4- Results and Discussion

4.1. Composting Experiment:

4.1.1. Changes of pH with time duration:

Following up the changes in compost pH with intervales time up to 60 days as listed in Table (3) and graphically illustrated by Fig.(6) indicated significant variation with time. In this respect, pH values tented to increase with time up to 60 days of incubation. This holds true with different composting treatments. In the same time, pH values were fluctuated according to composting treatments. The least pH value was detected with T_4 and the highest one with T_3 as revealed by the . These results gave us the chance to conclude that the treatments applied to compost combination significantly affected the changes in pH values along with time intervals. Maximum increase in pH values was recorded after 60 days of fermentation with T_3 where it reached to 7.

Simultaneously, **(Sellami et al. 2007)** found that the pH tended to stabilize at values around 8 and 9 at the end of the composting process, the windrows' electrical conductivities were increased because of the ion concentrations due to weight loss and humidification with an effluent of 22.0 dS m^{-1}.

In our study, pH values did not exceeds 7 during the humification periods of composting process.

Table (3): Effect of different compost treatments interacted with incubation periods on pH value changes.

Treat.*	Incubation intervals (day)					
	0	15	30	45	60	Mean
T1	5.57 fgh	5.77 fg	6.36 cd	6.41 cd	6.49 bc	6.12
T2	5.40 ghi	5.80 ef	6.40cd	6.60 bc	6.59 cd	6.16
T3	5.70 fgh	5.77 fg	6.60 bc	6.80 ab	7.00 a	6.37
T4	4.88 k	4.93 k	4.93 k	5.03 jk	5.30 ij	5.01
T5	5.37 hij	5.4 7 fgh	6.47 bcd	6.70 abc	6.70 abc	6.14
T6	5.60 fgh	6.19 d	6.12 de	6.22 d	6.40 cd	6.11
Mean	5.42	5.79	6.15	6.29	6.42	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation, (B) Interaction (AxB)

0.1806 0.1780 0.3276

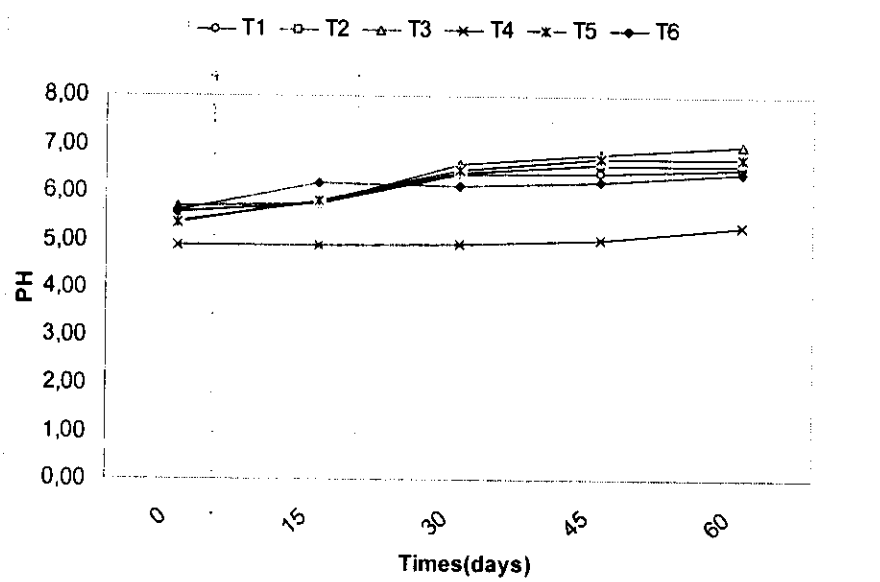


Fig (6): Interaction between different compost treatments and time of incubation on pH value changes.

4.1.2. Changes of EC with time :

Changes of electrical conductivity (EC) of composting media are listed in Table (4) and graphically illustrated by Fig. (7). This parameter was significantly affected by either composting treatment and incubation time intervals. In this regard, incubation intervals reflected fluctuated trends

depending on composting treatments. For example, with T_4,T_1 EC values tended to increase after 15 days, then decreased with increasing time intervals up to 60 days. Reversible trend was noticed with T_2 where the EC values still increases with increasing time intervals up to 60 days. Similar increase, but with different extents, were noticed with T_3, T_4 and T_5. In case of T_6, EC values were increased with time progress up to 30 days, where the highest peak was detected, but tended to decrease with 45 and 60 days intervals. The overall means showed that EC values tended to increase up to 30 days and highest values was recorded with T_6 and the lowest one was recorded with T_4. The composting treatments could be ranked as following:

$$T_6 > T_1 > T_5 > T_3 > T_2 > T_4$$

Table (4): Effect of different compost treatments and incubation periods on EC(Sdm^{-1}) value changes.

Treat.	Incubation intervals (day)					
	0	15	30	45	60	mean
T 1	13.87 f	15.06 e	13.97 f	11.03 jk	10.47 k	12.89
T 2	8.03 o	9.37 l	9.08 lm	9.00 lmn	8.53mno	8.80
T 3	11.34 ij	11.40hig	11.55 hij	11.63 hij	11.60 hij	11.49
T 4	4.17 q	6.76 P	8.30 no	8.50mno	8.90 lmn	7.34
T 5	11.00jk	11.25 ij	12.15 gh	12.00 hi	12.77g	11.82
T6	28.75a	27.75 b	27.75 b	23.32 c	20.80d	24.72
mean	11.90	13.61	13.96	12.57	12.17	12.84

L.S.D. (0.05)

Compost Treatment (A)	Time of incubation (B)	Interaction(A×B)
0.3731	0.3679	0.6770

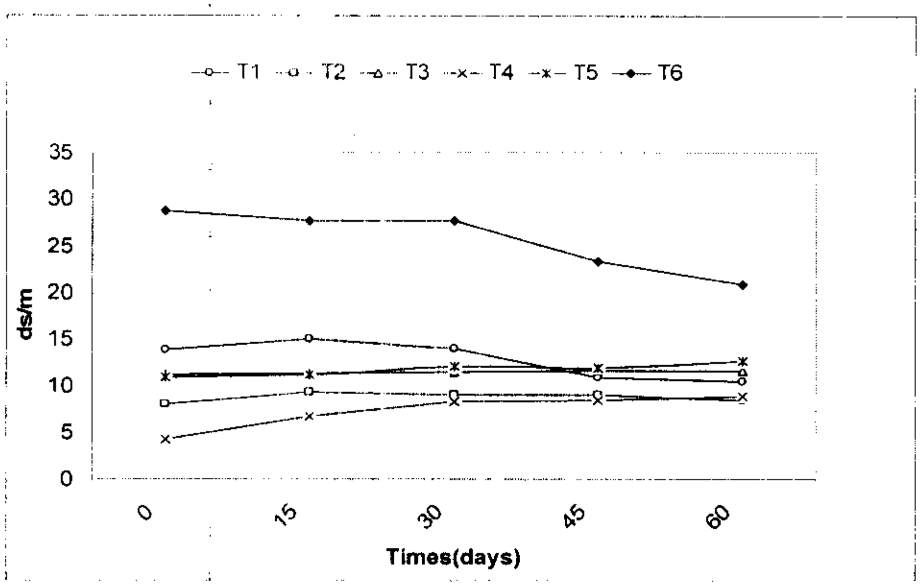


Fig (7): Interaction between different compost treatments and time of incubation on EC value changes.

4.1.3. Nitrogen content in composted materials as affected by different Treatments and incubation :

Nitrogen percent in compost media as affected by additive and time of incubation was presented in Table (5) and graphically illustrated by Fig (8). It is obvious that the different treatments induced different N percentages. As indicated by the overall means, the highest N percent was occurred with T6 while the lowest one was induced by T_4. In this regard, the composting treatments could be ranked as following:

$$T_6 > T_3 > T_{15} > T_5 > T_2 > T_4$$

Concerning the incubation intervals, the overall mean reflected that N percent was increased with increasing time intervals where the highest N percent was noticed after 60 days. It means that the compost could be reached the maturity stage

at this time where it was rich in nitrogen content comparing to the other time intervals. In conclusion, both the treatments and incubation period have significant effects on nitrogen content of the composted materials. Also, we can select T_6 as the best treatment, which enriched the composted materials.

In addition to the carbon organic reduction which took place with pH and electrical conductivity changes, **(Sellami et al. 2007)** indicated that the nitrogen content showed an increase resulting from the loss of dry weight as carbon dioxide, and water evaporation during the mineralization of the organic matter. This correlates with the previous observations about composting experiments **(Alburquerque et al., 2006; Bernal et al., 1998; Meunchang et al., 2005; Paredes et al., 2000, 2002).** Windrow III (0.2% sesame shells + 50% poultry manure + 50% exhausted olive cake) was characterized by a higher total nitrogen content of

1.35% compared to that of Windrows II (75% exhausted olive cake + 25% poultry manure + 0% sesame shells) and IV (0% sesame shells + 50% poultry manure + 50% exhausted olive cake) (1.25%). This could be related to the initial composition of the mixture in the windrow including poultry manure (50%) and sesame shells.

Table (5): Effect of different compost treatments interacted with incubation periods on N% changes.

Treat.	Incubation intervals (day)					
	0	15	30	45	60	Mean
T1	0.945 ijk	1.020hij	1.385fgh	1.792ef	2.470 bc	1.52
T 2	0.886 jk	0.773 k	0.773 k	1.250ghi	1.250ghi	0.99
T 3	1.061 hij	1.263ghi	1.427fgh	1.989 de	2.800 ab	1.71
T 4	0.657 k	0.663 k	0.821 jk	0.975 ijh	1.016 hij	0.83
T 5	0.888 jk	1.070hij	1.228hij	1.674efg	2.383 cd	1.45
T6	1.867 e	1.933de	2.0 37de	2.567 bc	3.133 a	2.15
mean	1.05	1.11	1.28	1.71	2.18	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation (B), Interaction (AxB)

0.2099 0.2069 0.3808

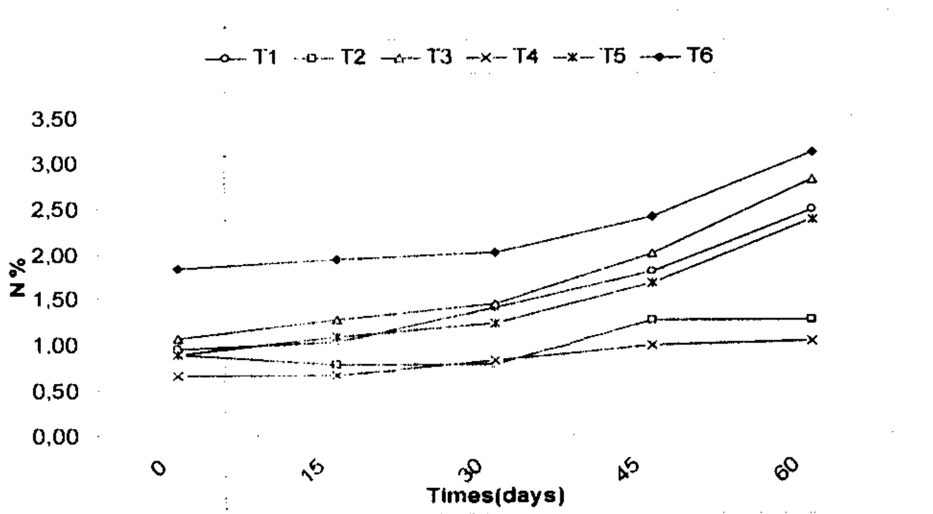


Fig (8): Effect of different compost treatments interacted with incubation periods on N% changes.

4.1.4. Change of C/N ratio with time:

Carbon to nitrogen ratio of composted materials listed in Table (6) and graphically illustrated by Fig. (9) indicated significant variation with time process and combined additives. At 0 time, higher C/N ratio were detected with T_4 as compared to other treatments the lowest one was recorded with T6,.T4 treatments induced the highest C/N ratios amongst the all other treatments This holds true with all time intervals. The overall means showed that the C/N ratio of composted materials became very narrow at 60 days of incubation. It means that it reached maturity stage and became rich in N content. This matter gave us a prediction that the composted materials at this stage could be mineralized faster and considered as nutrient storage especially for N element. In this regard, T_6 treatment is considered as the best treatment that positively affected the maturity of composted materials and makes it easily to degrade faster than other additive treatments. Although, the C/N ratio under T_4 was slightly decreased with time, but still higher than other treatments indicating a low rate of degradation and consequently N mineralization.

As a consequence of the trend of carbon and the nitrogen variations, **(Sellami et al. 2007)** found that the C/N ratio was decreased during the composting process. The initial ratio of C/N, which ranged between 20 and 27, substantially decreased in all windrows depending on its composition. Also, they stated that the C/N reduction was the result of total organic carbon loss. In fact, the high initial C/N ratio in the windrows needed an excessively long composting time. However, the longer bio oxidative phase led to a greater proportion of the organic matter fraction being degraded during the composting process

Table (6): Effect of different compost treatments interacted with incubation periods on C/N ratio changes.

Treat.	Incubation intervals (day)					
	0	15	30	45	60	Mean
T 1	48.67cd	40.00 f	31.57 h	22.13 i	15.10 jkl	31.49
T 2	49.33 cd	45.97de	45.83 ef	32.03 gh	20.02 ij	38.64
T 3	46.33 de	38.10 fg	33.03 gh	22.65 i	12.63 kl	30.54
T 4	72.07 a	67.96 a	53.91 bc	40.05 f	37.65 fg	53.65
T 5	51.46bcd	42.31 ef	32.59gh	18.00ijk	12.44 kl	31.40
T6	22.08 l	20.46 ij	17.19 ijk	13.71 kl	10.15 l	16.72
Mean	48.32	42.47	35.68	24.76	17.99	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation (B), Interaction AxB)

3.036 2.993 5.508

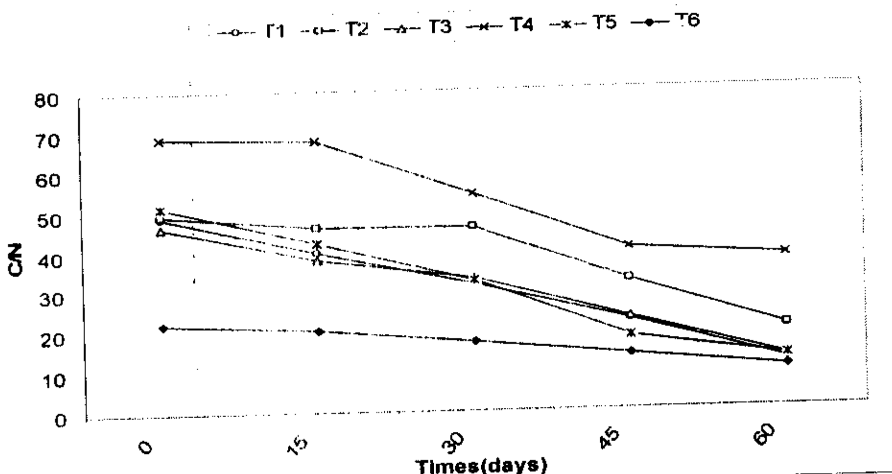


Fig (9): Interaction between different compost treatments and time of incubation on C/N value changes.

4.1.5. Organic matter content of composted materials:

Changes of organic matter of composted materials as affected by time incubation intervals and additives is listed in Table (7) and graphically illustrated by Fig. (10). Concerning the effect of additive treatments, the organic matter content was fluctuated according to each treatment. For example, at T_1 the organic matter was decreased after 15 days, then increased at 30 days, then increased again up to 60 days of incubation. While, T_2 showed slight increase in organic manure content with time intervals. Reversible trend was noticed with the rest of treatments (T_3, T4, T5 and T_6), where the organic manure content tended to decrease slightly with time progress. The overall means indicated that the originated organic manure was more able to degrade with time progress up to 60 days of incubation. In the same time, the addition of T_6 had encouraged this process of degradation (mineralization of organic N). The priorities of treatments could be ranked as following:

$$\mathbf{T_6 > T_2 > T_1 > T_3 > T_5 > T_4}$$

In accordance, (**Sellami et al., 2007**) stated that organic matter was degraded at the end of the process. The organic matter decomposition brought some variations of pH in all windrows (combinations). Windrows have different organic contents attributed to its initial composition and confectionary wastewater.

Table (7): Effect of different compost treatments interacted with incubation periods on OM (%) changes.

Treat.	Incubation intervals (day)					
	0	15	30	45	60	mean
T 1	78.77Bcd	70.74def	72.71fgh	69.33hij	61.81 mn	70.67
T 2	61.25mno	70.37ghi	70.95ghi	68.00jkl	64.69lmn	67.12
T 3	75.34cde	74.42cde	74.05def	68.96ijk	68.94ijk	72.40
T 4	84.71 a	82.75 ab	81.20 ab	77.87cde	60.34 no	77.43
T 5	81.03 ab	77.75def	77.67def	70.54ghi	65.86klm	74.57
T6	79.31 bc	78.04bcd	73.14efg	73.90def	57.02 o	72.28
Mean	76.74	75.68	74.95	71.43	63.11	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation (B), Interaction (AxB)
2.439 2.405 4.426

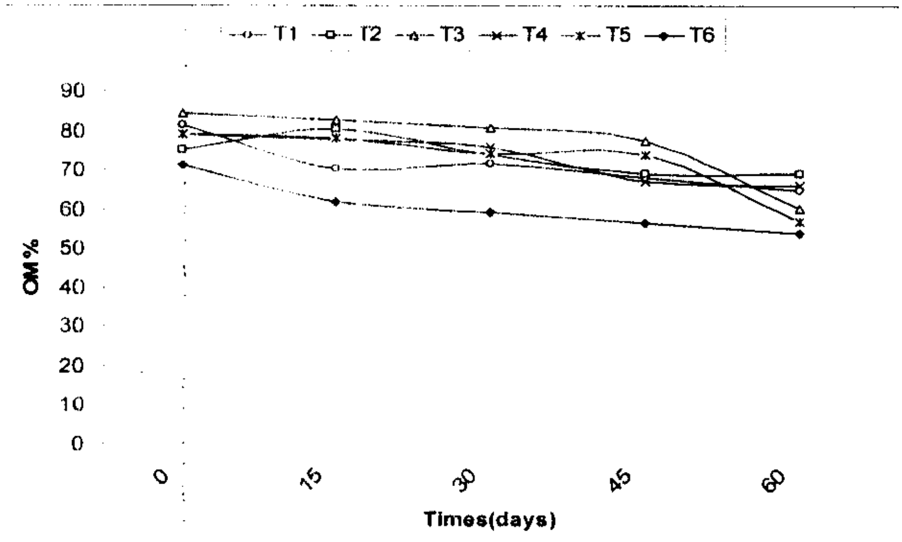


Fig (10): **Interaction between different compost treatments and time of incubation on OM(%) value changes.**

4.1.6. Phosphorus content of composted materials:

As shown in Table (8) and Fig (11), the percentage of P in composted materials as affected by incubation time and additives was fluctuated. It seems that phosphorus percent in organic wastes (compost) was frequently affected by addition treatments. For instance, the highest P percent was resulted by application of T_5 treatment as revealed by overall mean.

On the other hand, low P percent was occurred with T_4 treatment. There was no big significant difference between the rest treatments. Dealing with effect of incubation intervals, data showed that T_5 treatment reflected an increase in P percent after 15 days of incubation. A sharp decrease in P percent was noticed at 45 days of incubation, while it reached the maximum at 60 day interval. Similar trend, but in low extent, was recorded with T_4. The overall mean of time intervals indicated that the highest percent of P was induced by application treatments at 60-days interval while the lowest one was noticed after 30 days of incubation. This holds true with all of application treatments.

Table (8): Effect of different compost treatments interacted with incubation periods on P (%) changes.

Treat.	Incubation intervals (day)					
	0	15	30	45	60	Mean
T 1	0.571efg	0.657def	0.560efg	0.631 cde	0.780abc	0.64
T 2	0.633 cde	0.703bcd	0.580efg	0.621def	0.847 ab	0.68
T 3	0.573efg	0.630cde	0.580 efg	0.657def	0.737abc	0.64
T 4	0.420hij	0.420hij	0.347jk	0.363ijk	0.413hi	0.39
T 5	0.623def	0.747abc	0.704bcd	0.770abc	0.840 ab	0.74
T6	0.780abc	0.863 a	0.510fgh	0.531fgh	0.513fgh	0.66
mean	0.60	0.67	0.55	0.60	0.70	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation (B), Interaction AxB)

0.07271 0.0716 0.1319

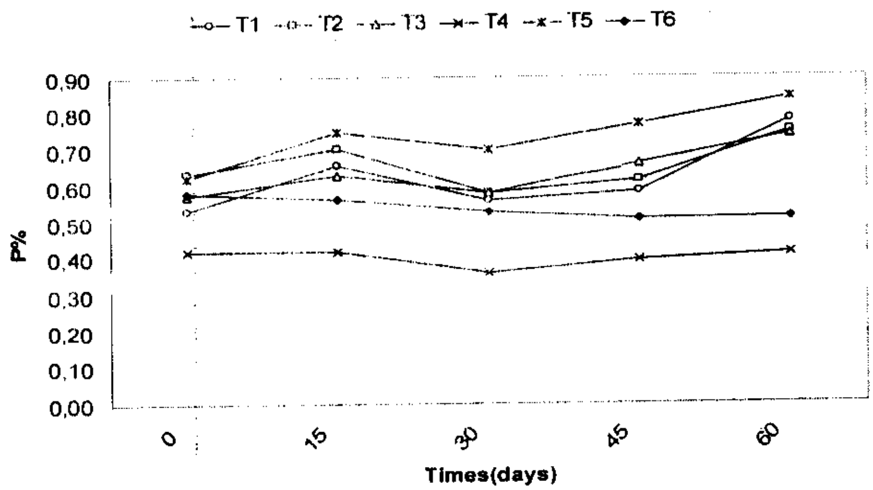


Fig (11): Interaction between different compost treatments and time of incubation on P% value changes.

4.1.7. Potassium content of composted materials :

Effect of different additives on K^+ contents in compost is presented in Table (9) and graphically illustrated by Fig (12).Generally, K^+ content was frequently affected by interaction between treatments and incubation periods. Comparison between treatments indicated the superiority of T_6 over all the other treatments where K^+ contents were highly increased from 15 days to 60 days intervals. In this respect, T_4 came to the next. Potassium content was erratic as affected by incubation time intervals. The overall mean indicated that high K^+ contents were recorded only at 15 and 60-day intervals.

From the abovementioned results, we can conclude that the compost was richness in K^+ content at 60 day, which we believe it is the mature stage, when T_4 and T_6 were applied. As composting leads to production of minerals **(Zucconi and De Bertoldi, 1987)**, the concentrations of P, K, Ca and Mgdetermined by **(Sellami et al. 2007)** at the beginning and again after 70 days of processing, showed a significant increase of the minerals. It was observed that the compost humidified with confectionery wastewater has higher contents of major minerals P, K, Ca and Mg, compared to the compost humidified with water. As a matter of fact, the use of wastewater during composting improved the fertilization value of the end products. Moreover, the percentage of poultry manure incorporated as a raw material had a positive effect on the mineral composition [Windrows III (0.2% sesame shells + 50% poultry manure + 50% exhausted olive cake) and IV (0% sesame shells + 50% poultry manure + 50% exhausted olive cake)].

Table (9): Effect of different compost treatments interacted with incubation periods on K (mg kg $soil^{-1}$) value changes.

Treat.	Incubation intervals (day)					
	0	15	30	45	60	Mean
T 1	6413efg	5417cd	4500ijk	4667ijk	7083def	5616.00
T 2	6190efg	4917ghi	5417fgh	6847efg	6583efg	6190.80
T 3	6083efg	5917ghi	6750efg	6677efg	8750cde	6635.40
T 4	7093def	6083efg	6173efg	8000cde	9583 c	7386.40
T 5	6080efg	6167efg	6250efg	5967efg	6917efg	6276.20
T6	15390a	16265 a	14841 b	14982 b	16170 a	14929.60
mean	7858.17	7461.00	7321.83	7856.67	9181.00	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation (B), Interaction(AxB)
1136 1120 2062

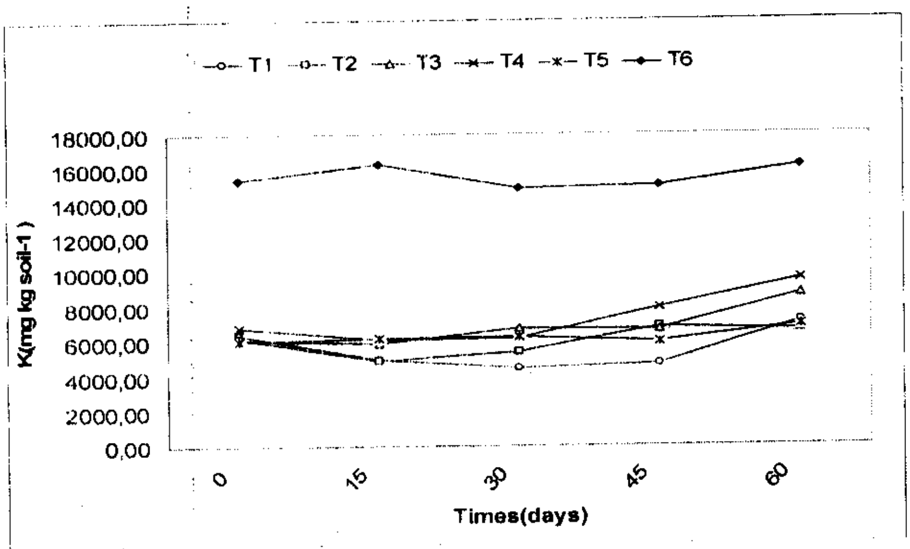


Fig (12): Interaction between different compost treatments and time of incubation on K (mg kg $soil^{-1}$) value changes.

4.1.8. Micronutrients in compost

Iron :

The content of Fe in compost as affected by additives along the incubation period was presented in Table (10) and graphically illustrated by Fig (13). Fe content in most treatments was increased after 15 days of incubation. Reversible trend was after 30 days where it decreases in most treatments. At 45 day, Fe content was increased in case of T_1 and T_5, decreased with T_3 and T_6 and steady state with T_2 and T_4 when compared to the period of 30 days. In spite of treatments, the highest values of Fe in compost were detected at 60 days interval. The overall mean of treatments indicated the superiority of T_1 over the others followed by T_5. On the other hand, the lowest Fe value was recorded with T_6.

Table (10): Effect of different compost treatments interacted with incubation periods on Fe (µg g soil^{-1}) value changes.

Treat.	Incubation intervals (day)					
	0	15	30	45	60d	Mean
T 1	2008def	2798 ab	2550 abc	2734 ab	3020 a	2622.00
T 2	2006def	2895 a	2576abc	2610 abc	2171 cde	2451.60
T 3	1951def	2080 def	2403bcd	1945 def	2859 ab	2247.60
T 4	1837 ef	2598 abc	2043 def	2020 def	2678 ab	2235.20
T 5	1673fg	2178cde	2840 ab	3000 a	2898a	1931.5
T6	1330gh	1760efg	1376gh	1077 h	1734 efg	1212.83
Mean	1800.00	2384.83	2298.00	2231.00	2560	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation (B), Interaction (AxB)

226.40 223.20 410.80

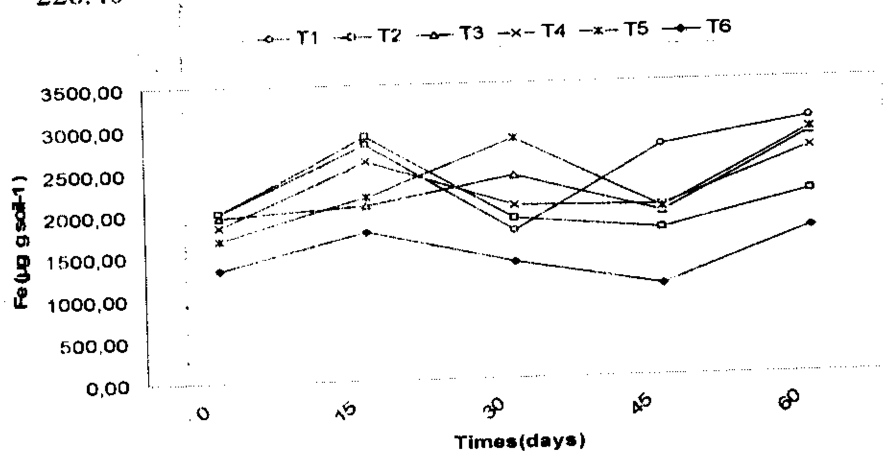


Fig (13): **Interaction between different compost treatments and time of incubation on Fe (µg g soil^{-1}) value changes.**

Copper :

Copper content in the composting materials as affected by pretreatments and incubation time intervals was presented in Table (11) and graphically illustrated by Fig (14). It is obvious that the Cu content of organic media was significantly increased with progress of incubation time intervals. This holds true under all composting treatments except T6 treatment where the Cu content tended to decrease after 30 days up to 60 days intervals as compared to zero time interval. The overall average of incubation time intervals showed that the high Cu content of compost media was induced at 15 days interval followed by 30 days interval. At the same time, T6 treatment was superior over the other pretreatments as indicated from the overall average of composting treatments.

Table (11): Effect of different compost treatments interacted with incubation periods on Cu (µg g $soil^{-1}$) value changes.

Treat.	Incubation intervals (day)					
	0	15	30	45	60	mean
T 1	176.3de	225.2bc	209.7 cd	189.0cde	215.6 cd	203.15
T 2	149.0ef	210.8 cd	211.5 cd	212.3 cd	204.4 cd	197.60
T 3	194.3 cd	207.2 cd	215.9 cd	204.9 cd	205.9 cd	205.65
T 4	128.9f	201.3 cd	205.9 cd	205.6 cd	201.1 cd	188.56
T 5	179.0cde	207.1cd	217.9 cd	213.8 cd	212.3 cd	206.02
T6	387.6 a	406.1 a	365.7a	310.1 b	260.5b	346.00
Mean	194.92	242.95	237.76	222.61	216.63	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation (B), Interaction (AxB)

21.68 21.38 39.34

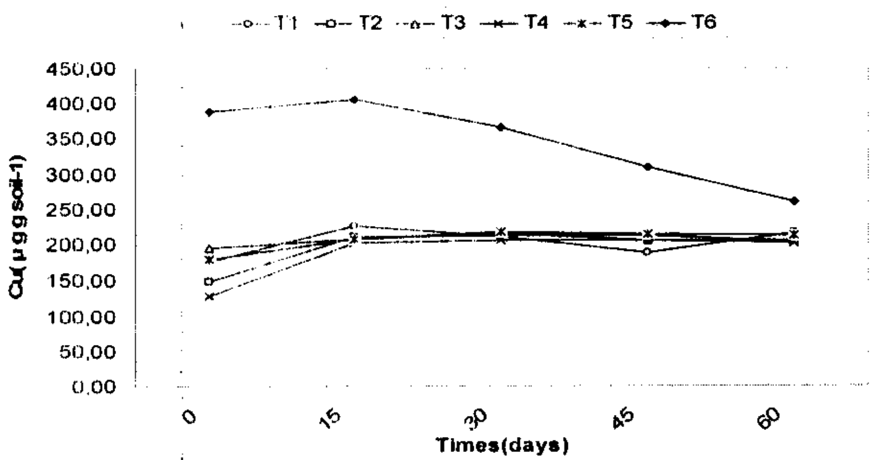


Fig (14): Interaction between different compost treatments and time of incubation on Cu (µg g $soil^{-1}$) value changes.

Manganese :

Manganese content in compost is listed in Table (12) and graphically illustrated by Fig (15). Generally, Mn content was increased with time interval progress. Likewise, it positively affected by composting treatments. For example, at 0 time the Mn content was differentially affected by treatments where it was higher in case of T_3, T_5 and T_6 than T_1, T_2 and T_4 treatments. This trend was fluctuated along with incubation time intervals. The overall average of composting treatments indicated the following rank:

$$T_1 > T_6 > T_3 > T_2 > T_5 \geq T_6$$

Also, the overall average of incubation time intervals indicated that the Mn content of compost was significantly increased after.

Table (12): **Effect of different compost treatments interacted with incubation periods on Mn (μg g soil^{-1}) value changes.**

Treat.	Incubation intervals (day)					
	0	15	30	45	60	mean
T 1	107.9jkl	184.3efg	221.1de	190.3def	203.4def	181.40
T 2	106.5ijk	131.3fgh	195.8def	185.1efg	203.0def	164.34
T 3	119.7hij	130.5fgh	170.9efg	131.0fgh	184.3efg	147.28
T 4	106.0ijk	126.6ghi	138.5fgh	120.8ghi	155.7efg	129.52
T 5	122.3ghi	133.0fgh	165.3efg	135.4fgh	137.8fgh	138.76
T6	125.3ghi	238.7 d	238.17 d	203.4def	292.7 a	219.65
Mean	114.61	157.40	188.30	161.00	196.15	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation (B), Interaction (AxB)

35.3 34.88 64.19

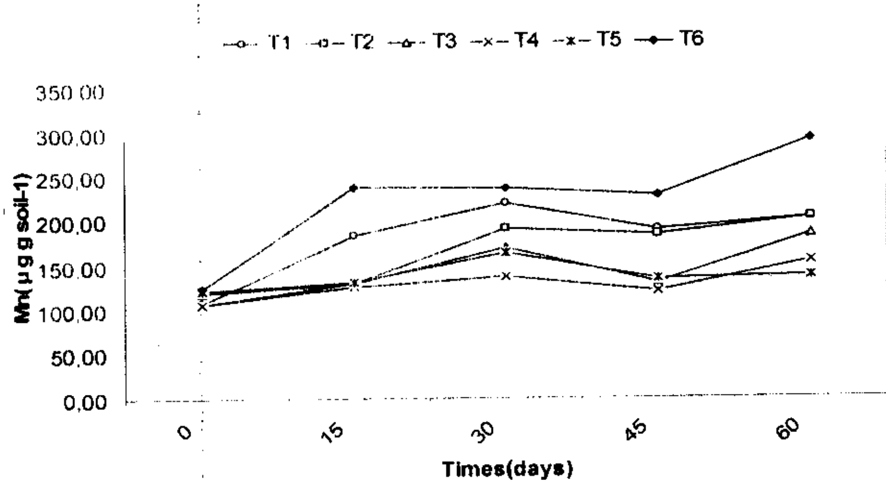


Fig (15): **Interaction between different compost treatments and time of incubation on Mn (μg g soil^{-1}) value changes.**

15 day interval then decreased but all intervals were higher than 0 time interval. It means that the best value of Mn content was occurred at 15 day incubation time interval as compared to other intervals.

Zinc :

As shown in Table (13) and Fig (16), Zn content of compost was significantly affected by pretreatments of composting process and with incubation time intervals. In this respect, under T_1 Zn content was highly increased at 15 day interval then decreased with time progress up to 60 day interval. The content of Zn was fluctuated along with time intervals depending on composting treatments. The overall average of time intervals showed that Zn was actively concentrated at 15 day interval followed by 30 day interval as compared to other periods. On the other hand, the overall average of composting treatments indicated the superiority of T_6 over the others. T_1 treatment came to the next although it accounts about the half of those recorded with T_6.

Table (13): Effect of different compost treatments interacted with incubation periods on Zn (µg g $soil^{-1}$) value changes.

Treat.	Incubation intervals (day)					
	0	15	30	45	60	mean
T 1	109.0fgh	176.3def	196.5 de	101.5ghi	163.9def	149.44
T 2	119.3efg	152.7def	177.3def	126.6def	158.5def	146.88
T3	125.0def	206.8 d	184.7def	139.3def	165.7def	164.30
T 4	88.0 hi	117.6efg	122.1 efg	95.25ghi	95.75ghi	103.74
T 5	104.3fgh	84.25hi	103.3fg h	81.58 i	155.1def	105.71
T6	636.0 a	536.0 b	477.8 c	481.9 c	510.9 c	528.52
Mean	196.93	212.28	210. 28	171.02	208.31	

L.S.D. (0.05)

Compost Treatment (A), Time of incubation (B), Interaction (AxB)

38.82 38.27 70.73

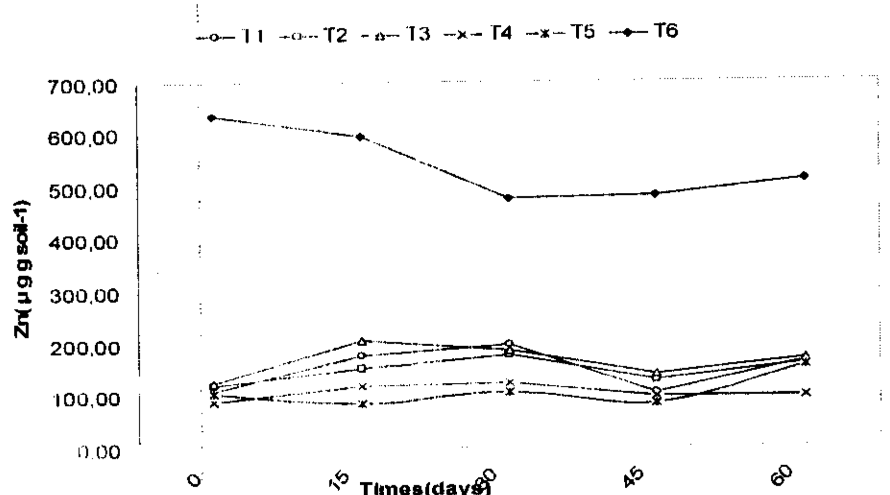


Fig (16): Interaction between different compost treatments and time of incubation on Zn (µg g $soil^{-1}$) value changes.

4.2. Field Experiment:

This experiment was constructed to study the effects of organic media on yield production and yield quality of potato varieties grown in sandy soil under drip irrigation system. Different characteristics of potato growth i.e. vegetative parameter (shoot, tuber dry matter yield) and quality of tuber constitutes (starch, NO_3 and nutrients uptake) were examined.

4.2.1 Effect of compost treatments and inorganic fertilizer on shoot dry matter of potato varieties.

Shoot dry matter yield of different potato varieties as affected by application of compost treatments was presented in Table (14) and graphically illustrated by Fig (17). Considering spunta variety, the dry matter yield of shoots was significantly affected by compost treatments. For example, when spunta was totally treated with organic manure the best values of shoot dry weight induced with treatment T_5 followed by T_3 then T_1. Reversibly, the lowest values were recorded with T_4 and T_6. Generally, all compost treatments resulted in higher values of shoot dry weight than those recorded with totally mineral fertilizer treatment (4.91 g $plot^{-1}$)except T4 which produced the lowest values. In this regard, the relative increase in shoot dry weight was accounted 34%, 52% and 53% over those totally treated with chemical fertilizer for T_1, T_3 and T_5, respectively. The combined treatment of 50%MF and 50%OM, resulted in, generally, higher shoot dry weight than those recorded with either fully mineral fertilizer or fully organic manure treatments. For instance, T_1 induced relative increase accounted for 25% over the same treatment under 100%OM. When 50% MF + 50% OM was applied. In this respect, the highest relative increase

(79%) was noticed with T_4 when comparison was hold between 100 OM and 50%MF +50 OM treatments. Considering the dry weight of Spunta shoots under combined treatment (50% OM + 50%MF), the best treatments of compost application could be ranked as following:

$$T_5 > T_2 > T_3 > T_1 > T_4 > T_6$$

The overall mean of compost treatments showed the superiority of T_5 and T_3 over the others. Similarly, the overall mean of mineral fertilizer and organic manure treatments reflected the superiority of combined treatment (50% OM + 50% MF) over the totally organic and/or totally mineral fertilizer treatments.

Burn variety showed a reversible trend, where the dry weight of shoots reduced, in most treatments higher with 100%OM than with 50%+50% MF treatnents . In this regard, the compost treatments could be ranked as following:

$T_3 > T_5 > T_1 > T_2 > T_6 > T_4$ under 100% OM

$T_5 > T_1 \geq T_3 > T_2 > T_6 > T_4$ under 50% OM + 50% MF

It is clear that all treatments were better under 100% OM than under 50%OM + 50%MF. The overall average of compost treatments reflected the superiority of T_3 over others. In general, shoot dry weight of burn variety as affected by OM treatments was lower than those recoded for spunta variety.

The fertilizing powers of the composts were tested through agronomic trials **(Sellami et al. 2007).** The stem growth showed that the different composts did not have any phytotoxic effect since their application did not exhibit any negative impact on the development of the potato. The growth curves of the potato on different amended parcels with composts showed good stem elongation (0.59–0.68 m) compared to that of the control parcel (0.56 m).

Table (14): Effect of inorganic-N fertilizer and organic compost treatments on shoot dry weight (kg plot^{-1}) of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100% MF	100% OM	50% OM + 50% MF	Mean	100% MF	100% OM	50% OM+ 50% MF	Mean
Control	4.91jk	-	-	4.91	4.51k	-		4.51k
T1	-	6.59gk	8.21cd	7.40	-	6.64fgh	6.97efg	6.81
T2	-	5.07jk	10.04b	7.55	-	6.08hi	5.10jk	5.59
T3	-	7.48def	8.80c	8.14	-	8.12cd	6.94efd	7.53
T4	-	4.63jk	6.89efg	5.76	-	2.43l	3.02l	2.73
T5	-	7.50de	11.79a	9.64	-	7.55de	7,18efd	7.37
T6	-	4.96jk	5.43ij	5.20	-	2.92l	3.07l	3.00
Mean	-	6.04	8.53		-	5.63	5.38	

L.S.D. (0.05)

Compost Treatment (A),	Rate of compost (B),	Variety of Potato (C),	interaction (A×B×C)
0.3341	0.4279	1.032	0.7675

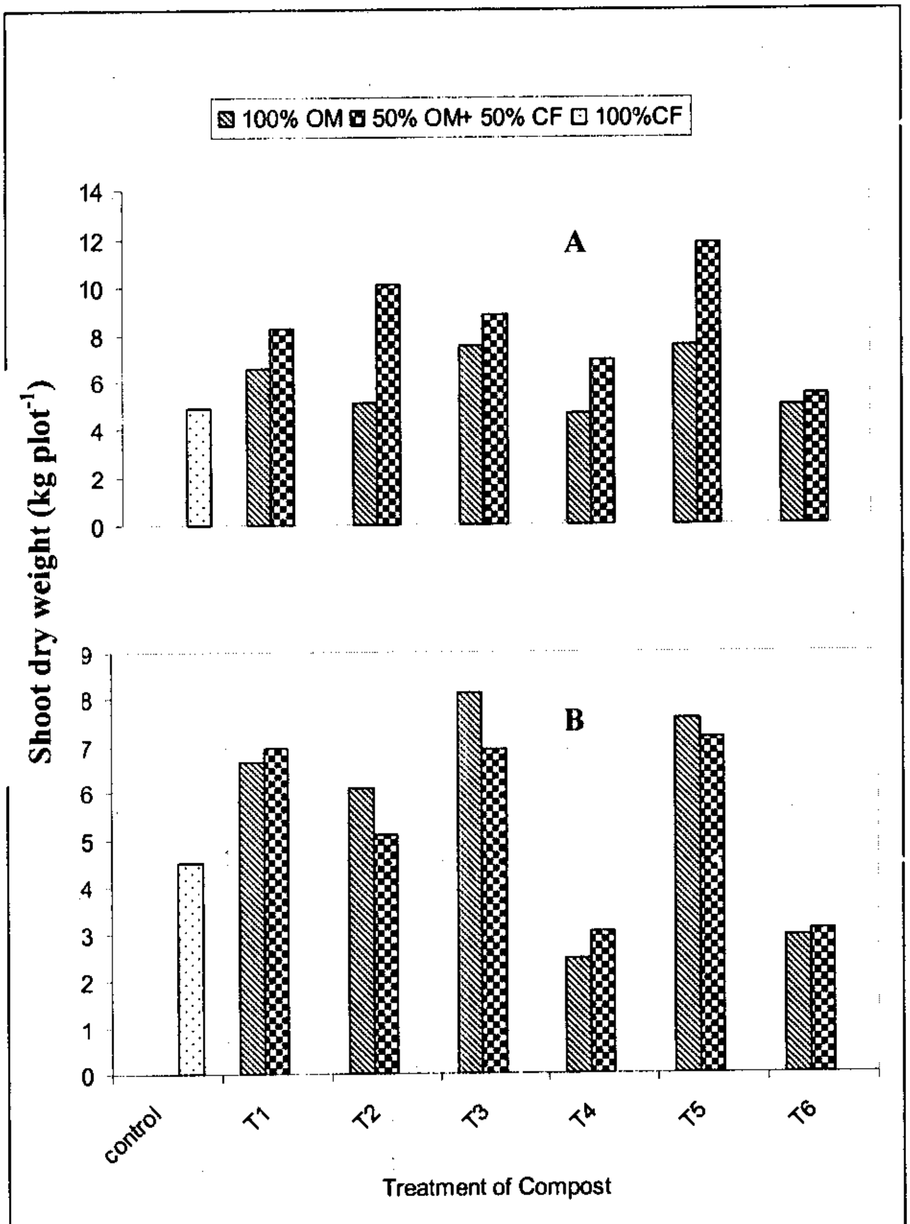


Fig (17): Effect of inorganic-N fertilizer and organic compost treatments on shoot dry weight (kg $plot^{-1}$) of (A) spunta and (B) Burn potato varieties.

(a) Tubers dry weight:

(a) Tubers dry weight:

The dry weight of tuber of different potato varieties treated with different compost combinations was presented in Table (15) and graphically illustrated by Fig (18). High values of tuber dry weight were induced by application of T_2 and T_5 followed by T_1, while T_3, T_4 and T_6 resulted in high reduction in tuber dry weight. The most effective treatments mentioned above (T_2, T_5 and T_1) under 100%OM reflected higher tuber dry weight as compared to 100% MF (19.92 kg plot^{-1}). Reversibly, the treatment T_3,T_4 and T_6 induced significant reduction in tuber dry weight comparing to 100% MF. Relatively, it account for 10%, 33% and 64% lower than 100% MF, for T_3,T_4 and T_6 , respectively under Spunta cultivation. Another view was recorded with application of 50%OM+ 50% MF, where the tuber dry weight was less than those of 100%OM for T_1, T_2 , T_4 and T_5, while it was higher in case of T_3 and T_6. Generally, the application of compost only (100% OM) in different treatments resulted in higher tuber dry weight than combination of 50%OM+ 50% MF. as indicated by overall averages. In the same time, the overall averages of compost treatments indicated the superiority of T_1, T_2 and T_5 over T_3, T_4 and T_6.

Considering the Burn variety, data of tuber dry weight reflected, to some extent, the same trends but to lower extent. This indicated the superiority of Spunta variety over Burn variety although both of them were deferentially responded to composting treatments.

Our results are in agreement with those obtained by(**Haase et al. 2007**) who found that tuber dry matter (DM) was highest after application of potassium sulfate + horn grits (PSHG). Cattle manure (CM) also caused significantly higher tuber DM yields (+0.7 t ha^{-1} or +11.4%) than control (CON). Only in 2002, tuber DM yields of cv. Marlen was higher (+19%) compared with cv. Agria. Their results confirmed the difference between cultivars in response to organic and/or inorganic nutrients sources, which we have in our study. In the same time, it improves the importance of organic additives (organic farming) in reoriented the nutrient status in potato fields.

Table (15): Effect of inorganic-N fertilizer and organic compost treatments on tuber dry weight (kg plot[-1]) of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100% MF	100% OM	50% OM + 50% MF	Mean	100% MF	100% OM	50% OM+ 50% MF	Mean
Control	19.92g	-	-	19.92	11.27n	-		11.27
T1	-	25.35c	23.67d	29.[illegible]1	-	16.09i	11.93mn	14.01
T2	-	39.54a	16.54i	28.04	-	22.36e	12.6lm	17.61
T3	-	17.91h	21.24f	19.58	-	20.92f	13.86jk	17.39
T4	-	13.37kl	11.08n	12.23	-	10.08o	6.54pq	8.31
T5	-	30.43b	21.47ef	25.95	-	18.3h	12.42lm	15.36
T6	-	7.09p	14.73j	10.91	-	5.61q	6.13pq	5.87
Mean	-	22.28	19.62		--	15.56	10.62	

L.S.D. (0.05)

Compost Treatment (A), 0.3625

Rate of compost (B), 0.5260

Variety of Potato(C) 1.268

Interaction (A× B × C) 0.9436

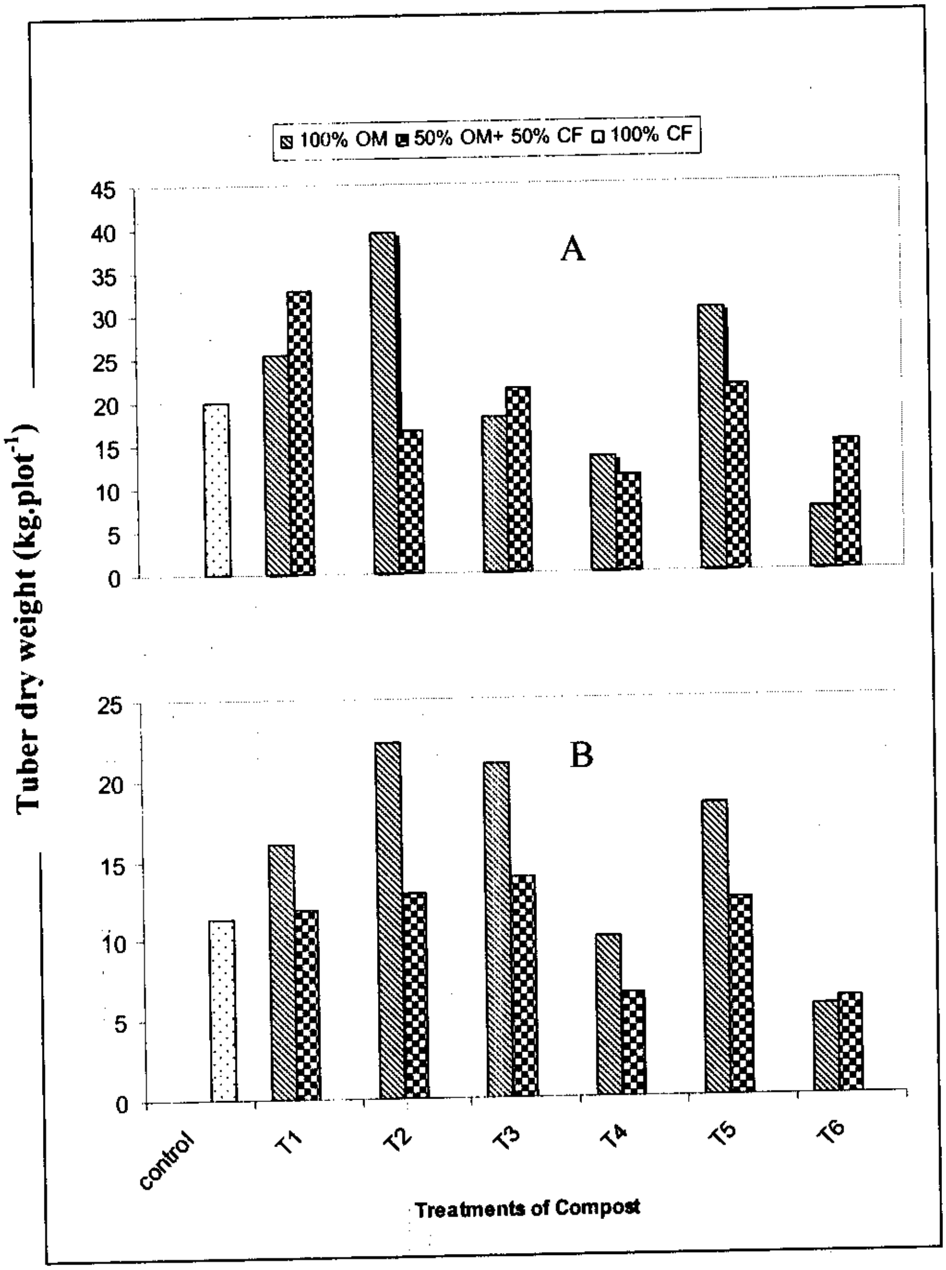


Fig (18): Effect of inorganic-N fertilizer and organic compost treatments on tuber dry weight (kg.plot^{-1}) of (A) spunta and (B) Burn potato varieties.

(b)Tuber yield:

The total yield of tuber of potato varieties as affected by organic matter additions and compost treatments was presented in Table (16) and graphically illustrated by Fig (19). In this regard, spunta variety was positively affected by organic manure and mineral fertilizer treatments as well as compost treatments. Results showed that application of 100% MF induced higher tuber yield than T_3,T_4 and T_6 when compared to 100%OM. While, T_1 and T_2 resulted in slight increase in tuber yield over 100%MF. In case of T_5 with 100%OM, the best value of tuber yield was recorded against 100%MF, where it relatively accounts for about 24% over the totally mineral fertilizer treatment. It is vigorous that T_5 was the best among compost treatments. The picture was turned on in case of combination of organic amendment and mineral fertilizer (50%+50%) where the tuber yield was enhanced with compost treatments, exceptT_2,T_4 and T_6,comparable to those recorded with totally mineral fertilizer application. In this respect, the relative increase of tuber yield was accounted for about 27%, 15% and 28% for T_1, T_3 and T_5, respectively. It is clear that T_5 is the best among treatments. This was confirmed by the overall mean. Similarly, the overall averages of additives combinations reflected the superiority of combined treatment over totally organic treatment, but both of them are still lower than 100% mineral fertilizer treatment.

Concerning the burn variety, positive effect of compost treatment was noticed with T_1, T_2, T_3 and T_5 either applied alone or in combination with mineral fertilizer. The lowest tuber yield was recorded with T_4 and T_6. The overall average of compost treatments showed the superiority of T_3 over others. In the same way, the application of 100%OM was better than combination of 50%OM and 50% mineral fertilizer. Both of them were nearly closed to the tuber yield induced by application of totally mineral fertilizer. Generally, the tuber yield of spunta variety was better than those of burn variety.

Results after **(Van Delden et al. 2003)** indicated that a spring-applied slurry is to be preferred over an autumn-applied slurry in order to avoid over-winter N losses. Tuber yield for a mid-late cultivar was larger than for an early cultivar when harvested on 1 September, but was generally smaller when harvested on 1 August. The residual soil mineral N (RSMN) of the mid-late cultivar was smaller than of the early one at both harvest dates due to a larger crop N uptake. Tuber yield was at most 5% smaller with application of manure having an N/P ratio of 4.0 than with a ratio of 6.2. On farms recently converted from conventional farming, simulated yields were about 5% larger (with large historical N inputs) or smaller (with small historical N inputs) that on farms with a stable soil N content. Patterns of N uptake suggest that organic N with a large proportion of mineral N and applied shortly after emergence, could improve potato yields in organic farming.

So, **(Haase et al. 2007)** stated that total yields of potato tubers depended strongly on the individual year and varied between 27.9 and 35.3 t ha^{-1} (cv. Agria). Results indicate a strong influence of fertilizer treatment on total tuber yields and those relevant for processing into crisps (40–65 mm) or French fries (proportion of tubers >50mm in yield >35 mm). Highest yields were obtained after application of the combined mineral K (potassium sulphate) and organic N (horn grits) source. The response of tuber yield to cattle manure was not consistent over the growing seasons, which confirms that cattle manure is generally a very insecure source of plant available N in the year of application. Possibly, the positive yield response in 2004 was due to K rather than N, since only tuber K concentration and uptake were significantly affected. Overall, the results suggest that in organic potato cropping the correlation between available K - as determined with the common soil test procedures - and yield response may be low. Response of tuber yields graded for crisps and French fries production confirmed that cultivars have to be chosen carefully to secure adequate tuber yield of the required size grades.

On farm manure **(Sellami et al. 2007),** the yield was ranged between 30.5 and 37.5 tons ha^{-1} when planting amended, amended with the composts, They added that the mixture of compost with 25% farm manure significantly improved the productivity of the potato crop. However, even mixed, the highest yields remained in parcels amended with the composts obtained from Windrows III (0.2% sesame shells + 50% poultry manure + 50% exhausted olive cake), then II (75% exhausted olive cake + 25% poultry manure + 0% sesame shells). It could be concluded that the sesame shells, together with the confectionery effluent used for humidification played an important role. Also, the ratios of exhausted olive cake and poultry manure should be considered to optimize the fertilizing properties of the prepared compost. Tubers' size and dry matter content were affected depending on the soil amendment. For all tested composts, tubers of the medium grade were predominant.

Table (16): Effect of inorganic-N fertilizer and organic compost treatments on tuber yield (kg $plot^{-1}$) production of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100% MF	100% OM	50% OM+ 50% MF	Mean	100% MF	100% OM	50% OM+ 50% MF	Mean
Control	110.0d	-	-	110.0	66.0ij	-		66.0
T1	-	110.5d	140.0ab	125.25	-	70.0i	68.0ij	69.00
T2	-	110.5d	104.0h	107.25	-	80.0h	81.0gh	80.50
T3	-	85.0g	127.0c	106.00	-	94.2F	82.0gh	88.09
T4	-	51.0k	64.0j	57.50	-	38.0m	37.0mn	37.50
T5	-	136.0b	141.0a	138.50	-	82.0gh	82.0gh	82.00
T6	-	42.50l	78.0h	60.00	-	33.0n	33.0n	33.00
Mean	-	89.20	109.00		-	66.20	63.83	

L.S.D. (0.05)

Compost Treatment (A)	1.706
Rate of compost (B)	2.246
Variety of Potato (C)	5.416
Interaction (A × B × C)	4.029

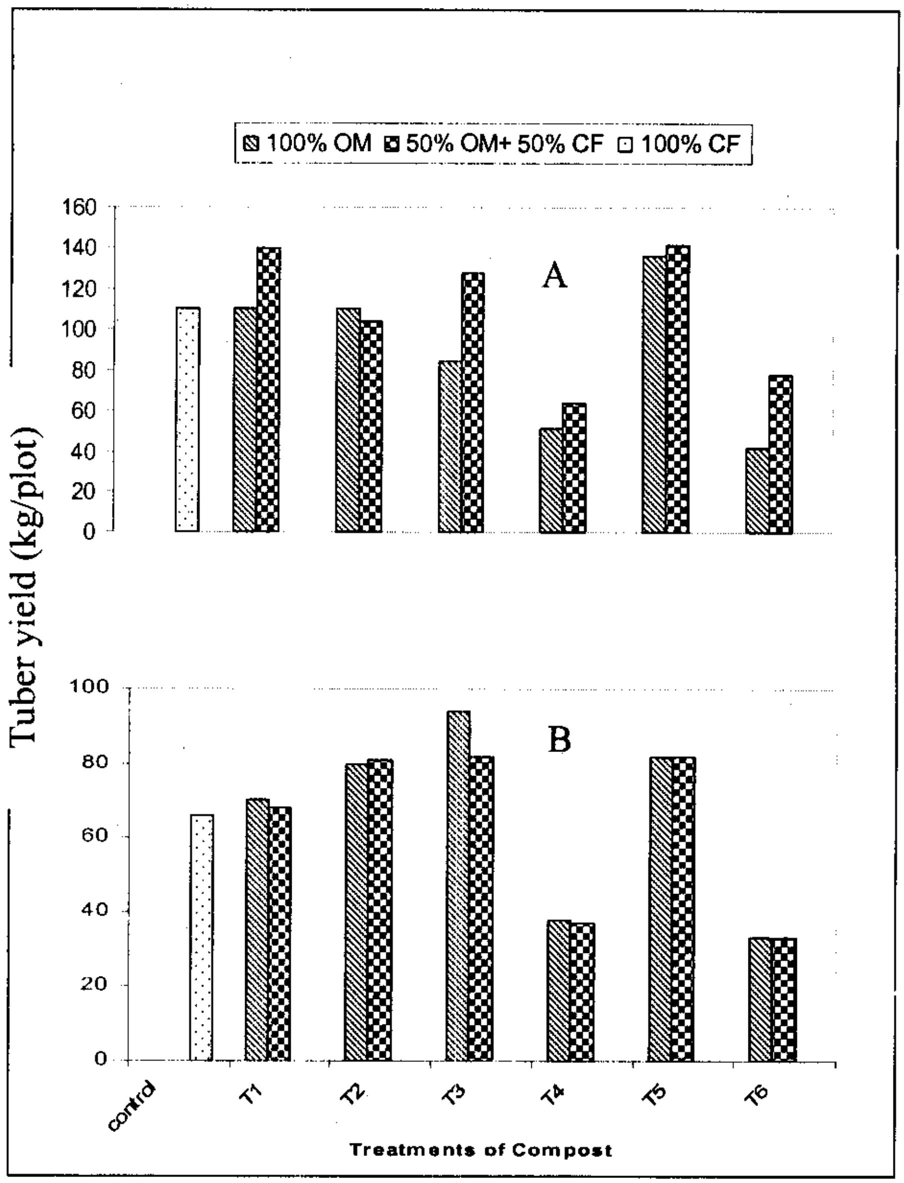


Fig (19): Effect of inorganic-N fertilizer and organic compost treatments on tuber yield (kg/plot) production of (A) spunta and (B) Burn potato varieties.

4.2.2.Nutrients uptake by potato varieties:

(a) Nitrogen uptake by shoots:

Nitrogen uptake by potatoes shoot as affected by compost treatments and combined fertilizer was listed in Table (17) and graphically illustrated by Fig (20). For Spunta variety, it was clear that application of organic manure either solely or in combination with mineral fertilizer enhanced N uptake by shoots, in most compost treatments, comparing to the totally applied mineral fertilizer. Under 100%OM, the effect of compost treatments on N uptake by shoots could be arranged as following:

$$T_3 > T_5 > T_2 > T_1 > T_4 > T_6$$

All compost treatments, expect T_6, induced high N uptake by shoots over totally mineral fertilizer treatments. In this regard, T_3 was the best where it results in relative increase in N uptake over 100% MF by about 179%. This trend, in general, of N uptake was significantly enhanced by combination of 50% OM and 50% MF. under this treatment, all compost treatments expect T_3, induced an increase in shoot-N uptake as compared to 100% OM or 100%MF treatments. With this potato variety, the overall average indicated the superiority of combined fertilization treatment over individuals (100% OM or 100% MF). Dealing with compost application treatments, the overall averages showed that T_5 is the best one.

Nitrogen uptake by shoot of Burn variety was significantly affected by fertilization treatments and compost application treatments. Under most of compost treatments, the application of organic manure either alone or in combination with mineral fertilizer induced high N uptake by shoots as compared to totally fertilized with mineral fertilizer. In case of 100% OM, T_5 gave the best value of shoot-N uptake followed by T_1, while the lowest value was recorded with T_4. Under combined treatment, T_1 was the best and T_6 was the lowest one. Considering the overall average, potato plants treated with totally organic, uptake more N than those treated with totally mineral f fertilizer or combination of them. In general, nitrogen uptake by shoots of Burn variety was lower than those uptaken by shoots of Spunta variety.

Table (17): Effect of inorganic-N fertilizer and organic compost treatments on N uptake (kg $plot^{-1}$) by shoot of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100% MF	100% OM	50% OM+ 50% MF	mean	100% MF	100% OM	50% OM+ 50% MF	Mean
Control	0.71 jkl	-	-	0.71	0.65jkl	-		0.65
T1	-	0.99ghi	2.18b	1.59	-	1.56de	1.72cd	1.64
T2	-	1.28f	1.33ef	1.31	-	0.67jkl	0.82ijk	0.75
T3	-	1.98bc	1.59de	1.79	-	1.77cd	1.10fgh	1.44
T4	-	0.91hij	1.19fg	1.05	-	0.44m	0.51lm	0.48
T5	-	1.78cd	3.07a	2.43	-	2.21b	1.34ef	1.78
T6	-	0.61klm	0.73ijk	0.67	-	0.47lm	0.50lm	0.49
mean	-	1.26	1.68		-	119	1.00	

L.S.D. (0.05)

Compost Treatment (A)	0.1242
Rate of compost (B)	0.1398
Variety of Potato (C)	0.3371
Interaction (A × B × C)	0.2508

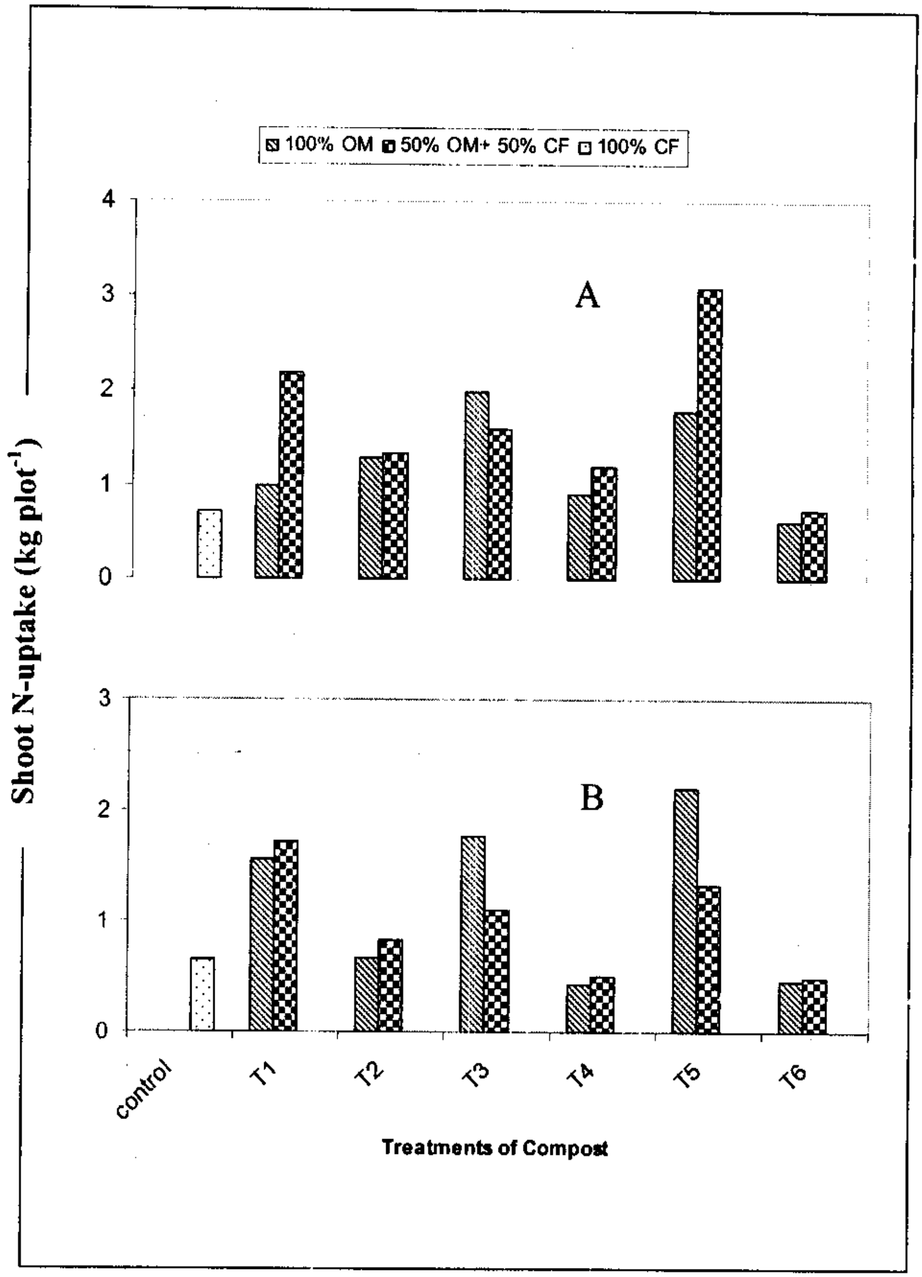


Fig (20): Effect of inorganic-N fertilizer and organic compost treatments on N-uptake (kg plot^{-1}) by shoots of (A) spunta and (B) Burn potato varieties

(b) Potassium uptake by shoot:

Potassium uptake by potatoes shoot as affected by compost and fertilization treatments was presented in Table (18) and graphically illustrated by Fig (21). Potassium as one of the most effective nutrients for potato growth was frequently affected by fertilization strategies and compost treatments. For Spunta variety treated with totally organic amendment, the K uptake by shoots was enhanced by T_3 and T_5 while T_2 and T_6 showed lower content of K when compared to potato plants totally treated with mineral fertilizer. Relatively, T_3 and T_5 induced an increase of K uptake by shoot over 100%MF by about 99% and 47%, respectively. View under combined treatment (50% OM + 50% MF) was a little bit different, where the most of compost treatments resulted in enhancement of K uptake by shoots as compared to totally mineral fertilizer treatment. In this respect, T_2 and T_5 were the best followed by T_6. Also, the overall average showed the superiority of combined treatment over individuals (100%MF or 100%OM). Approximately, the same tends were noticed with Burn variety with a little bit exceptions. In this connection, the overall average showed that T_5 is the best among compost treatment and there was no significant difference between organic manure alone or in combination with mineral fertilizer, but both of them gives higher values of K uptake by shoots than those recorded with totally mineral fertilizer treatment. Generally, K uptake by shoots of Burn variety was significantly lower than those of Spunta variety.

Table (18): Effect of inorganic-N fertilizer and organic compost treatments on K uptake (kg plot^{-1}) by shoot of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100% MF	100% OM	50% OM+ 50% MF	Mean	100% MF	100% OM	50% OM+ 50% MF	Mean
Control	0.92fgh	-	-	0.92	0.55ijk	-	-	0.55
T1	-	0.93efg	0.92fgh	0.93	-	0.95efg	0.88fgh	0.92
T2	-	0.64hij	2.14a	1.39	-	0.75ghi	0.74ghi	0.75
T3	-	1.83ab	0.94efg	1.39	-	1.06def	1.04def	1.06
T4	-	0.94efg	0.75ghi	0.85	-	0.31k	0.51jk	0.41
T5	-	1.35cd	2.16a	1.76	-	1.6bc	1.23def	1.42
T6	-	0.89fgh	1.29cde	1.1	-	0.45jk	0.49jk	0.47
Mean	-	1.10	1.37		-	0.85	0.82	

L.S.D. (0.05)

Compost Treatment (A)	0.1014
Rate of compost (B)	0.4374
Variety of Potato (C)	0.3254
Interaction (A × B × C)	0.1814

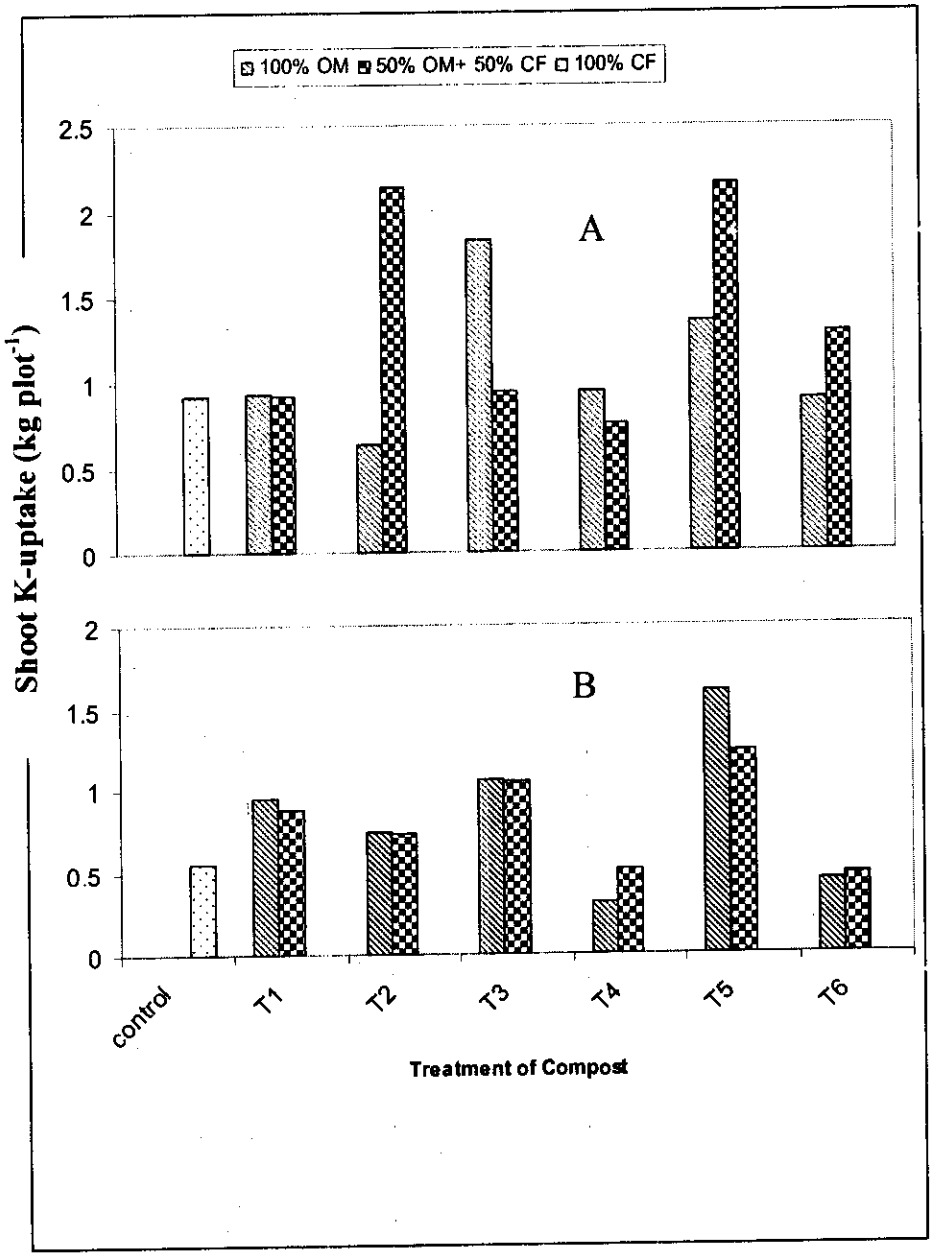


Fig (21): Effect of inorganic-N fertilizer and organic compost treatments on K-uptake by shoots (kg plot^{-1}) of (A) spunta and (B) Burn potato varieties.

(c)Phosphorus uptake by shoot:

Phosphorus uptake by shoot of potato varieties as affected by fertilization strategies and compost treatments is listed in Table (19) and graphically illustrated by Fig (22). Spunta variety did not reflect any significant difference between either amendment combination or compost treatments when P uptake by shoots was considered. Similar trend was noticed with Burn variety. All organic treatments either applied solely or in combination with mineral fertilizer had enhanced P uptake by shoots against mineral fertilizer alone. This holds true with both Spunta and Burn varieties. Also, there was no significant difference between the two varieties when P uptake by shoots was considered.

The results obtained by **(Ohno et al. 2005)** suggested that addition of animal manures may increase the bioavailability of soil P by increasing the concentration of soil dissolved organic carbon (DOC). The use of crop management systems, which uses animal manure, can be beneficial from an agronomic perspective by decreasing the requirement for inorganic fertilizer to meet crop demand. So, it is in harmony with us where the P uptake by shoots of potato varieties was enhanced by application of different compost combinations either alone or in mixture with inorganic fertilizer comparing to inorganic fertilizer solely.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100 % MF	100 % OM	50% OM+ 50% MF	Mean	100 % MF	100 % OM	50% OM+ 50% MF	Mean
Control	0.19a	-	-	0.19	0.19a	-	-	0.19
T1	-	0.33a	0.33a	0.33	-	0.37a	0.31a	0.35
T2	-	0.24a	0.41a	0.33	-	0.31a	0.27a	0.29
T3	-	0.31a	0.37a	0.34	-	0.42a	0.28a	0.36
T4	-	0.18a	0.25a	0.22	-	0.11a	0.12a	0.11
T5	-	0.33a	0.52a	0.43	-	0.33a	0.31a	0.32
T6	-	0.24a	0.22a	0.23	-	0.11a	0.11a	0.11
Mean	-	0.27	0.35		-	0.27	0.24	

L.S.D. (0.05)

Compost Treatment (A)	26.75
Rate of compost (B)	31.68
Variety of Potato (C)	76.39
Interaction (A × B × C)	56.83

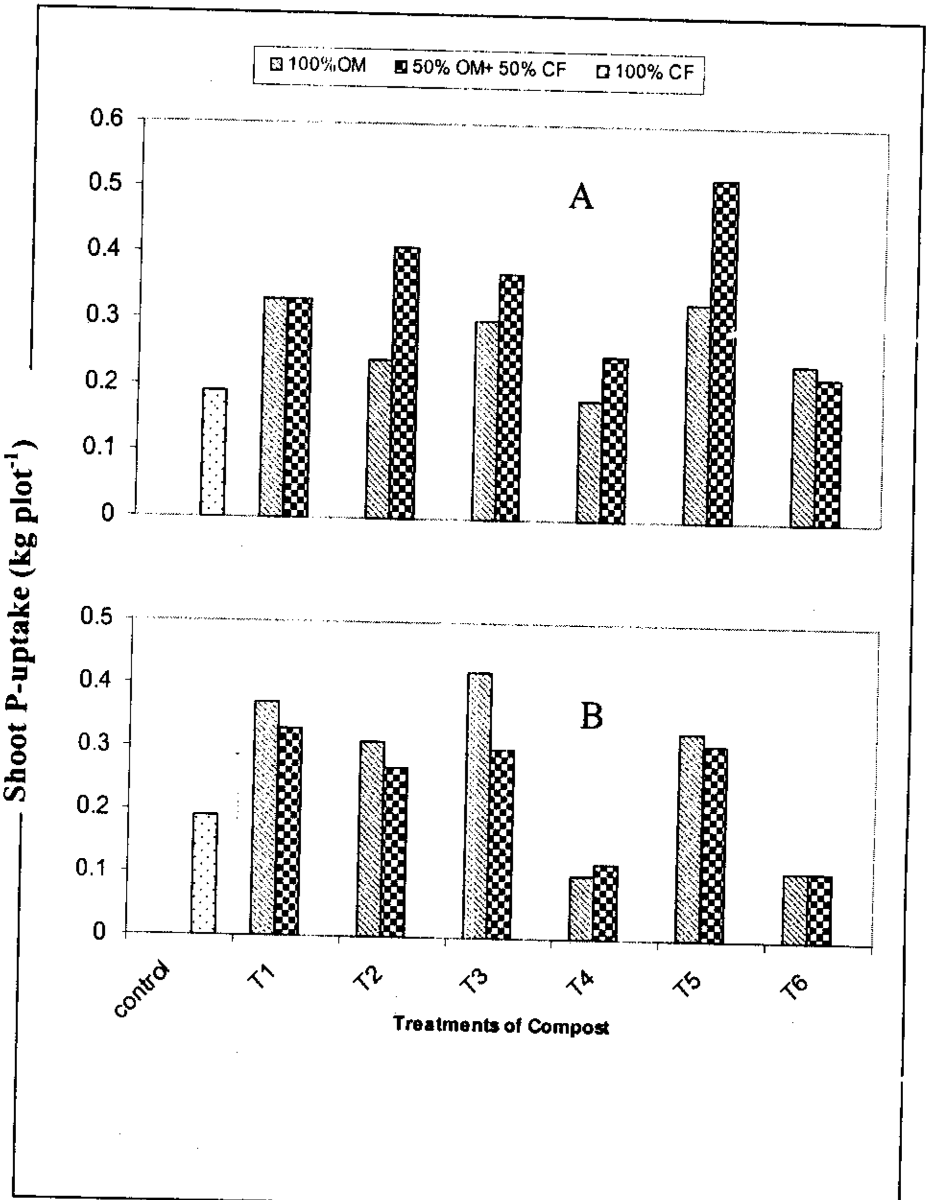


Fig (25): Effect of inorganic-N fertilizer and organic compost treatments on P-uptake by shoots (kg plot^{-1}) of (A) spunta and (B) Burn potato varieties.

(d) Nitrogen uptake by potato tuber:

(d) Nitrogen uptake by potato tuber:

Values of N uptake by potato tuber as affected by compost treatments and fertilization strategies are presented in Table (20) and graphically illustrated by Fig (23). Firstly, it is worthy to mention that N uptake by tuber, in general, was higher than those uptaken by potato shoots. Spunta variety showed significant accumulation of nitrogen in tuber correlated to compost applications. In most of the compost treatments, the addition of 100%OM had increased N uptake by tuber over those recorded with 100%MF. For instance, T_1, T_2, T_3 and T_5 accumulated 4.3, 6.9,4.3 and 6.1 g N $plot^{-1}$, respectively against 2.7 g N $plot^{-1}$ for added 100% mineral fertilizer. These values are double or more than those recorded with totally mineral fertilized plots. Among the compost treatments, T_5 and T_2 seems to be the best ones. The lowest value of N uptake by tuber was recorded with T_6 followed by T_4. Corresponding values of N uptake under combined treatment (50%OM + 50%MF) were fluctuated according to compost treatments. In general, they were lower than those recorded with totally organic fertilized plots. Treatments of T_1, T_3 and T_5 showed an increase of N uptake over those of totally mineral fertilized plots, while T_2, T_4 and T_6 induced low N uptake when compared to 100%MF treatment. In conclusion, plants treated with totally organic materials had accumulated more N in tuber than those treated with totally mineral fertilizer or with combined treatment. In the same time, the overall mean indicated the superiority of T_5 over other compost treatments when N uptake by tuber was considered.

Similar trends were noticed with Burn variety but to lower extent. On line with us, the highest N uptake (127 $kgNha^{-1}$) was measured in 2003 when also very high tuber DM and N concentrations were recorded. Tuber N uptake and concentration were significantly influenced by fertilization and the year with consistently highest values for both parameters after application of either potassium sulphate + horn grits (PSHG) or horn grits (HG). The two cultivars differed significantly in terms of tuber N uptake only in 2002 **(Haase et al. 2007).**

Table (20): Effect of Inorganic-N Fertilizer and organic Compost Treatments on N uptake by tuber (kg plot^{-1}) of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100% MF	100 % OM	50% OM+ 50% MF	Mean	100% MF	100% OM	50% OM+ 50% MF	Mean
Control	2.65hij	-	-	-	1.77klm			-
T1	-	4.263d	5.407c	4.74	-	3.527efg	2.743hi	3.14
T2	-	6.880a	2.037ijk	4.46	-	3.130a	1.563lmn	2.35
T3	-	4.317d	3.720def	4.02	-	4.117de	2.423hij	3.27
T4	-	2.217ijk	1.932jkl	1.72	--	1.790klm	1.140mn	1.47
T5	-	6.087b	5.227c	5.66	-	4.390d	2.977gh	3.69
T6	-	0.963n	2.213ijk	1.59	-	0.980n	0.9667n	0.98
Mean	-	4.09	3.31		-	2.99	1.97	

L.S.D. (0.05)

Compost Treatment (A) 0.2064

Rate of compost (B) 0.3781

Variety of Potato (C) 0.9117

Interaction (A × B × C) 0.6783

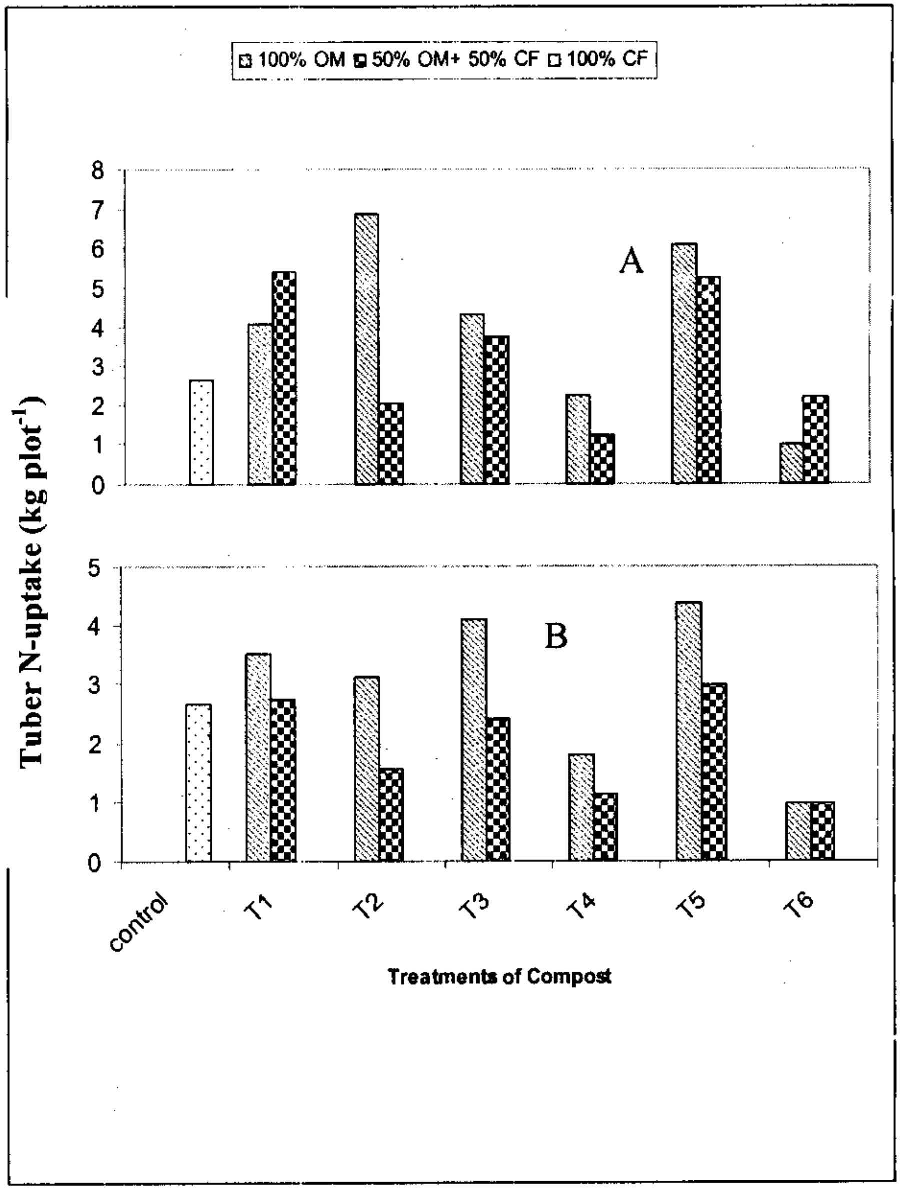


Fig (23): Effect of inorganic-N fertilizer and organic compost treatments on N-uptake by tubers (kg plot^{-1}) of (A) spunta and (B) Burn potato varieties.

(e) Potassium uptake by tuber:

Potassium uptake by tuber of potato varieties treated with different compost treatments and fertilization strategies was presented in Table (21) and graphically illustrated by Fig (24). Spunta variety significant untaken of K when treated with totally organic materials comparing to the plants treated with totally mineral fertilizer. Concerning the compost treatments, results showed that T_1, T_3 and T_5 were the best while T_2, T_4 and T_6 were low. In this respect, T_5 caused relative increase in K uptake by tuber accounted for 185% over those recorded with plant treated with 100% mineral fertilizer. The treatments T_3 and T1 come to the next. Severe reduction in K uptake by spunta tuber was recorded with T_6 as compared to plants totally treated with mineral fertilizer. Under application of 50%OM plus 50%MF, most of the compost treatments induced an increase in K uptake ranged from slight to high values over those of plants totally treated with mineral fertilizer.

For example, T_1, T_2 and T_5 resulted in relative increase in K uptake by about 65%, 130% and 110%, respectively over those of totally fertilized with mineral fertilizer. In contrast, T_4 resulted in severe reduction in K uptake as compared to the plants totally treated with mineral fertilizer. Generally, K uptake by tuber was better under 100%OM than 50%+50%MF and or 100%MF treatments. In addition, T_5 seemed to be the best treatment of compost addition when K uptake by tuber was considered. Similar trends, but to low extent, were noticed with Burn variety. In conclusion, both of the two potato varieties had accumulated more K in tubers than those recorded with plant shoots.

(Haase et al. 2007) found that the highest K uptake was measured after application of potassium sulfate + horn grits (PSHG), which was significantly higher than after cattle manure (CM) and potassium sulfate (PS) alone, while the latter two treatments caused significantly higher K uptake than HG and control (CON). The K uptake of cv. Marlen was higher compared to cv. Agria in two of three seasons (2002 and 2003). These results to some extent are in harmony with the results we have.

Tuber K concentration was affected by fertilizer application and the year significantly. Up to three-way interactions were established (F×CV×Y: $p < 0.01$). Nevertheless, there was a significant response, i.e. an increased tuber K concentration due to CM, PS and PSHG fertilization in every case-except for cv. Agria in 2003 **(Haase et al. 2007).**

Nutrient (N, P, K) input and off take were studied for 4 years with crops grown on sandy soil containing peat in The Netherlands **(Vos 1996).** The crop rotations were S (potato/sugar beet/potato/spring wheat) and C (continuous cropping with potato). Two levels of nitrogen supply were: (1) the standard rate for the region minus 15% (Nl); and (2) the standard rate plus 15% (N2). Soil analyses were used as a guide for input of P and K. Organic matter treatments were a control versus extra addition of organic matter. Nutrient inputs considered included nitrogen deposition from the atmosphere (44 kg ha^{-1} $year^{-1}$). Offtake was nutrients in harvested products. Nitrogen balances (input minus offtake) ranged from 31 to 100 kg ha^{-1} $year^{-1}$ and were significantly higher for N2 than for Nl. The P and K balances were close to zero. Averaging data per crop species yielded characteristic values for nutrient concentrations in harvested products, nutrient off take and nitrogen balances. Spring wheat showed the smallest nitrogen balance, followed by potato; sugar beet showed large nitrogen surpluses. The differences in nitrogen balances between the extremes of the potato plots were 134 kg ha^{-1} for Nl and 154 kg ha^{-1} for N2 treatments, caused by a factor 2 in difference in yield and a factor 1.6 in nitrogen concentration.

Generally, our results, more or less, are in agreement with the results of **(Haase et al. 2007)** who concluded that an increase in soil N status at early crop growth stages can best be accomplished by applying horn grits, rather than cattle manure, or by cultivating potatoes after a pre-crop such as grass-clover, as compared to cereal grains. Results show clearly that the use of cattle manure in organic agriculture impedes the optimization of more than one nutrient in terms of the nutrition of the potato crop. Data indicate a low potential of fresh cattle manure to increase plant available N and tuber N uptake. Accordingly, a yield response to cattle manure cannot be predicted. Data on tuber K uptake imply the yield response to CM (in one of 3 years) to be due to an increased availability of K rather than NO_3-N. Moreover, it can be concluded that K availability can be increased by cattle manure and mineral K fertilization equally. Yet, the high level of tuber K contents even from unfertilized plots suggests that loamy sand may have a potential to supply K from its reserves, not accounted for in the soil analysis commonly used.

In order to increase tuber FM yields, the combination of mineral K fertilizer and an organic N source, such as horn grits proved to be an excellent alternative to CM in terms of timely N-availability, tuber N uptake and concentration. Mineral K or horn grits applied together provide a better nutritional regime for increasing tuber yield than when applied solely.

When tubers are marketed for industrial processing of tubers, the portions of certain size-grades and the dry matter content of tubers play an important role. In this connection, the choice of cultivar may be a more efficient agronomic measure to increase financial returns than fertilization.

Table (21): Effect of inorganic-N fertilizer and organic compost treatments on K uptake by tuber ($kgplot^{-1}$) of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100 % MF	100 % OM	50% OM+ 50% MF	Mean	100 % MF	100 % OM	50% OM+ 50% MF	Mean
Control	1.39ij	-	-	1.39	0.67lm			0.67
T1	-	2.21ef	2.30de	2.25	-	1.50hi	0.99kl	1.25
T2	-	1.82gh	3.20b	2.51	-	1.55hi	0.98kl	1.01
T3	-	3.08b	1.80gh	2.44	-	1.95fg	1.50hi	1.73
T4	-	1.11jk	0.86kl	0.99	-	0.33m	0.32m	3.29
T5	-	3.96a	2.93bc	2.79	-	2.62cd	1.71gh	2.16
T6	-	0.75kl	1.62gh	1.19	-	0.24m	0.30m	0.22
Mean	-	2.16	1.78		-	1.78	1.43	

L.S.D. (0.05)

Compost Treatment (A)	0.1603
Rate of compost (B)	0.1977
Variety of Potato (C)	0.4767
Interaction (A × B × C)	0.3546

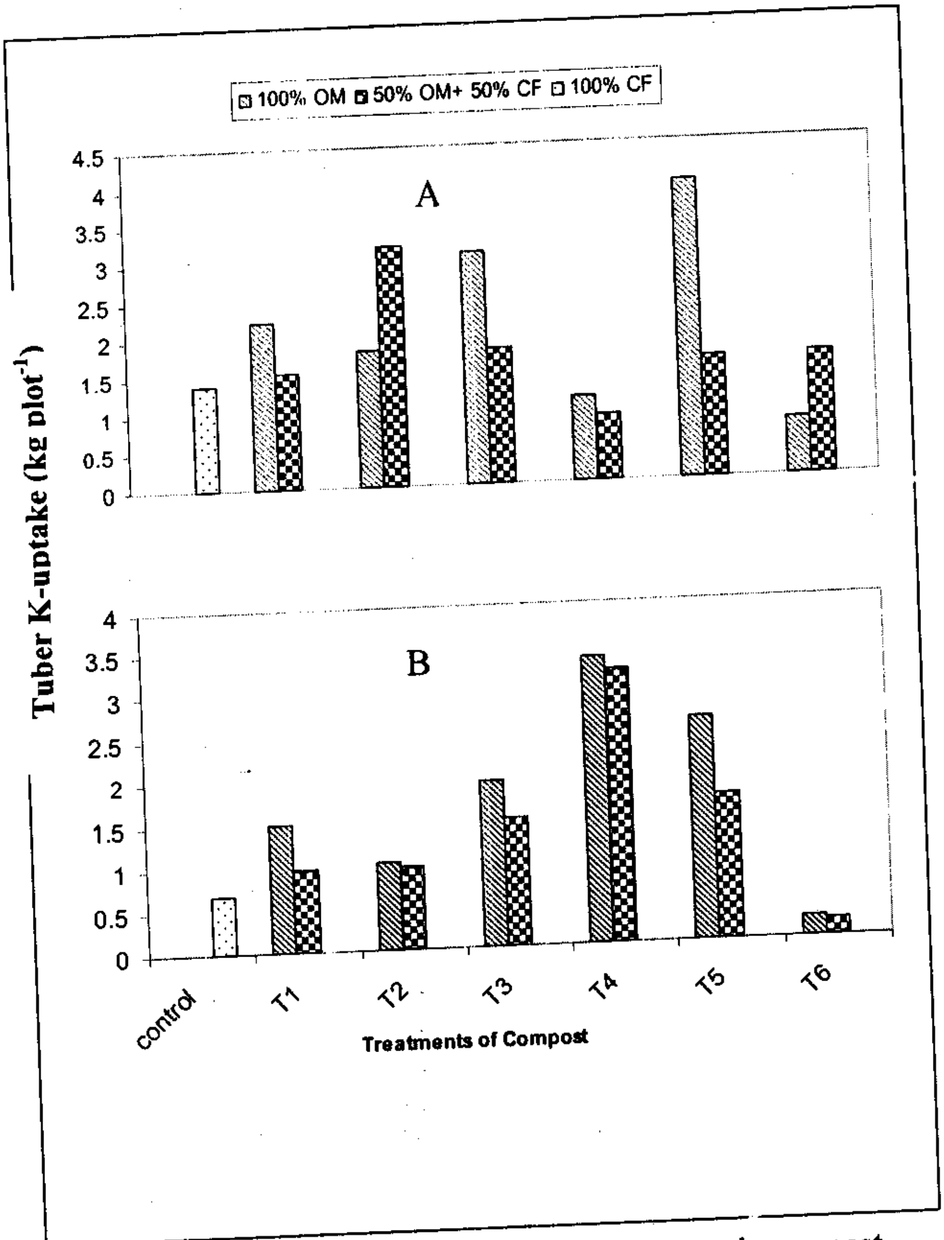


Fig (24): Effect of inorganic-N fertilizer and organic compost treatments on K-uptake by tubers (kg plot^{-1}) of (A) spunta and (B) Burn potato varieties.

4.2.3.Starch accumulation in potato tubers:

Starch content in tubers of potato varieties treated with chemical and organic fertilizer was presented in Table (22) and graphically illustrated by Fig (25). With spunta variety, composted organic materials either applied solely or in combination with mineral fertilizer significantly affected starch content of tubers. All compost treatments applied under fully organic treatment had induced an increase in starch content of tubers when compared to the plants totally treated with mineral fertilizer. In this regard, T_3 was the best treatment followed by T_5 then T_1.

Similar observations were noticed with combined treatment (50%OM + 50%MF). There was no big significant difference between totally organic treatment and the combined treatment when starch content was considered. Similar trend was noticed with Burn variety, but the values of starch content in tuber were to somewhat extent, lower than those recorded with Spunta variety. Some reductions in starch content were noticed with T_4 Under organic additions as compared to the treatment of 100% mineral fertilizer. Comparison between compost treatments indicated the superiority of T_6 over the others. On the other hand, there was no big significant difference between totally organic treatment and combined one.

Applied nitrogen significantly decreased the starch content of tubers up to 100 kg N ha^{-1} and no significant change was observed at higher levels of its application. Application of nitrogen to the potato crop significantly enhanced the protein content of tubers, whereas no significant effect was found on the reducing or non-reducing sugars. The decrease in starch content of tubers with increase in applied nitrogen may be attributed to the dilution effect as a result of an increase in the dry matter produced **(Sharma and Arora, 1988).**

Our results of starch content in tubers are in accordance with those mentioned above, where it was lower with application of 180 kg mineral-N fed-1 than those recorded with application of organic compost either alone or in combination with the half dose of mineral fertilizer-N. This holds true with both potato varieties.

(Sharma and Arora 1988) added that significant increases in the starch and protein yields of potatoes were found up to the application of 200 kg N ha^{-1} in the absence and 250 kg N ha^{-1} in the presence of farmyard manure (FYM) which shows that response to nitrogen increased when it is applied along with FYM. The increase ih yields of starch and proteins by potatoes were significant up to the application of 60 kg P_2O_5 ha-x in the absence and 30 kg P_2O_5 ha^{-1}in the presence of FYM. In the case of potassium application, significant increases in starch and proteins were recorded up to 150 kg K_2O ha^{-1} in the absence and 100 kg K_2O ha^{-1} in the presence of FYM. This indicated that the response of potatoes to phosphorus and potassium decreased in the presence of FYM. The increases in the starch and protein contents of potatoes were found to be associated with the increase in the tuber dry matter yield as a result of applied nutrients.

Our values of starch accumulated in tubers are nearly closed to those recorded by **(Salama 2005)** who found that starch content was significantly correlated with potato varieties and organic matter addition.

Table (22): Effect of inorganic-N fertilizer and organic compost treatments on starch in tubers(g100g^{-1} fresh. weight) of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100 % MF	100 % OM	50% OM+ 50% MF	Mean	100 % MF	100 % OM	50% OM+ 50% MF	Mean
Control	17.47def	-	-	-	15.14ij	-	-	-
T1	-	19.21abc	18.77abc	18.99	-	16.41fg	15.20ij	15.81
T2	-	18.67abc	18.19cde	18.40	-	15,79hi	14.10j	14.95
T3	-	19.73a	18.50bcd	19.1	-	16.73fg	15.12ij	15.90
T4	-	18.11cde	17.46def	17.80	-	14.27j	14.02j	14.16
T5	-	19.62ab	18.70abc	19.20	-	16.49fg	16.55fg	16.6
T6	-	18.24cde	18.2cde	18.20	-	16.2ghi	17.25ef	16.75
Mean	-	18.90	18.31		-	15.98	15.39	

L.S.D. (0.05)

Compost Treatment (A) 0.4877

Rate of compost (B) 1.488

Variety of Potato (C) 1.465

Interaction (A × B × C) 1.090

Table (22): Effect of inorganic-N fertilizer and organic compost treatments on starch in tubers(g100g^{-1} fresh. weight) of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100 % MF	100 % OM	50% OM+ 50% MF	Mean	100 % MF	100 % OM	50% OM+ 50% MF	Mean
Control	17.47def	-	-	-	15.14ij	-	-	-
T1	-	19.21abc	18.77abc	18.99	-	16.41fg	15.20ij	15.81
T2	-	18.67abc	18.19cde	18.40	-	15,79hi	14.10j	14.95
T3	-	19.73a	18.50bcd	19.1	-	16.73fg	15.12ij	15.90
T4	-	18.11cde	17.46def	17.80	-	14.27j	14.02j	14.16
T5	-	19.62ab	18.70abc	19.20	-	16.49fg	16.55fg	16.6
T6	-	18.24cde	18.2cde	18.20	-	16.2ghi	17.25ef	16.75
Mean	-	18.90	18.31		-	15.98	15.39	

L.S.D. (0.05)

Compost Treatment (A)	0.4877
Rate of compost (B)	1.488
Variety of Potato (C)	1.465
Interaction (A × B × C)	1.090

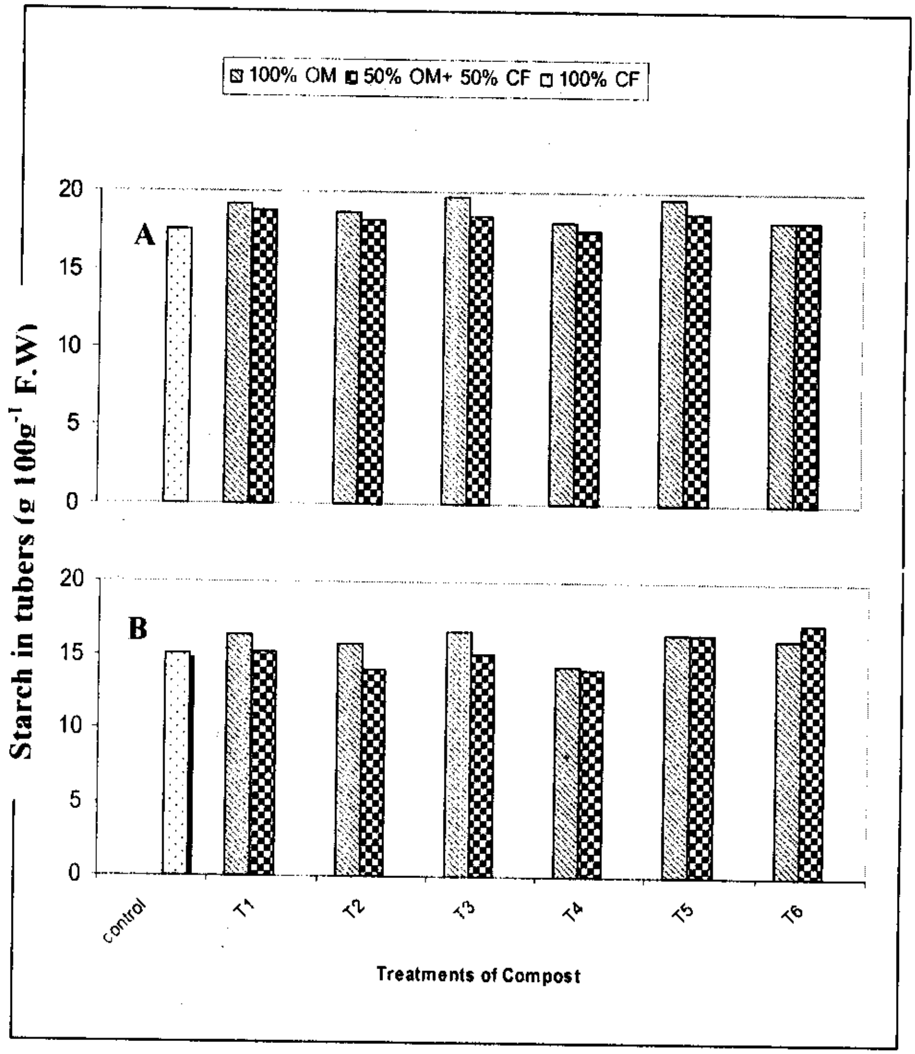


Fig (25): Effect of inorganic-N fertilizer and organic compost treatments on starch in tubers (g $100g^{-1}$ F.W) of (A) spunta and (B) Burn potato varieties.

this regard, low content of NO_3^- was detected in tubers of Burn variety when compared to Spunta variety.

The results obtained by(**Dueñas et al. 2006)** showed that the highest tuber yield of 36.42t ha^{-1} and lowest nitrate in potato tubers (40ppm) was produced by fertigation and the lowest tuber yield of 15t ha^{-1} and highest nitrate in potato tubers (724ppm) was produced by traditional irrigation systems.

Concerning the variety effect, significant variation in nitrate content of different varieties treated with farmyard manure was recorded earlier **(Hamouz, 1991)**. Application of compost and NPK fertilizers were found to correlate with nitrate in either potato tubers or soil **(Nazarov, 1992)**. **(Vogtmann *et al.* 1993)** stated that compost significantly reduced nitrate content. Our results, to some extent, are in harmony with those mentioned above.

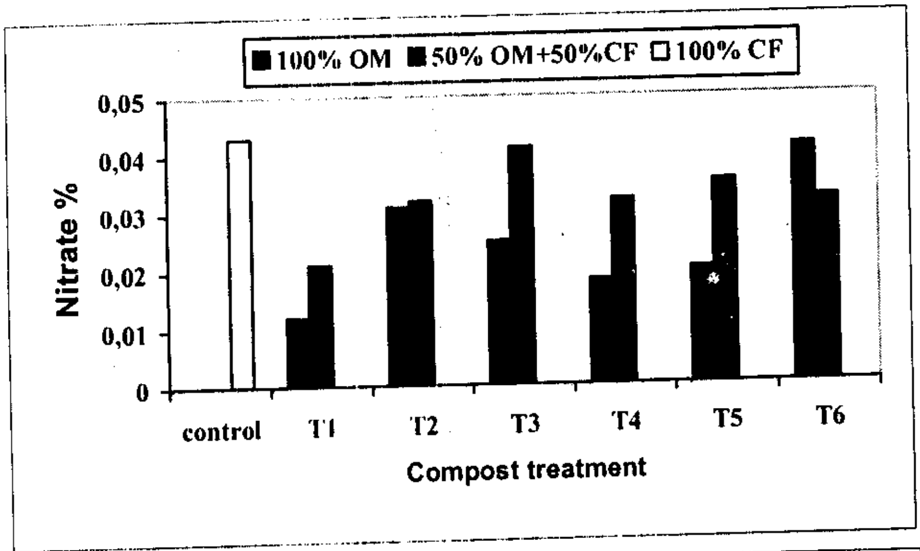
On the other hand, we are in consistent with the results obtained by **(Salama ,2005)** who found that the application of organic matter at rate of 5.2 t ha^{-1} had reduced the nitrate content in tubers of two potato varieties with significant variation between them.

Table (23): Effect of inorganic-N fertilizer and organic compost treatments on NO_3% in tubers of potato varieties.

Treat.	Spunta				Burn			
	Inorganic-N Fertilizer and organic Compost Treatments							
	100 % MF	100% OM	50% OM+ 50% MF	Mean	100% MF	100% OM	50% OM+ 50% MF	Mean
Control	0.043a	-	-	0.043	0.026cde	-	-	0.026
T1	-	0.012hi	0.021def	0.017	-	0.05i	0.032bcd	0.019
T2	-	0.031bcd	0.032bcd	0.032	-	0.031bcd	0.022def	0.027
T3	-	0.025cde	0.041ab	0.033	-	0.026cde	0.015ghi	0.024
T4	-	0.018fgh	0.032bcd	0.025	-	0.021def	0.026cde	0.024
T5	-	0.020efg	0.035abc	0.028	-	0.017fgh	0.017gh	0.017
T6	-	0.041ab	0.032bcd	0.037	-	0.023def	0.028cde	0.037
Mean	-	0.030	0.032		-	0.020	0.020	

L.S.D. (0.05)

Compost Treatment (A)	0.2710
Rate of compost (B)	0.0555
Variety of Potato (C)	0.1339
Interaction (A × B × C)	0.9965



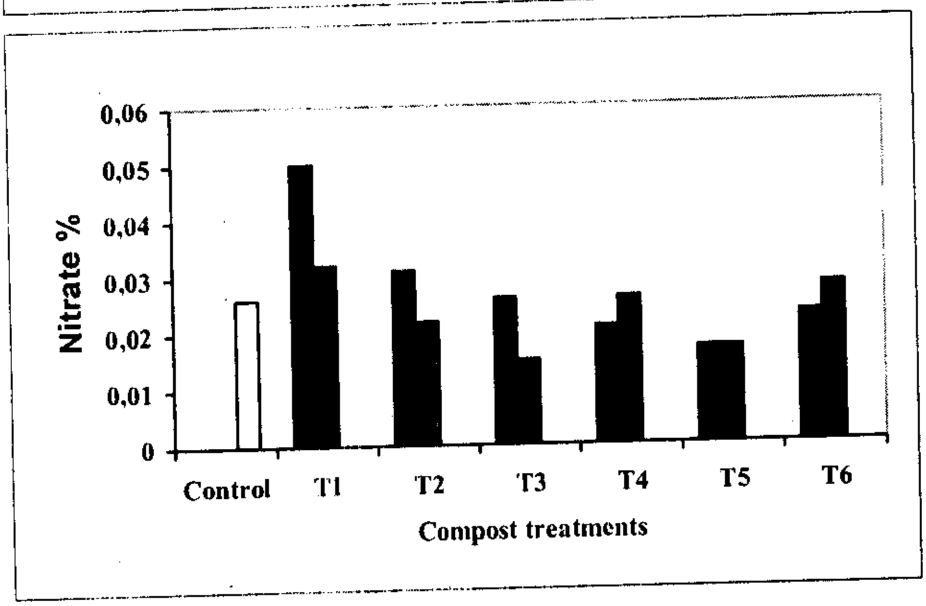


Fig (26): **Effect of inorganic-N fertilizer and organic compost treatments on NO_3 % in tubers of (A) spunta and (B) Burn potato varieties.**

4.3. Application of ^{15}N isotope dilution technique:

In this part of thesis we will concentrate our discussion on the role of ^{15}N stable isotope on recognition of nitrogen sources, i.e. fertilizer-N, organic-N, and soil-N, that derived to the potato varieties and uptake by the different plant organs. In the same time, the application of this technique gave us the chance to estimated exactly the ^{15}N recovered from the mineral N form as well as the percentage of fertilizer use efficiency (%FUE). Using the indirect labeling method, depending on isotope dilution concept, as described by **(Hood et al. 1999) and (Hood 2002),** we have estimated the portion of nitrogen gained from the composted materials incorporated in soil media and utilized by shoots and tubers of potato plants.

4.3.1 Nitrogen derived from fertilizer (%Ndff):

Nitrogen derived from fertilizer gained by shoots of different potato varieties, either as percentage or absolute values, under different organic treatments is presented in Table (24) and graphically illustrated by Fig (27). Results showed that more than half of the fertilizer-N was utilized by shoots of both potato varieties treated with totally mineral fertilizer (180 kg N fed^{-1}). It means that about 40% of the added fertilizer-N may lost by any of the responsible mechanisms, i.e. dentrification, volatilization, leaching ...etc., or remained in soil profile. Spunta variety treated with combined fertilizers (50% OM+50% MF) reflected low percentages of N derived from fertilizer depending on compost treatments. These percentages ranged from 1% to 25%. In this regard, T_4 followed by T_5 were the best treatments induced high percent (24.9% and 21.9%, respectively) of N derived from mineral fertilizer. The lowest portion of Ndff was resulted from application of T_2 and T_6 treatments. It is worthy to mention that when full-recommended dose of fertilizer (180 kg N fed^{-1}) was solely added, nitrogen was efficiently used by shoots of spunta variety. Similar trend with a little bit difference was noticed with Burn variety. The best percent of Ndff was occurred with T_5 (24.8%). Generally, the portion of Ndff gained by shoots was very low under compost treatments as compared to the totally mineral fertilized treatment. Our results are in consistent with those obtained by(**Halitligil et al. 2002)** who found that the portion of Ndff was increased with increasing fertilizer rate up to 400 kg N ha^{-1}, but over that (1,000 kg N ha^{-1}) the reversible trend was occurred.

They concluded that the excess of nitrogen was lost by leaching in the NO_3 form to the underground water causing an environmental problem for human being.

Nitrogen derived from chemical fertilizer by tubers of potato varieties is presented in Table (2) and graphically illustrated by Fig (2). It is obvious that the portion of Ndff by tubers of both potato varieties was lower than those recorded with shoots. A less than 50% of the added fertilizer-N was uptake by tubers. The best percent Ndff was recorded with T1 and T_3 for Spunta and burn varieties, respectively. Burn variety showed, in general, higher percent of Ndff than those recorded with Spunta variety. This holds true under most of the compost treatments.

The results obtained by **(Halitligil et al. 2006)** showed that 33.5 t ha^{-1} mean total marketable tuber yield was obtained with application of 600 mm irrigation water. Also, it was found that water did not move below 90 cm of soil layer in drip irrigation-fertigation system, suggesting that no N movement occurred beyond 90 cm soil depth. Although the % ^{15}N a.e. values of the soil solutions taken from the tensionics were highest in those placed at the 65 cm soil depth (0.095-1.06 % ^{15}N a.e.), no ^{15}N was detected at the 85 cm depth for all locations and for every treatment. Tuber yields and % Ndff increased when N was applied with drip irrigation-fertigation system in comparison to the application to the soil and then drip irrigation. At harvest, more N was accumulated at 0-30 and 30-60 cm depths with fertigation treatments.

Table (24): Effect of different compost treatments on portion and quantity of nitrogen derived from chemical fertilizer and uptake by shoots of potato varieties.

Treat.	Spunta				Burn			
	100% MF		50% MF + 50% OM		100% CF		50% MF + 50% OM	
	%	kg plot^{-1}	%	kg plot^{-1}	%	kg plot^{-1}	%	kg plot^{-1}
Chemical	59.4	0.42	-	-	58.2	0.38	-	-
T1	-	-	6.42	0.14	-	-	2.5	0.04
T2	-	-	1.24	0.017	-	-	14.3	0.12
T3	-	-	9.4	0.15	-	-	9.2	0.10
T4	-	-	24.9	0.30	-	-	8.0	0.04
T5	-	-	21.9	0.67	-	-	24.8	0.33
T6	-	-	1.2	0.009	-	-	7.1	0.04

MF = mineral fertilizer; OM = organic compost

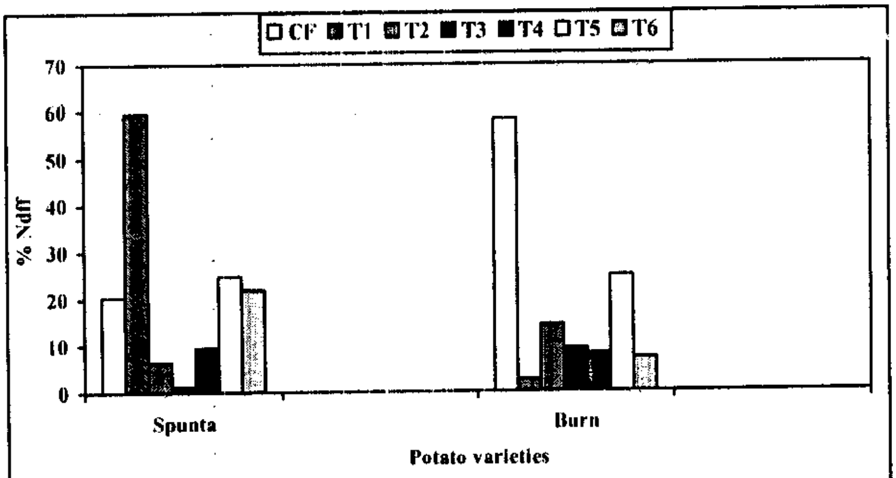


Fig (27) Effect of different compost treatments on N derived from chemical fertilizer and uptake by shoot of potato varieties

Table (25): Effect of different compost treatments on portion and quantity of nitrogen derived from chemical fertilizer and uptake by tubers of potato varieties.

Treat.	Spunta				Burn			
	100% MF		50% MF + 50% OM		100% MF		50% MF + 50% OM	
	%	kg $plot^{-1}$	%	kg $plot^{-1}$	%	kg $plot^{-1}$	%	kg $plot^{-1}$
Chemical	45.3	1.20	-	-	43.8	0.78	-	-
T1	-	-	21.2	1.15	-	-	17.4	0.48
T2	-	-	11.9	0.24	-	-	3.4	0.05
T3	-	-	5.2	0.19	-	-	21.3	0.52
T4	-	-	5.1	0.10	-	-	3.5	0.04
T5	-	-	4.5	0.24	-	-	18.8	0.56
T6	-	-	4.4	0.10	-	-	13.2	0.13

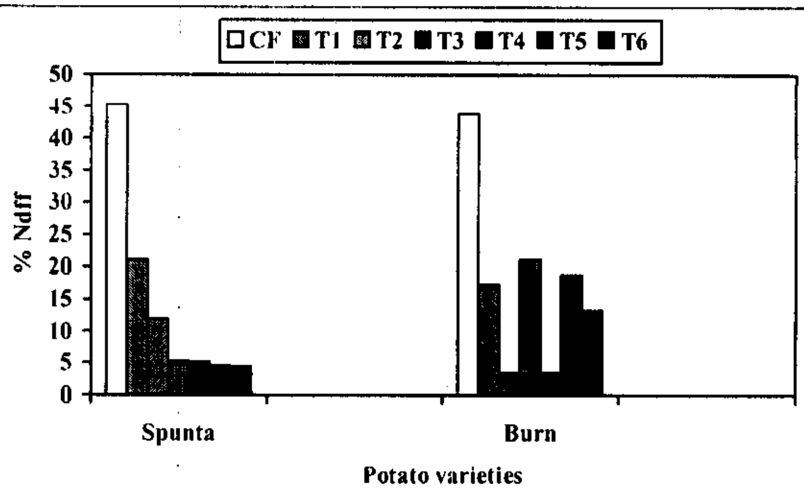


Fig (2) Effect of different compost treatments on nitrogen derived from chemical fertilizer and uptake by tubers of different potato varieties

4.3.2. Nitrogen derived from compost (%Ndfcomp):

The percentage and amounts of nitrogen derived by shoots of potato varieties from organic compost incorporated into the soil are presented in Table (26) and graphically illustrated by Fig (29). Compost treatments have a great effect on portions of N derived from organic compost. In this respect, the shoots of spunta variety showed considerable benefits from organic compost. In other turn, the great bulk of nitrogen uptake by shoots was derived from organic compost as compared to the portion of Ndff. The best percentages of Ndfoc were recognized with T_2 and T_6 followed by T_1 then T_3 treatments.

In case of burn variety; data showed that the application of T_1 treatment induced the best benefits from organic residues, which composted in different mixtures. Treatments of T_6, TT_4 and T_3 came to the next. It seems that most of the compost treatments were effective on releasing mineralized N to the burn variety as compared to spunta variety. It is worthy to mention that the lowest percent of Ndfoc was recorded with T5 treatment.

Table (26): Effect of different compost treatments on portion and quantity of nitrogen derived from compost and uptake by shoots of potato varieties.

Treat.	Spunta				Burn			
	100% MF		50% MF + 50% OM		100% MF		50% MF + 50% OM	
	%	kg plot^{-1}	%	kg plot^{-1}	%	kg plot^{-1}	%	kg plot^{-1}
Chemical	-	-	-	-	-	-	-	-
T1	-	-	84.8	1.85	-	-	93.9	1.62
T2	-	-	97.0	1.30	-	-	65.2	0.53
T3	-	-	77.8	1.24	-	-	77.6	0.85
T4	-	-	41.2	0.49	-	-	80.7	0.41
T5	-	-	48.2	1.48	-	-	39.7	0.53
T6	-	-	97.3	0.71	-	-	82.7	0.41

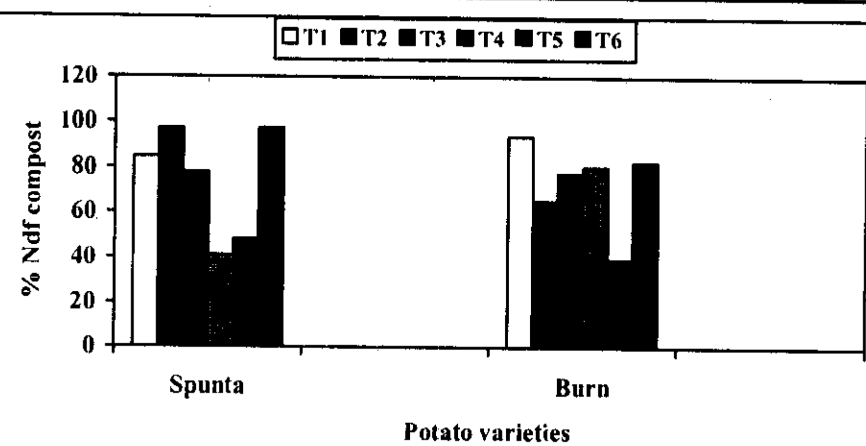


Fig (29) Effect of different compost treatments on nitrogen derived from organic residues and uptake by potato varieties

Nitrogen gained from organic compost by tubers of different potato varieties is listed in Table (27) and graphically illustrated by Fig (30). With spunta variety, there was no significant difference between T_3, T_4, T_5 and T_6 when the portion of Ndfoc gained by tubers was concerned. Lowest percentages of Ndfoc were resulted in by application of T_1 and T_2 treatments.

Concerning the burn variety, fluctuated trend of compost treatments was noticed. In this regard, T_2, T_4 and T_6 gives higher percentages of Ndfoc than those recorded with T_1, T_3 and T_5 treatments.

Generally, there was no big significant difference between nitrogen gained by shoots and tubers from the organic compost. This holds true with both potato varieties.

In this regard, (**Hood *et al.* 2000)** showed that the values of Ndfr obtained using the new approach to the isotope dilution technique gave good agreement with the direct values in most treatments. The cross-labelling approach allowed easy comparison of the two methodologies. The challenge now is to develop a field pre-labelling procedure that will allow indirect estimations of Ndfr for a variety of organic residues. However, **(Hood et al. 1999)** showed that pool substitution as described by(**Jenkinson *et al.* 1985) and(Hart *et al.* 1986)** could lead to erroneous values for the quantity of N derived from mineralization of residues. But the values, which we have, are lower or to some extent nearly closed to the values recorded by the aforementioned literature.

Table (27): Effect of different compost treatments on portion and quantity of nitrogen derived from organic compost and uptake by tubers of potato varieties.

Treat.	Spunta				Burn			
	100% MF		50% MF + 50% OM		100% MF		50% MF + 50% OM	
		kg $plot^{-1}$		%	%	kg $plot^{-1}$	%	kg $plot^{-1}$
Chemical	-	-	-	-	-	-	-	-
T1	-	-	27.5	1.49	-	-	37.9	1.04
T2	-	-	59.3	1.21	-	-	87.9	1.37
T3	-	-	82.2	3.06	-	-	24.0	0.58
T4	-	-	82.6	1.60	-	-	87.6	0.99
T5	-	-	84.6	4.42	-	-	33.0	0.98
T6	-	-	85.0	1.88	-	-	52.9	0.51

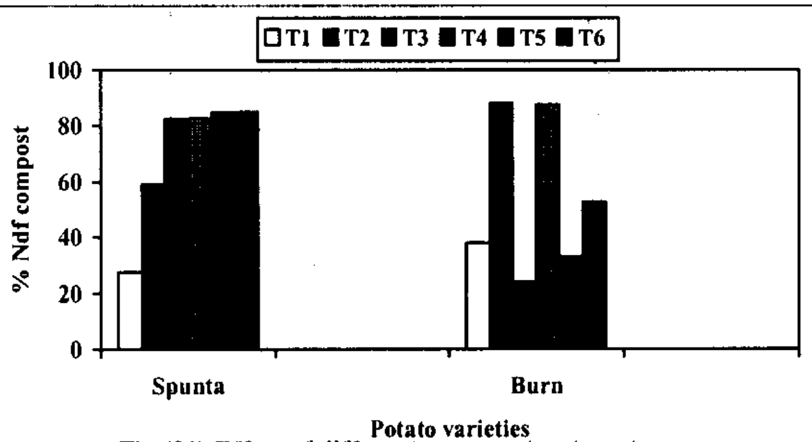


Fig (30) Effect of different compost treatments on nitrogen derived from organic residues and uptake by tubers of potato varieties

4.3.3. Nitrogen derived from soil (% Ndfs):

Portion and absolute values of nitrogen gained from soil pool by shoots of potato varieties treated with organic compost in different combinations are listed in Table (28) and graphically illustrated by Fig (31). Approximately, more than 40% of nitrogen uptake by shoots of potato varieties was gained from soil pool when the plants were totally fertilized with mineral fertilizer. The application of organic compost treatments declined these percentages which mean that the plants became dependable on other N sources rather than soil pool. Lowest portion of Ndfs under spunta variety was recorded with T_2 and T_6 treatments. Moderate percentages of Ndfs were recorded with T_4 and T_5 treatments. With burn variety, the portions of Ndfs were ranged from 4 to 36% according to the organic compost treatments. The high percent of Ndfs was only recognized with T_5 treatment followed by T_2. Generally, there was no big significant difference between potato varieties when the portion of Ndfs was considered.

Table (28): Effect of different compost treatments on portion and quantity of nitrogen derived from soil and uptake by shoots of potato varieties.

Treat.	Spunta				Burn			
	100% MF		50% MF + 50% OM		100% MF		50% MF + 50% OM	
	%	kg $plot^{-1}$	%	kg $plot^{-1}$	%	kg $plot^{-1}$	%	kg $plot^{-1}$
Chemical	40.7	0.29	-	-	41.9	0.27	-	-
T1	-	-	8.8	0.19	-	-	3.6	0.06
T2	-	-	1.8	0.02	-	-	20.5	0.17
T3	-	-	12.8	0.20	-	-	13.2	0.15
T4	-	-	33.9	0.40	-	-	11.4	0.06
T5	-	-	29.9	0.92	-	-	35.5	0.48
T6	-	-	1.5	0.01	-	-	10.2	0.05

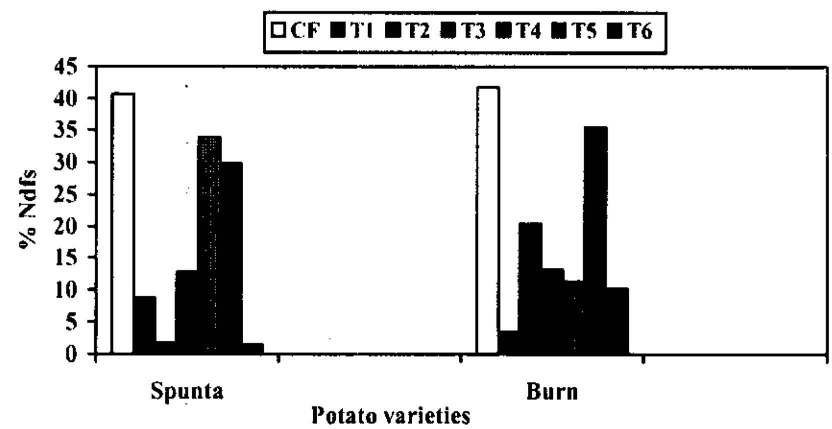


Fig (31) Effect of different compost treatments on nitrogen derived from soil by potato shoots

Nitrogen derived from soil pool and uptake by tuber of potato varieties as affected by compost treatments is presented in Table (29) and graphically illustrated by Fig (32). With tubers of both potato varieties more than 50% of the nitrogen uptake was derived from soil pool. The application of organic compost to spunta variety induced declines in the portion of N derived from soil when compared to the plants totally fertilized with chemical fertilizer. More declines in Ndfs percentages were resulted from application of T_3, T_4, T_5 and T_5 treatments. The % Ndfs under T_1 treatment was nearly closed to that recorded with totally chemical fertilized site. Under burn cultivation, T_3 and T_5 followed by T_1 resulted in %Ndfs nearly to those of totally chemical fertilized treatment. More declines in %Ndfs was observed with T_2, T_4 and T_6 treatments. It seems that burn variety was partially dependent on portion of N derived from soil by tubers.

Table (29): Effect of different compost treatments on portion and quantity of nitrogen derived from soil and uptake by tubers of potato varieties.

Treat.	Spunta				Burn			
	100% MF		50% MF + 50% OM		100% MF		50% MF + 50% OM	
	%	kg $plot^{-1}$		%	kg $plot^{-1}$	kg $plot^{-1}$	%	kg $plot^{-1}$
Chemical	54.8	1.45	-	-	56.2	0.99	-	-
T1	-	-	51.3	2.77	-	-	44.7	1.23
T2	-	-	28.8	0.59	-	-	8.7	0.14
T3	-	-	12.6	0.47	-	-	54.7	1.33
T4	-	-	12.3	0.24	-	-	8.9	0.10
T5	-	-	10.9	0.57	-	-	48.2	1.43
T6	-	-	10.6	0.23	-	-	33.9	0.33

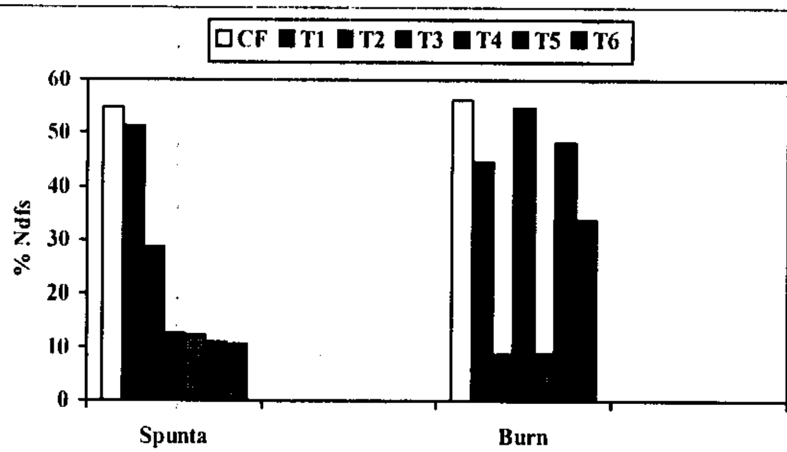


Fig (32) Effect of compost treatments on portion of nitrogen derived from soil by potato tubers

4.3.4. Fertilizer use efficiency (% FUE):

The percentages of efficient use of either chemical or organic fertilizers uptaken by shoots of potato varieties are listed in Table (30) and graphically illustrated by Fig (31). Generally, the chemical fertilizer either applied solely or in combination with organic compost was not efficiently used by potato varieties. In case of spunta shoots, the percent of fertilizer use efficiency not exceeds 30% when chemical fertilizer was totally applied. The application of organic compost treatments showed very low efficiency especially under T6 and T2 treatments. High % FUE was only recorded with T5 treatment. In general, the %FUE under burn cultivation was lower than those recorded with spunta variety when T1, T3, T4 and T5 treatments were considered.

Regardless the potato varieties and fertilizer type, our data about %FUE are in accordance either for shoots or tubers with those obtained by **Maidl et al. (2002)** who found that the fertilizer N recovery in plant biomass tuber and foliage ranged from 35.9% to 68.5% at growth stage EC 79; the main fraction was allocated to tubers. Also, they added that placement of fertilizer N in the ridge had a positive effect on N recovery, when the total N amount was applied at planting. In broadcast application, fertilizer N recovery was higher when the fertilizer doses were split, as compared with a single broadcast application at planting. When fertilizer N was applied in split doses, the effect of N placement became negligibly small. Fertilizer N recovery in soil ranged from 19.5% to 24.6%, and total recovery ranged from 60.1% to 88.0%. Rainfall between planting and plant emergence, and conditions restricting plant development in early developmental stages were related with unaccounted fertilizer N losses. Therefore, the positive effects of split N applications or fertilizer placement are most likely to occur under unfavorable growing conditions.

Table (30): Effect of different compost treatments on efficient use of chemical and organic fertilizers by shoots of potato varieties.

Treat.	SPUNTA		BURN	
	100% CF	50% CF + 50% OC	100% CF	50% CF + 50% OC
	% FUE			
Chemical	27.1	-	24.5	-
T1	-	17.7	-	5.1
T2	-	2.2	-	15.2
T3	-	19.0	-	12.7
T4	-	38.0	-	5.1
T5	-	85.0	-	41.8
T6	-	1.14	-	5.1

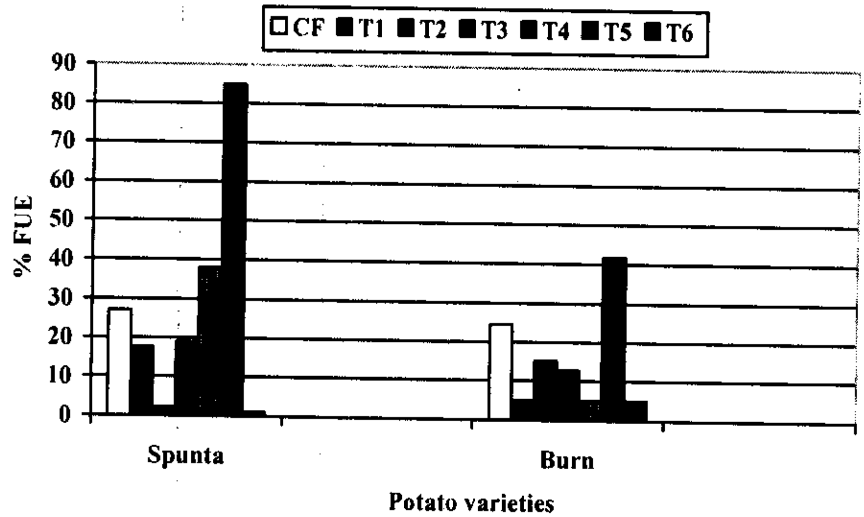


Fig (33) Effect of compost treatments on fertilizer use efficiency by shoots of potato varieties

The data of fertilizer use efficiency by tubers of potato varieties was presented in Table (31) and graphically illustrated by Fig (34). The %FUE under spunta variety was highly significant than those recorded with burn variety when chemical fertilizer was totally applied. It means that the tuber of spunta variety was dependent on chemical fertilizer than those derived from soil pool. The percentage of FUE was declined with application of organic compost treatments indicating the dependence of spunta tubers on other N source rather than chemical fertilizer (organic N). The %FUE under treatments T2 and T5 was similar. These were the highest percentages among the treatments. The lowest percentage of FUE was recorded with T6 followed by T1 treatment.

With burn tubers, the %FUE was enhanced by application of T1, T3 and T5 treatments as compared to the plants totally fertilized with chemical fertilizer. On the other hand, the lowest percent of FUE was noticed with application of T4 treatments.

As an average, the chemical fertilizer either applied solely or in combination with organic compost was efficiently used by tubers than by shoots. This holds true under both potato varieties cultivation.

The results obtained by **Halitligil et al. (2002)** showed that the optimum marketable tuber yield was obtained with 600 kg N/ha. Tuber N uptake was increased slightly, while leaf plus vine N uptake increased considerably when the N rate was increased from 400 to 1,000 kg N/ha. The %NUE values decreased nearly by half and the amount of N fertilizer in the 0–200 cm soil layer increased more than 3 times when the N rate was increased from 400 to 1,000 kg N/ha. Nearly half of the applied fertilizer N (45.6%) at 400 kg

N/ha and more than half of the applied fertilizer N (60.8%) at 1,000 kg N/ha was still in the 0–200 cm soil layer after harvest. Four times more N fertilizer was leached below 200 cm soil depth when 1,000 kg N/ha N was applied instead of 400 kg N/ha. Their results also indicate that there is a potential contamination of groundwater due to leaching of the applied N fertilizer. These results, more or less, are on line with our results about the portion of N derived from chemical ammonium sulfate fertilizer as well as the percent of fertilizer use efficiency.

The field results after **Dueñas et al. (2006)** on N use efficiency were further confirmed by those obtained from lysimeters (lisimetric tanks with an area of $0.2375m^2$ and 60cm deep, with potato [Desiree Variety] as indicative crop), which were installed at the same field site and ^{15}N-labelled urea fertilizer (20% ^{15}N). The fertilization rate used for the potato was 180kg of N per ha, two methods of application of the fertilizer were compared: one at sowing and another as split applications (50% at sowing and 50% at 30 days later). The results obtained by means of the isotopic method proved that the efficiency of N fertilizer rises to 35% when was applied at times when the crop is in the most need for nitrate (30 days after the germination of the crop). In the case of fertigation the dose can be divided into several applications and be applied in the moments of maximum demand. In the management conditions established up to 1993, the nitrate contents in tuber exceeded the permissible limit of 250 mg/kg. Though the introduction of fertigation in potato fields matches with a period of diminishing urea applications, it can be asserted that the low nitrate content (less than 100 ppm) in potato obtained under this condition is due to the combination of two characteristics of this irrigation system, more efficient use of the fertilizer and high harvesting yields.

Saif et al. (2006) found that all fertigated treatments gave significantly higher yield than surface application treatment (Ns). Their study showed that, the drip system and method of fertigation used can potentially save water usage by 50% without any reduction in yield compared with that obtained with the surface application treatments. In addition, the efficient use of N fertilizer was high for all fertigation treatments compared to the surface application (Ns).

Table (31): Effect of different compost treatments on efficient use of chemical and organic fertilizers by tubers of potato varieties.

Treat.	SPUNTA		BURN	
	100% CF	50% CF + 50% OC	100% CF	50% CF + 50% OC
	% FUE			
Chemical	77.4	-	50.3	-
T1	-	19.0	-	60.8
T2	-	30.4	-	6.3
T3	-	24.1	-	65.8
T4	-	12.7	-	5.2
T5	-	30.4	-	70.9
T6	-	12.7	-	16.5

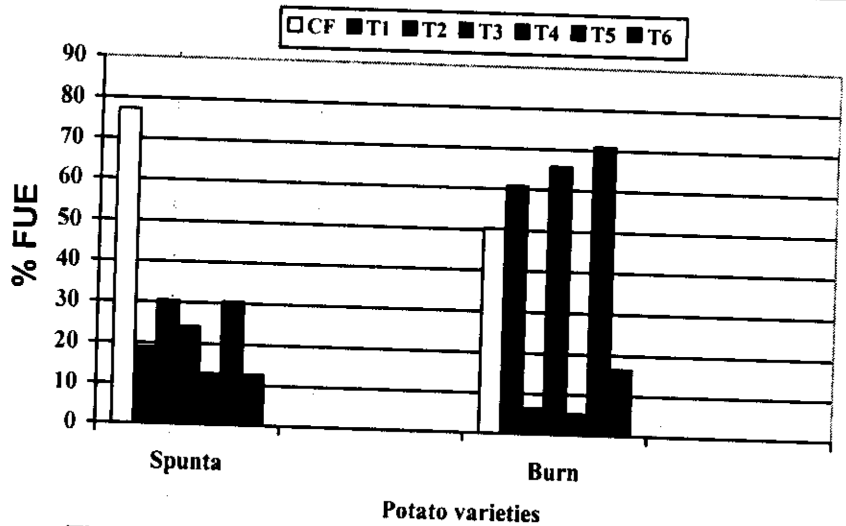


Fig (34) Effect of compost treatments on fertilizer use efficiency by tubers of potato varieties

4.3.5. ^{15}N Recovered by potatoes:

^{15}N fraction recovered by shoots of potato varieties is presented in Table (32) and graphically illustrated by Fig (35). Shoots of spunta variety recovered 0.84 kg ^{15}N plot^{-1} while shoots of burn variety recovered 0.76 kg ^{15}N plot^{-1} when both varieties were totally fertilized with chemical ammonium sulfate fertilizer. The application of organic compost in combination with chemical fertilizer in ratio of half: half reduced the amount of ^{15}N recovered by shoots of both varieties. This may be due to amount of nitrogen mineralized from the organic source, which made a big dilution for nitrogen pool ($^{14}N/^{15}N$ ratio) and in the same time we should keep in mined that the labeled ammonium sulfate was applied at half dose of those applied solely. The effect of compost treatments on the amount of ^{15}N recovered by shoots was fluctuated. This holds true for both potato varieties. In this regard, T5 treatment seems to be the best one among others under spunta and/or burn cultivation. As an average, the amounts of ^{15}N recovered by shoots of spunta variety were significantly higher than those of burn variety as affected by organic compost treatments.

Table (32): Effect of different compost treatments on ^{15}N recovered by shoots of potato varieties.

Treat.	SPUNTA		BURN	
	100% CF	50% CF + 50% OC	100% CF	50% CF + 50% OC
	^{15}N Recovery (kg plot^{-1})			
Chemical	0.84	-	0.76	-
T1	-	0.28	-	0.086
T2	-	0.033	-	0.23
T3	-	0.30	-	0.20
T4	-	0.59	-	0.08
T5	-	1.34	-	0.66
T6	-	0.017	-	0.07

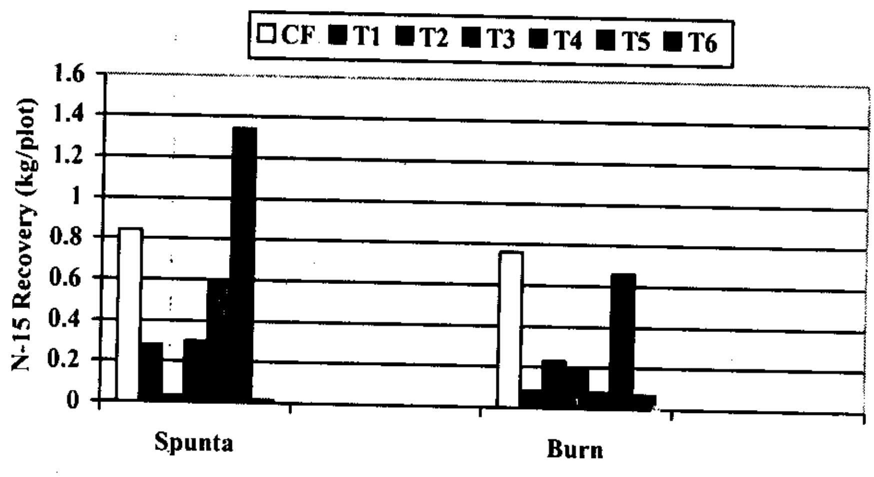


Fig (35) N-15 recovered by shoots of potato varieties as affected by compost treatments

^{15}N recovered by tubers of potato varieties as affected by compost treatments is listed in Table (33) and graphically illustrated by Fig (36). It is obvious that the ^{15}N recovered by tubers of potato varieties totally fertilized with chemical fertilizer was higher than those recorded with shoots. In this respect, comparison held between the two varieties indicated that the amounts of ^{15}N recovered by spunta tubers were significantly higher than those of burn variety. Like those detected with shoots, the application of organic compost had reduced the amounts of ^{15}N recovered by tubers of potato varieties. In most of compost treatments, the ^{15}N recovered by spunta tubers was higher than those recorded with burn tubers.

Generally, the amounts of ^{15}N recovered by tubers were higher than those recovered by shoot system of both potato varieties. In the same time, the effects of organic compost treatments were frequent depending on compost preparation treatments and variety of potato plants.

Table (33): Effect of different compost treatments on ^{15}N recovered by tubers of potato varieties.

Treatments	SPUNTA		BURN	
	100% CF	50% CF + 50% OC	100% CF	50% CF + 50% OC
	^{15}N Recovery (kg plot^{-1})			
Chemical	2.40	-	1.55	-
T1	-	2.29	-	0.95
T2	-	0.48	-	0.11
T3	-	0.38	-	1.03
T4	-	0.20	-	0.079
T5	-	0.47	-	1.12
T6	-	0.19	-	0.26

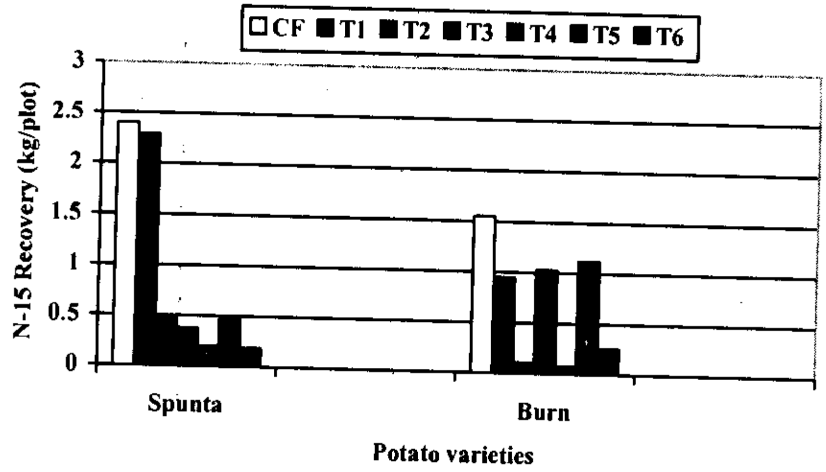


Fig (36) N-15 recovered by tubers of potato varieties as affected by compost treatments

General remark

Generally, our findings are in agreement with many others studies which have shown that soil amendment with compost would improve physical soil properties and availability of nutrients **(Adler and Sikora, 2003; Al-Widyan et al., 2005; Canali et al., 2004; Mbagwu, 1989; Rivero et al., 2004; Sikora et al., 2003).** Microbial flora would be also activated **(Crecchio et al., 2004; Haruta et al., 2005).** The incidence of the nematodes and the pathogens would be reduced, thus increasing crop yields **(Abdelhamid et al., 2004; Boulter-Bitzer et al., 2006; Duffy, 2003; Rigane et al., 2002; Viessman and Hammer, 1998; Zinati et al., 2001).**

Considering the safety requirements of composts intended for agricultural use, the following aspects evaluating composts safety have been studied and confirmed the efficiency of the process; (i) plant and human potential pathogens **(Dia´nez et al., 2007; Duffy, 2003; Hachicha et al., 2006; Gong et al., 2006; Kotsou et al., 2004),** (ii) biodegradation of various organic chemicals such as hormones **(Hakk et al., 2005),** antibiotics **(Arikan et al., 2007),** and organic pollutants: pesticides and polycyclic aromatic hydrocarbons **(Al-Hassan et al., 2004; Atagana, 2004; Semple et al., 2001)** and (iii) heavy metal **(Guerra-Rodrı´guez et al., 2006; Ihnat and Fernandes, 1996; Vanni et al., 2000).**