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Bio-Organic Fertilization and its Impact on Apricot Young Trees in Newly Reclaimed Soil

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Abstract: This study was carried out on young Canino apricot trees (*Prunus armeniaca* L.) during 2006/2007 and 2007/2008 seasons in National Research Centre station at Nubaria region. Response of vegetative growth, leaf mineral and chlorophyll contents to organic fertilization (Compost) either or in combination with tested biofertilizers (Yeast. *Candida tropicalis* and/or *Azospirillum lipoferum*) were compared with mineral fertilization. Compost was added in three levels i.e., 50, 100 and 150 % based on actual N recommended by Egyptian Ministry of Agricultural (75 and 150 g for 1^{st} and 2^{nd} season, respectively). Results indicated that mineral fertilization significantly improved values of all tested parameters compared with all treatments in the first season. While in the second one, high levels of the organic fertilizer (100 or 150 % Compost) in combination with both biofertilizers reflected best results with regard to vegetative growth parameters. This revealed promoting effects of both biofertizers. The effect of yeast was attributed to being a natural source of cytokinins, protein, nucleic acid and vitamin B. whereas the effect of azospirllium was attributed to its nitrogen fixation, auxins biosynthesis and reducing soil pH and thus releasing fixed nutrients. This was also reflected on achieving the highest macro and micro nutrients and chlorophyll in the leaves of these treatments.

Key word: Young apricot trees · Canino · Organic fertilization · Biofertilization · Vegetative growth · Macro and micro nutrients · Chlorophyll

INTRODUCTION

An increasing demand for transferring fertilization practices from using the conventional mineral fertilizers to organic fertilizers. This is basically due to hazards resulting from the former on both human health and the environment in addition to the increasing cost of the mineral fertilizers [1]. The effect of organic fertilizers is not solely attributed to its content of macro and micro nutrients but also due to its beneficial effects on the soil structure and its effect in decreasing the soil pH and used releasing fixed macro and micro nutrients [2, 3]. Compared with the conventional mineral fertilization and organic fertilization was found to have a highest effect of organic fertilization concerning leaf area on Flame seedless grapevine [4] and numbers of lateral shoots per plant on almond [5]. On the contrary, Rena and Schupp [6] didn't found any significant increase concerning shoot growth on apple trees *Cv.* Macoun in case using organic fertilization. Biofertilizers are biological preparations containing primarily potent strains of microorganisms in sufficient number. Which, have definite beneficial role in the fertility of soil rhizosphere. Through its contents of different strains of a symbiotic associative diazotrophes, solubilizing microorganisms of phosphate, silicate dissolving microorganisms [7].

Azospirillum could be used to replace some of nitrogen fertilizer requirement and the efficiency of Azospirillum as biofertilizer depend on the soil and climatic factors and crop management [8]. Yeast is considered as a natural source of cytokinins - stimulates cell division and enlargement as well as the synthesis of protein, nucleic acid and vitamin B [9, 10]. A promoting effect was evidently detected when combining organic fertilization with biofertilzation in terms of vegetative growth parameters on peach compared with organic fertilization only [11]. The scope of the present investigation is to detect the comparative effects of

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mineral and organic fertilizers (combined or not combined with biofertilizers) on the vegetative growth of young Canino apricot trees grown in virgin land and the attained impact on leaf content of macro and micro nutrients and chlorophylls.

MATERIALS AND METHODS

This study was carried out during two successive seasons, (2006/2007 and 2007/2008) on young Canino apricot trees (one year after grafting) planted in experimental station of National Research Centre (NRC) at Nubaria region. Trees were planted at 4×5 m apart, in virgin sandy soil under drip irrigation system and subjected to normal (organic) cultural practices. The physical and chemical properties of the experimental soil are presented in Table 1 according to Wild *et al.* [12].

The experiment was set in a Completely Randomized Block Design with thirteen treatments each comprising three replicates each of four trees.

Treatments Included in Such Experiment Were as Follows:

T1 = Control 100% of NPK requirements as recommended by the ministry of agricultural (75 and 150g) N, (10 and 30g) P and (62.5 and 120g) K tree^{-1} in the 1st and 2nd season, respectively. Sources used were (224 and 448g) as ammonium nitrate, (62.5 and 187.5g) as calcium super phosphate and (125 and 240g) as potassium sulphate in the 1st and 2nd season, respectively. They were equal doses and applied starting from half of March up to the end of September. This treatment was given the symbol Control (Mineral NPK).

T2 = 50 % of recommended NPK (2.6 and 5.2 Kg) as compost + (294.8 and 566g) feldspar (to fulfill the K requirements) tree^{-1} in the 1st and 2nd season, respectively. This treatment was given the symbol 50 % O.N.*

T3 = 100 % of recommended NPK (5.2 and 10.4 Kg) as compost tree^{-1} in the 1st and 2nd season, respectively. This treatment was given the symbol 100 % O.N.

T4 = 150 % of recommended NPK (7.8 and 15.6 Kg) as compost tree^{-1} in the 1st and 2nd season, respectively. This treatment was given the symbol 150 % O.N.

T5 = T_2 + *Azospirillum lipoferum* (**A.**). This treatment was given the symbol 50 % O.N. + A.

Table 1: Physical and chemical analysis of the soil

Characters	Value
Particle size distribution	
Clay %	7.20
Silt %	2.00
Sand %	90.80
Texture	Sand
EC (mmhos cm^{-1})	1.53
pH	8.82
Organic matter %	0.13
Total carbonate %	2.00
Available macronutrients (%)	
N	0.47
P	0.21
K	0.67
Available micronutrient (ppm)	
Zn	1.20
Cu	2.30
Fe	1.00

T6 = T_3 +**A.** This treatment was given the symbol 100 % O.N. + A.

T7 = T_4 +**A.** This treatment was given the symbol 150 % O.N. + A.

T8 = T_2+Yeast. *Candida tropicalis* (**Y.**). This treatment was given the symbol 50 % O.N. + Y.

T9 = T_3 + **Y.** This treatment was given the symbol 100 % O.N. + Y.

T10 = T_4 + **Y.** This treatment was given the symbol 150 % O.N. + Y.

T11 = T_8 + **A.** This treatment was given the symbol 50 % O.N. + Y. + A.

T12 = T_9 + **A.** This treatment was given the symbol 100 % O.N. + Y. + A.

T13 = T_{10} + **A.** This treatment was given the symbol 150 % O.N. + Y. + A.

* O.N. (Organic Nitrogen)

Both Compost and feldspar were added in the last week of December. And the chemical composition of the tested Compost and natural rock (feldspar) are shown in Table 2 and 3, respectively.

Azospirillum lipoferum (A.) or Yeast. *Candida tropicalis* (Y.) were added with rate (300ml tree^{-1} year^{-1}) from each one or (600 ml tree^{-1} year^{-1}) in a combination between them to above mentioned of organic nitrogen treatments. Each rate was applied after diluted to reach 1 litter with water. Either A. or Y. were isolated and identified by Gomaa [13] were grown to the late exponential phase in a sterilized medium prepared in Microbiology Dept., NRC. The resultant cultures were contained (1.6×106 cell ml^{-1}) for A. or (3.2×105 cuf ml^{-1}) for Y. Biofertilizers were applied at 15 January in both

Table 2: Physical and chemical analysis of compost

Characters	El-Neel compost
Weight of m^3 (Kg)	600.00
Humidity %	25.00
pH	8.20
EC (mm cm^{-1})	2.50
Organic matter %	51.00
Organic carbon %	31.00
C/N ratio	17.00
Total nitrogen %	1.80
Total phosphorus %	0.80
Total potassium %	1.50
Fe ppm	47.60
Mn ppm	32.20
Cu ppm	3.40
Zn ppm	4.70

Table 3: Components of natural rock fertilizer (Feldspar)

Component (%)	Value
L.O.I	0.85
SiO_2	68.10
AL_2O_3	17.16
Fe_2O_3	0.45
CaO	0.80
MgO	0.04
K_2O	10.56
Na_2O	1.39
TiO_2	0.05
MnO	0.02
P_2O_5	0.11
Cl	0.11
SO_3	0.15

seasons directly on the root during planting in the first season while in the second season it's added above organic amendments.

Morphological Determinations: At the end of the growing season (second week of October) the following parameters were measured on the trunk of the trees in the first season and main branches in the second. But leaf area was measured in mid-July

- Number of shoots per tree
- Length of shoot (cm)
- Number of leaves per shoot
- Leaf area (cm^2) according to Ahmed and Morsy [14].
- Shoot dry weight (g)
- Root dry weight (g)
- Shoot / Root ratio

Chemical Analysis

Leaf Macro and Micro Elements Content: Sample Leaves were oven dried and grounded for determination the following nutrient elements:

- N-Using the modified micro-kjeldahl method as lined by Pregl [15].
- P-Percentage as dry weight was estimated as described by Chapman and Pratt [16].
- K-Flamephotometerically determined according to Brown and Lilleland [17].
- Fe, Zn and Mn-spectrophotometerically determined using atomic absorption (Model, spectronic 21 D) as described by Jackson [18].

Leaf Chlorophyll Contents: Chlorophyll a and b were colormetrically determined in fresh leaf samples according to Saric *et al.* [19].

Leaf Carbohydrate Content: was determined according to Smith *et al.* [20].

Statistical Analysis: Obtained data was subjected to analysis of variances (ANOVA) according to Snedecor and Cochran [21] using MSTAT program. (LSR) were used to compare between means of treatments according to Duncan [22] at probability of 5 %.

RESULTS AND DISCUSSION

Morphological Determinations: It is evident from Table 4 and 5 that highest effect of fertilization treatments on all considered vegetative parameters was attributed to the control treatment in the first season. However, in the second season this treatment ranked second after both150% and 100% Compost + Y. + A. treatments. This was untrue for shoot length where 150% ranked first followed by 100% which ranked the second. Whereas, control ranked the third. Concerning dry weight, biofertilizer applications improved dry weight compared with organic treatments without biofertilizers especially in the second season, these results in agreement with El-Shenawy and Fayed [23]. The positive effects of organic fertilization on vegetative growth parameters could be attributed to their effects on supplying trees with their requirements of various nutrients as a relatively long times, as well as, their effect on lowering soil pH which could aid in facilitating the availability of soil nutrients and improving physical characters in favour of root development [24]. The enhancement of plant growth due to inoculation with N fixing bacteria could be attributed to the capability of these organisms to produce growth regulators such as auxins, cytokinies and gibberillins which affect production of root biomass and nutrients uptake Abo El-Khashab [25]. These results are also in

Table 4: Effect of organic and bio-fertilization on vegetative parameters of Canino apricot in 2006/2007 and 2007/2008 seasons

	No. Shoots		Shoot length (cm)		No. Leaf / shoot		Leaf area (cm^2)	
Treatment	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
Control (Mineral NPK)	50a	61b	29a	53c	25a	44b	29.532a	31.058ab
50% O.N.	34h	43g	19f	39i	14h	31g	17.858fg	24.916de
100% O.N.	38g	50f	19f	32j	17g	35ef	20.722def	25.978cde
150% O.N.	39f	53e	20ef	46g	17g	36de	21.735de	26.026cde
50% O.N. + A	37g	49f	16g	43h	17g	34f	16.593g	23.636e
100% O.N. + A	40f	55de	21e	51cde	18f	40c	21.772de	26.835b-e
150% O.N. + A	42e	55de	22d	48efg	20e	38cd	21.973de	26.962b-e
50% O.N. + Y	39f	54e	21e	47fg	19f	38cd	20.374ef	25.504cde
100% O.N. + Y	47bc	59bc	24c	53cd	21c	42b	24.028bcd	30.474a-d
150% O.N. + Y	46c	59bc	23d	50de	21cd	40c	23.796bcd	29.453a-d
50% O.N. + Y + A	44d	57cd	23d	50ef	20de	40c	22.445cde	27.896b-e
100% O.N. + Y + A	47b	65a	27b	65b	24b	50a	26.184b	31.637ab
150% O.N. + Y + A	49a	65a	27b	69a	24b	50a	25.491bc	33.390a

Mean separation within each column by Duncan Multiple Range (0.05)

Means with similar letters are insignificantly different

Table 5: Effect of organic and bio-fertilization on dry weight and S/R ratio of Canino apricot in 2006/2007 and 2007/2008 seasons

	Shoot dry weight (g)		Root dry weight (g)		Shoot/Root ratio	
Treatment	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
Control (Mineral NPK)	210.92a	1470.66c	79.96a	334.77c	2.95a	3.58e
50% O.N.	79.60l	487.96l	43.02f	247.72l	1.85i	1.97m
100% O.N.	92.02j	526.07k	49.93e	251.90j	1.85i	2.09l
150% O.N.	104.85i	645.10j	50.19e	253.44i	2.09h	2.55i
50% O.N. + A	87.38k	525.63k	49.21e	248.18l	1.78i	2.12k
100% O.N. + A	119.60g	766.93g	56.68d	255.72h	2.11gh	3.00g
150% O.N. + A	140.22f	694.98h	57.74d	274.55g	2.43d	2.53j
50% O.N. + Y	115.72h	655.07i	49.74e	250.22k	2.33e	2.62h
100% O.N. + Y	175.12c	1285.43d	70.74b	314.97d	2.47d	4.67b
150% O.N. + Y	159.10d	1068.85e	57.77d	294.04f	2.75b	3.64d
50% O.N. + Y + A	147.02e	969.82f	66.93c	301.77e	2.20fg	3.21f
100% O.N. + Y + A	177.44c	1507.95b	71.41b	358.80b	2.22f	4.15c
150% O.N. + Y + A	184.64b	1656.13a	71.52b	363.33a	2.58c	4.95a

Mean separation within each column by Duncan Multiple Range (0.05)

Means with similar letters are insignificantly different

agreement with those reported by Abd El-Naby and Gomaa [26] on banana and Abd El-Naby *et al*., [27] on banana.

Chemical Analysis

Leaf Macro and Micro Elements Content:

Leaf nitrogen content (%): Results in Table 6 show that, leaf N content was significantly affected by different treatments during both seasons. In the first season, N fertilization in mineral form increased leaf N content to 2.45%, where no significant difference was observed between the control treatment and compost of either 150 or 100% + Y. + A. But during the second season, compost at 150% + Y. + A. revealed the highest leaf N content. In additional, significant increase in N content was found between most treatments and compost at 50% either alone or with A. treatment. Generally, treatments included biofertilizer applications reflected higher N content as compared with sole compost treatments and this effect was more pronounced with Y. treatment as compared with A. application.

Table 6: Effect of organic and bio-fertilization on macro element of Canino apricot in 2006/2007 and 2007/2008 seasons

	N %		P %		K %	
Treatment	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
Control (Mineral NPK)	2.45a	2.61b	0.60bc	0.57bc	2.20a	2.32b
50% O.N.	2.06h	2.25e	0.46d	0.46e	0.50i	0.75h
100% O.N.	2.22fg	2.38cde	0.47cd	0.53cd	0.96h	1.48fg
150% O.N.	2.23fg	2.41cd	0.47cd	0.53cd	1.02h	1.49fg
50% O.N. + A	2.18g	2.27de	0.47cd	0.49de	0.95h	1.35g
100% O.N. + A	2.25ef	2.50bc	0.49bc	0.56bc	1.27g	1.64e
150% O.N. + A	2.25ef	2.49bc	0.49bc	0.56bc	1.42f	1.79d
50% O.N. + Y	2.24fg	2.49bc	0.48cd	0.55c	1.17g	1.58ef
100% O.N. + Y	2.35bc	2.60b	0.53bc	0.57bc	1.86cd	2.07c
150% O.N. + Y	2.32cd	2.60b	0.50bc	0.56bc	1.67e	1.85d
50% O.N. + Y + A	2.30de	2.54bc	0.53bc	0.57bc	1.81d	2.01c
100% O.N. + Y + A	2.40ab	2.61b	0.53b	0.60ab	1.93bc	2.47a
150% O.N. + Y + A	2.40ab	2.82a	0.58a	0.64a	1.97b	2.48a

Mean separation within each column by Duncan Multiple Range (0.05)
Means with similar letters are insignificantly different

Table 7: Effect of organic and bio-fertilization on micro elements of Canino apricot in 2006/2007 and 2007/2008 seasons

	Fe (ppm)		Mn (ppm)		Zn (ppm)	
Treatment	2006/2007	2007/2008	2006/2007	2007/2008	2006/2007	2007/2008
Control (Mineral NPK)	49.67a	49.67c	32.00a	34.33b	24.00a	29.00c
50% O.N.	36.00f	38.00g	20.00d	25.00d	18.00g	16.67k
100% O.N.	37.67ef	42.00f	24.33c	27.00d	19.00f	22.00i
150% O.N.	38.00e	42.00f	24.33c	31.67c	19.67ef	23.00h
50% O.N. + A	36.33ef	39.33g	21.67d	26.67d	19.00f	19.33j
100% O.N. + A	40.00d	46.00e	24.67c	32.00c	20.33de	24.00g
150% O.N. + A	40.67cd	46.67de	24.67c	33.00bc	20.33de	24.00g
50% O.N. + Y	40.00d	43.00f	24.33c	31.67c	20.00e	24.00g
100% O.N. + Y	42.33c	49.67c	25.67c	34.33b	22.67b	28.00d
150% O.N. + Y	41.67cd	47.00de	25.00c	33.00bc	21.00cd	24.67f
50% O.N. + Y + A	42.00c	48.00cd	25.33c	33.67bc	21.33c	27.00e
100% O.N. + Y + A	46.33b	52.33b	28.33b	34.67b	23.00b	32.00b
150% O.N. + Y + A	49.00a	54.33a	28.67b	37.33a	24.00a	33.00a

Mean separation within each column by Duncan Multiple Range (0.05)
Means with similar letters are insignificantly different

Leaf Phosphorous Content (%): Table 6 show that compost at 150% + Y. + A. gave the highest leaf P content (0.58% and 0.64%) for the first and second season, respectively. Where compost at 50 % gave the lowest values for both seasons (0.46%). Leaf P content was also increased in the second season than in the first one, especially with organic fertilization as combined with either biofertilizer treatment.

Previous data indicated that, organic and biofertilization gave the highest value of P content in leaves. Haggag *et al.* [28] reported that, using the biofertilizer (Phosphoriene) + organic fertilizer (Town refuse) increased P uptake in guava seedlings compared with chemical fertilization (Super phosphate).

Leaf Potassium Content (%): Potassium in leaf was significantly affected by all treatments, whereas 100% N in mineral form was the best treatment in the first season but in the second one 150% or 100% Compost + Y. + A. gave the highest leaf content of K (2.48% and 2.47%) respectively. Also, leaf content of K was increased in the second season than the first season.

The outstanding role of organic fertilization in reducing the loss of nutrients through drainage water could explain the present results. Similar results were reported by El-Kramany [29] who found that, biofertilizers helps in availability of mineral and their forms in the composted material and increases levels of extractable elements.

Leaf content of Fe, Mn and Zn (ppm): Data presented in Table 7 showed that leaf content of Fe, Mn and Zn were significantly affected by different treatments in both seasons. Control treatment gave the highest values in the first season while in the second season both 150% and 100% Compost + Y. + A. dominated, in this respect.

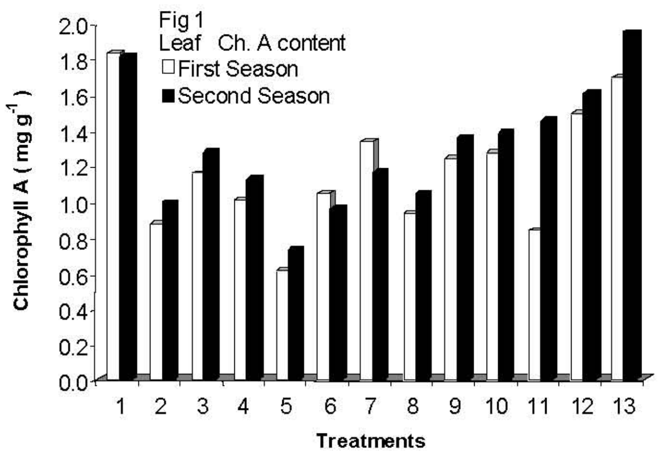

Fig. 1: Effect of organic and bio-fertilization on Leaf chlorophyll A content of Canino apricot in 2006/2007 and 2007/2008 seasons

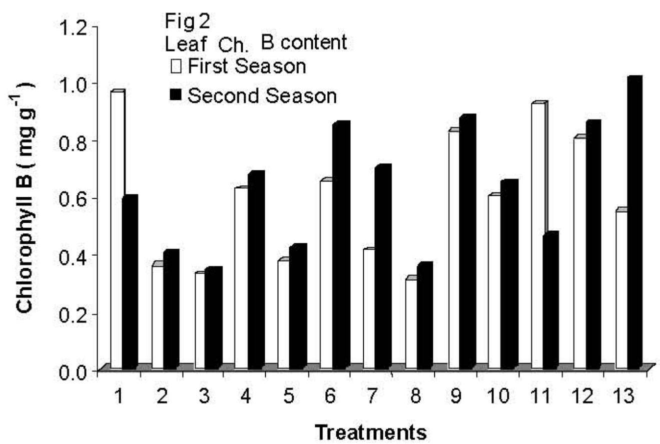

Fig. 2: Effect of organic and bio-fertilization on Leaf chlorophyll B content of Canino apricot in 2006/2007 and 2007/2008 seasons

Table 8: Effect of organic and bio-fertilization on Total carbohydrate of Canino apricot in 2006/2007 and 2007/2008 seasons

	Total carbohydrate %	
Treatment	2006/2007	2007/2008
Control (Mineral NPK)	12.23a	10.64b
50% O.N.	2.36h	2.57g
100% O.N.	3.54fg	4.64f
150% O.N.	4.16f	8.57e
50% O.N. + A	2.75gh	3.30g
100% O.N. + A	6.95d	9.60cde
150% O.N. + A	7.79d	9.02de
50% O.N. + Y	5.34e	8.97de
100% O.N. + Y	10.12bc	10.38c
150% O.N. + Y	9.51c	9.93cd
50% O.N. + Y + A	9.50c	9.81cde
100% O.N. + Y + A	10.33bc	11.71b
150% O.N. + Y + A	10.62b	13.67a

Mean separation within each column by Duncan Multiple Range (0.05)
Means with similar letters are insignificantly different

Leaf Chlorophyll Content: Data in Fig. 1 and 2. illustrate significant differences between treatments on leaf chlorophyll A content in both seasons which 100% N in mineral form gave the highest value of chlorophyll A content in the first season, while in the second one 150% Compost + Y. + A. gave the highest values followed by 100% Compost + Y. + A. However no significant differences were observed in chlorophyll B content between 100% N in mineral form, 100% Compost + Y., 50% Compost + Y. + A. and 150% or 100% Compost + Y. + A. in the first season, which 100% N as mineral form gave the highest value of leaf chlorophyll B content. On the opposite, in the second season 150% Compost + Y. + A. had the best values in leaf chlorophyll B.

Leaf Carbohydrate Content (%): Obtained data in Table 8 indicated that, 100% N in mineral form (control treatment) gave the highest total carbohydrate values

(12.23%). Significant differences were observed between other treatments except in the first season. But in the second season either 150% or 100% Compost + Y. + A. gave the highest value of total carbohydrate.

In general, obtained results showed that the increase in carbohydrates proceeded in parallel with the increase in leaf content of nitrogen where increasing nitrogen leads to an increase of chlorophyll, which in turn leads to increased photosynthesis and thereby increase the proportion of carbohydrates in the leaves.

CONCLUSION

The result of mineral fertilization was superior in the first season than the second, this might be due to the slow release of organic fertilizer. Biological fertilizer enhanced this effect but not to reach that of the mineral fertilizer. In the second season however high rates of organic fertilizer + *Azospirillum lipoferum* and *Candida tropicalis* (Yeast) had the utmost effect on the vegetative growth indicating that more nutrients have been released from the organic fertilizer that was applied in the first season. In addition, clear enhancing effects of both biofertilizers intern of there effect in cytokinins, protein, nucleic acid, vitamin B, nitrogen fixation, auxins biosynthesis, reducing soil pH and thus releasing fixed nutrients. This was reflected on higher contents of nutrients, chlorophyll in the leaves which led to higher efficiency in photothynsis and thus higher carbohydrates content.

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