.63		5.90			
L.S.D at 5%		A=0.05 B=0.05 C=0.08 D=0.08 AB=0.08 AC=0.11 AD=0.11 BC=0.11 BD=0.11 CD=0.15 ABC=0.15 AABD=0.15 ACD=0.22 BCD=0.22 ABCD=0.31											

A = compost type a= Compost (plant animal residues)
B = compost level b= Compost (plant residues)
C = storage period
D = Degree of temperature

Conclusions:

From the above mentioned results, it could be accomplished that application of N organic fertilizers at rate 160 N Kg fed^{-1} maximized averages of tubers yield, yield components (N, P and K), dry matters (%), specific gravity g/cm^3 and total soluble solids (TSS%), and decreased weight loss (%), nitrate and nitrite concentration (ppm), as compared to use N inorganic at rate 160 Kg fed^{-1}. Moreover, storage at cooling temperature (4 & 8ºC) produced higher tubers quality and increased tubers ability to storability and storage for long time after harvesting.

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تأثير معدلات و نوع السماد العضوي علي محصول وجودة درنات البطاطس (صنف نقولا) عند الحصاد وأثناء التخزين

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الملخص العربي

أجريت التجربة الحقلية خلال موسم الخريف في عام٢٠١٠ و ٢٠١١ وذلك بمحطة بحوث البساتين بالقناطر الخيرية وقسم تداول الفاكهة – معهد بحوث البساتين – مركز البحوث الزراعية – الجيزة – مصر وذلك لدراسة تأثير استخدام نوعين مختلفين من الكمبوست – كسماد عضوي– على المحصول ومكوناته و كذلك جودة الدرنات في نباتات البطاطس– صنف نيقولا – وذلك عند الحصاد و أثناء التخزين. تم إجراء ٧ معاملات حيث أستخدم التسميد المعدني بالجرعة الموصى بها لكل من النتروجين و الفوسفور و البوتاسيوم (١٦٠و ٩٦ و٥٠ كج/فدان علي التوالي) وذلك كمعاملة كنترول وتم استخدام نوعين من الكمبوست الأول كمبوست من مخلفات نباتية وحيوانية (أ) وكمبوست من مخلفات نباتية (ب) وذلك بـ ٣ معدلات لكل نوع من الكمبوست كما يلي ٨٠ و ١٢٠ و ١٦٠ وحدة نيتروجين للفدان تعادل استخدام (٦–٧) و (٩–١٠,٥) و (١٢–١٤) طن كمبوست للفدان لكل نوع على التوالي. تم الحصاد عند عمر ١١٠ يوم من الزراعة وتم نقل درنات البطاطس إلى ثلاجات المعهد حيث تم فرزها و تخزينها على درجة حرارة الغرفة (٣٢±٢ درجة مئوية ورطوبة ٦٥%) وعلى درجتا حرارة التخزين المبرد (٤ و ٨ درجة مئوية ورطوبة ٩٥:٩٠%). تم إجراء الدراسات الطبيعية والكيماوية بصفه شهرية بالنسبة للدرنات المخزنة على درجة حرارة الغرفة وكل ٤٥ يوم بالنسبة للدرنات المخزنة على حرارة التبريد (٤ أو ٨م°).

أظهرت النتائج المتحصل عليها أن تطبيق المستوى العالي من السماد العضوي (١٦٠كجم ن/فدان) لكل من نوعى الكمبوست المستخدم عدم وجود فروق معنوية في المحصول (طن/فدان) وكذلك محتوي الدرنات من العناصر الغذائية (نيتروجين–فوسفور– بوتاسيوم) وذلك مقارنة بمعاملة الكنترول في المقابل أظهرت المعاملات المعاملة بمختلف معدلات التسميد العضوي لنوعي الكمبوست المستخدم انخفاض معنوي لكل من تركيز النترات والنتريت في درنات البطاطس وذلك مقارنة بمعاملة التسميد المعدني الكامل (الكنترول). كما أوضحت النتائج أن الدرنات التي تم تخزينها علي درجات الحرارة المنخفضة (٤ أو ٨ م°) كانت لها فترة تخزينية أطول و صاحبها تقليل في معدل الفقد في الوزن وذلك خلال موسمي التجربة. أيضا أدي تطبيق التسميد العضوي إلي زيادة المادة الجافة والكثافة النوعية ونسبة المواد الصلبة الدائبة الكلية بدرنات البطاطس مقارنة بمعاملة الكنترول وأكثر من ذلك أدى التخزين علي درجات الحرارة المنخفضة إلي زيادة فترة حيوية وجوده درنات البطاطس.

بصفة عامة أدى استخدام التسميد العضوي (كمبوست أ ، ب) الحصول علي منتج عضوي عالي الجودة وذو قدرة تخزينية عالية من درنات البطاطس وصحي للاستهلاك الآدمي.