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Research Article

Productivity Improving of Artichoke in Organic Farming by Compost and Compost Tea Fertilization

Karima Kouki Khalfallah[Á], Nejib Turki[Á*], Mariem Rébaï[Á] and Ismaïl Ghazel[B]

[Á]Institut National Agronomique de Tunisie (INAT), 43 Avenue Charles Nicolle Tunis - Tunisia
[B]Station d'Appui de Manouba (SAM), Groupement Interprofessionnel des Légumes - Tunisia

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Abstract

Four fertilization program treatments based on compost and compost tea have been experienced in this study for artichoke in organic farming: Control Treatment (T0): 100% compost needs are made in solid form before planting (BP);Treatment 1 (T1): 50% compost needs are made in solid form BP , 25% are made in solid form at 22 weeks after planting (WAP) and 25% are applied as compost tea sprayed on the leaves weekly for 26 weeks from 12 WAP, Treatment 2 (T2): 50% compost needs are made in solid form BP and 50% in the form of compost tea applied by fertigation weekly for 26 weeks from 12 WAP and Treatment 3 (T3): 50% compost needs are made in solid form BP , 25% in the form of compost tea applied as a foliar spray and 25% in the form of compost tea applied by fertigation splitting of compost (T1 , T2 and T3) in all cases enhances the growth and development of plants relative to control (T0) for which 100 % of the compost requirements were made before planting. The best results were obtained with T3 , wherein treatment of the compost tea was made by foliar and also by fertigation. The contribution of compost once before planting (T0), which is the most common method currently used in organic farming has clearly shown its limits. Splitting compost is more effective than its incorporation in full in the soil before planting, that the combination of foliar spray and fertigation with compost tea gives better results than the use of each method of application lonely and very effective results can be achieved with artichoke led by organic methods in yield (17.4 t/ha) , precocity (3.5 t/ha early harvest) and the quality of the heads (15 t/ha were classified between Class Extra and class I).

Keywords: *artichoke, organic farming, compost, compost tea, foliar spray, fertigation.*

1. Introduction

Fertilization in organic agriculture is a holistic approach that aims to maintain and develop the natural soil fertility in the long term by encouraging the recycling of organic matter and compost production (Guet, 1993). Compost is product very rich by humus that results from the controlled aerobic fermentation (Peigné and Girardin, 2001), which is generally used in solid form as an amendment during soil preparation (CTAB, 2009). Nevertheless, in organic farming, limiting the input of compost to the soil preparation phase is likely to be unsatisfactory for crops during their cycle, especially when their nutrient requirements are highest . This is particularly true for demanding species such as artichoke (Odet *et al* , 1989; Bratsch, 2009) that develops a significant vegetative biomass and whose crop cycle extends over 7 months. Several authors have confirmed the positive effect of compost based fertilization on vegetable crops parameters such as strawberries, carrots, artichoke or pepper (MasmoudiCharfi*et al*, 2001;KoukiKhalfallah and Bouhaouech, 2009; Tarchoun and Ben Khedher , 2010; Turki and koukikhalfallah , 2014).

The compost extract is most often used as a soil or foliage microbiological inoculants as it contains millions of bacteria, fungi and other microorganisms that help keep plants free of diseases (Guet, 2003). It also reduces the toxicity potential of the organic acids by plants and toxic metabolites (Quarles, 2001) . Composts role as a crop fertilizer is also increasingly mentioned either by foliage spray, or by injection into the irrigation water (Merrill and McKeon, 1998; El Naggar , 2002;Nikolic, 2003).

This work aims to improve the organic fertilization of the artichoke. It offers the opportunity to test split of compost at the rate of 50% before planting and make the rest of the needs during the crop cycle in different forms.

2. Materials and Methods

2.1 Experimental site

The experiment was conducted in the Manouba- Support Station (SAM), which is under the Inter-professional Group of Vegetables (GIL). The SAM is located 3 km on the road of Tunis - Jedaida in the Manouba Governorate in northern Tunisia: latitude 36 ° 48 'north; longitude 10 ° 03 'East, altitude 469 m.

*Corresponding author: **NejibTurki**

The climate stage of the region of Manouba is the upper semi-arid. Rainfall is irregular with an annual average of 450 mm.

2.2 Plant material

"Violet d'Hyeres" is the artichoke Variety object of this test, which is one of the most cultivated in Tunisia and most appreciated for its profitability. It is generally classified as semi-late in comparison with other varieties.

2.3 Compost based fertilization

The compost used in this study was prepared by the Technical Center of Organic Agriculture (CTAB) using a mixture based on cattle manure (65%), poultry manure (20%), straw (10%) and sheep manure (5%). The duration of composting was 7 months. The total quantity of compost made to the culture of artichoke was 9T/ha . The compost needs assessment was based on the standard loading animals for a farm practicing organic farming (Jort, 2005) which states that the annual nitrogen input may not exceed 170 Kg / Ha and taking into account the analysis of the nitrogen content of the compost which is 2% of dry matter, and its dry matter content is 94%,

2.4 Compost tea extraction

The compost tea was prepared at the rate of once a week for 26 weeks using the method developed by (Weltzien, 1992) described and performed later by (Znaidi, 2002). For the foliar spray, the extraction was performed in accordance with the proportion of 1 volume compost for 5 volumes of water, while for fertigation, extraction was made in a larger volume of water in accordance with an extraction rate of 8% in order to have an easier time in homogeneous distribution of the compost tea on the whole plot concerned.

2.5 Experimental device

Four compost based fertilization treatments have been experienced in this trial:
Control Treatment (T0): 100% compost needs are made in solid form before planting ;
Treatment 1 (T1): 50% compost needs are made in solid form before planting , 25% are made in solid form at 22 weeks after planting (early stem elongation) and 25% are applied as compost tea sprayed on the leaves weekly for 26 weeks from 12 weeks after planting (5-6 leaves stage).
Treatment 2 (T2): 50% compost needs are made in solid form before planting and 50% in the form of compost tea applied by fertigation weekly for 26 weeks from 12 weeks after planting (5-6 leaves stage).
Treatment 3 (T3): 50% compost needs are made in solid form before planting , 25% in the form of compost tea applied as a foliar spray and 25% in the form of compost tea applied by fertigation weekly for 26 weeks from the 12th week after planting (5-6 leaves stage).

The experimental design is used in a randomized complete block with three replicates. In each block , the 4 treatments are randomly assigned to each represented by a basic plot with an area of 109.2 m^2. The blocks are made in the direction of planting lines and treatments distributed laterally at 2 lines per treatment.

2.6 Compost tea distribution program

A weekly distribution program of compost tea was prepared for T1, T2 and T3 treatments in the amounts provided for each treatment (Table 1). For this, the amount of the additional solid compost fraction on each treatment was divided in 26 equal portions, which were extracted in water and is completely distributed weekly by foliar spray for T1, either entirely by injection in the irrigation system for T2, or by using both means for parallel application in T3. Compost tea based fertilization started at the 12th week and was stopped at the 38th week after planting.

Table 1: Compost inputs provided for each treatment (t/ha)

Inputs	Treatments			
	T0	T1	T2	T3
Solid compost applied before planting	9	4,5	4,5	4,5
Solid compost applied 22 weeks after planting	0	2,25	0	0
Compost used in the extraction of Compost tea used for foliar spray	0	2,25	0	2,25
Compost used in the extraction of Compost tea used for fertigation	0	0	4,5	2,25
Total (T/Ha)	9	9	9	9

2.7 Parameters measured

- Parameters of vegetative growth in situ: Plant height and growth rate, foliage diameter, top bud height and Number of shoots formed per plant
- Assessment of biomass developed
- Crop yield and precocity
- Crop quality: weight means of heads, diameter means of heads and the harvest calibration, Harvest classification according to UNECE Standard (UNECE, 2003) on the commercial quality of artichokes

2.8 Statistical Analysis

Analysis was performed using the SPSS program (SPSS 17.0), by analysis of variance ($p<0.05$). In case of significance for interactions or between levels of the isolated factors, the DUCAN test was applied ($p<0.05$).

3. Results and Discussion

3.1 Parameters of vegetative growth

- Plant height and growth rate:
T3 treatment combining foliar fertilization and fertigation were best developed in height relative to the rest of the treatments, which did'nt show differences between them(Figure 1) .

The calculation of the plants elongation rate for successive periods of two weeks (Table 2) confirmed the superiority of T3 treatment compared to the rest of the above treatments from week 19.

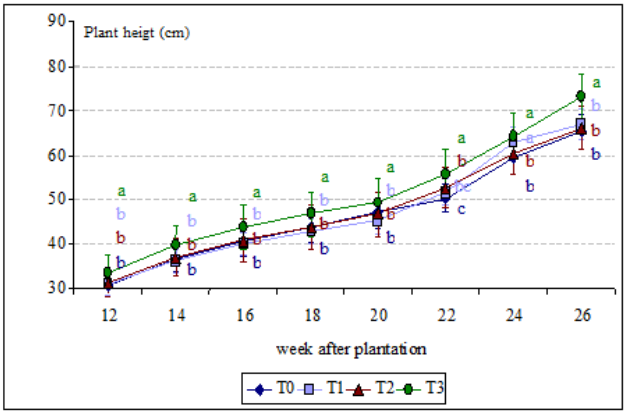

Figure 1: Evolution of plant height based on applied fertilization treatments

NB : The values for the same date and assigned by the same index are not significantly different at 5% risk of error.

Table2: Growth rate of artichoke plants by fertilization treatments applied

Growth rate (cm / day) / WAP	T0	T1	T2	T3
week 13 and 14	0,43 ± 0,16 a	0,41 ± 0,23 a	0,45 ± 0,24 a	0,37 ± 0,14 a
week 15 and 16	0,26 ± 0,76 a	0,26 ± 0,08 a	0,29 ± 0,08 a	0,27 ± 0,09 a
week 17 and 18	0,22 ± 0,06 a	0,20 ± 0,05 a	0,22 ± 0,06 a	0,22 ± 0,08 a
week 19 and 20	0,19 ± 0,06 bc	0,21 ± 0,07 b	0,17 ± 0,08 c	0,29 ± 0,14 a
week 21 and 22	0,28 ± 0,16 c	0,43 ± 0,12 b	0,46 ± 0,12 b	0,57 ± 0,09 a
week 23 and 24	0,66 ± 0,20 b	0,55 ± 0,13 c	0,60 ± 0,14 cb	0,94 ± 0,08 a
week 25 and 26	0,57 ± 0,20 b	0,46 ± 0,13 c	0,51 ± 0,14 cb	0,85 ± 0,08 a

NB :The values for the same period and assigned by the same index are not significantly different at 5% risk of error.

- Foliage diameter

Significant differences for foliage diameter between the four treatments have been registredon each date considered 2. Treatments are ranked in descending order for this parameter: T3> T2> T1> T0.

- Top bud height

Splitting compost fertilization (T1, T2 and T3) allows in all cases an improvement of the height of the top bud versus control T0 (Figure 3). However, T3 has the best result.

- Number of shoots formed per plant

T3 was significantly more favorable for artichoke plant shooting, followed by T1 and T2, which were fairly close and finally T0 (Figure 4).

3. 2 Assessment of biomass developed

- Foliage fresh weight

The assessment of leaves fresh weight on uprooted plants every month between November and April sowed that the T3 treatment was significantly more favorable among experienced treatment. Significant differences between treatments were already apparent from the first pulling made on November 22(Figure 5). The difference in T3 compared to other treatments remained almost constant from one date to another.

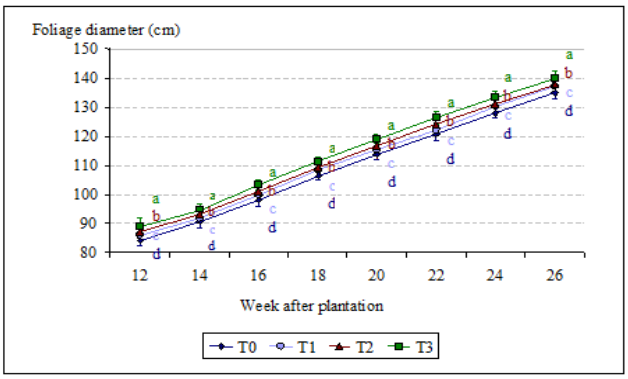

Figure 2 :Foliage diameter evolution of artichoke plants by fertilization treatments applied

NB : The values for the same period assigned by the same index are not significantly different at 5% risk of error.

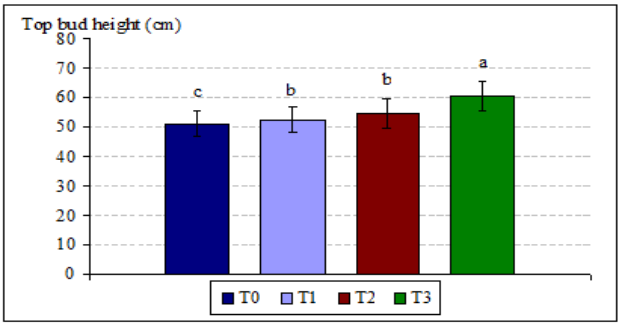

Figure 3: Top bud height based on fertilization treatments applied

NB : The values assigned by the same index are not significantly different at 5% risk of error.

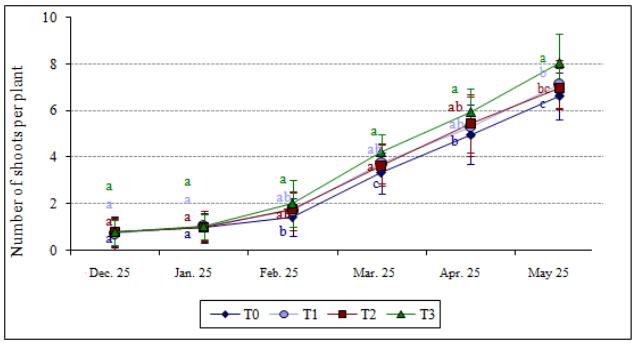

Figure 4: Number of shoots formed per plant of artichoke plants by fertilization treatments applied

NB : The values for the same period assigned by the same index are not significantly different at 5% risk of error

- Fresh weight of the strain

Fresh material developed at the strain was significantly higher in plants subjected to T3 treatment, followed distantly by T2 and finally T1 and T0, remained very close from pulling date to another (Figure 6).

- Fresh weight of roots

Roots are best developed in plants from T3 treatment right from the first pulling made within 70 days after planting. They were slightly less well developed in plants receiving treatments T1 and T2, which were higher than the control treatment T0 whose root fresh weight did not exceed 152 g/plant in the end of April (Figure 7).

- Yield and harvest precocity

The monitoring yield evolution expressed in fresh weight of heads every 15 days (Figure 8) reveals the superiority of T3 already from the first harvest . T1 and T2 treatments have resulted in lower yields , but significantly higher than those obtained by T0 treatment, especially from two and a half months after the beginning of harvest . The final yield shows that it is significantly higher for T3 (17.41 ± 0.45 t/ha) relative to T0 (over 79.6 % additional yield) ; T1 (more than 41,1 % additional yield) and T2 (more than 38.3 % additional yield).

In terms of the number of heads harvested , the final yield was estimated at 70,354 heads per hectare in T3, which significantly exceeds the yields obtained at T2 (64,704 heads per hectare) and in T1 (63,680 heads per hectare) and even more at T0 which has helped raise the 57,363 heads per hectare in the end.

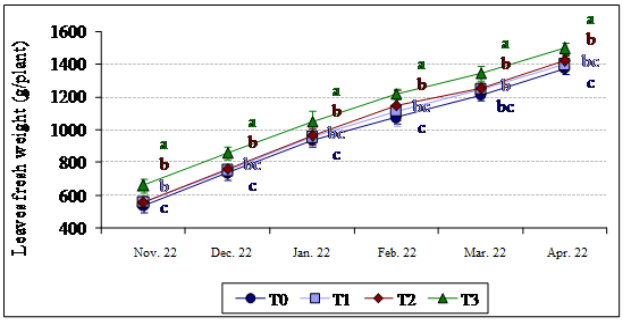

Figure 5: Fresh weight of artichoke leaves based on fertilization treatments applied

NB : The values for the same period assigned by the same index are not significantly different at 5% risk of error

The assessment of harvest precocity (Table 3) whereas the three periods : early (before January 15) , moderate early (between 16 January and 15 March) and late (after March 15) found that in general , the relative proportion of yield earned before January 15 is very low for all treatments and no more than 1.5 % of total yield in the best case , obtained with T3. The moderately early yield earned between January 16 and March 15 is for its part, between 17% and 21% respectively of the total yield observed in the T0 and T1 - T2 treatments ; T3 treatment allowed to achieve 19.5 % of the total yield of this period. Nevertheless , considering the mass of heads that make up these relative proportions, the T3 treatment is by far the most advantageous since it allows for more than double the performance of the control (1.68 ± 0.12 t/ha) and more an additional half t/ha compared to treatments T1 and T2. In regard to the late harvest , which is in all cases at least 78% of the total harvest , it was higher in T3 (13.91 ± 0.29) and exceeded that obtained in T0 by more 82.7 % more than T1 and T2 by 47.3% over 46.5 %.

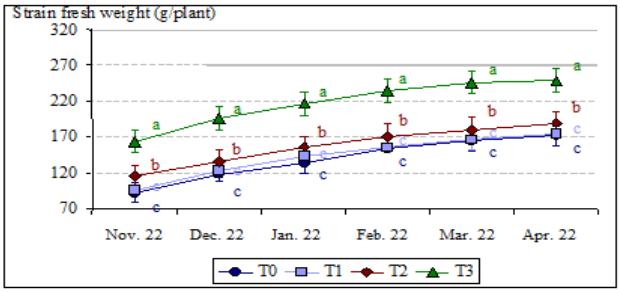

Figure 6: Fresh weight of artichoke strain based on fertilization treatments applied

NB :The values for the same period assigned by the same index are not significantly different at 5% risk of error

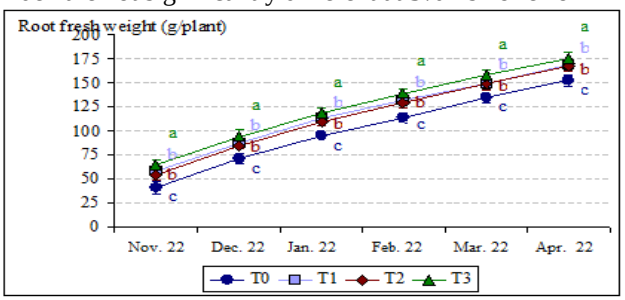

Figure 7: Fresh weight of roots artichoke based on fertilization treatments applied

NB : The values for the same period assigned by the same index are not significantly different at 5% risk of error

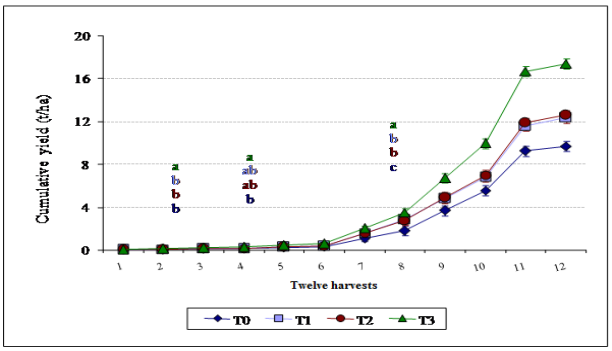

Figure 8: Cumulative yield evolution based on fertilization treatments applied

NB :The values for the same period assigned by the same index are not significantly different at 5% risk of error

Table3: Yield distribution (t/ha) by harvest period based on fertilization treatments applied

Period \ Treatment	T0	T1	T2	T3
Early yield (before Jan. 15)	0,12 ± 0,01 [b] 1 %**	0,10 ± 0,01 [b] 0, 7%	0,14 ± 0,01 [b] 1 %	0,26 ± 0,01 [a] 1,5 %
Moderate early yield (Jan.16 - Mar. 15)	1,68 ± 0,12 [c] 17,5 %	2,66 ± 0,13 [b] 21,5%	2,62 ± 0,06 [b] 21 %	3,24 ± 0, 12 [a] 19,5 %
Late yield (after Mar. 15)	7,89 ± 0,26 [c] 81,5%	9,78 ± 0,11 [b] 77,9%	9,83 ± 0,27 [b] 78 %	13,91 ± 0,29 [a] 79 %
Total yield	9,69 ± 0,49 [c] 100%	12,34 ± 0,47 [b] 100%	12,59 ± 0,47 [b] 100 %	17,41 ± 0,45 [a] 100 %

NB: * The values for the same period assigned by the same index are not significantly different at 5% risk of error

** Percentage of the final yield for the treatment in question for the period specified in column 1

3.4 Harvest quality

- Weight mean of heads

The weight mean of the flower head (Table 4) was significantly higher in plants receiving T3 treatment and the difference compared to other treatments was particularly significant for harvest made after March 15 . For T1 and T2 treatments, the weight mean of heads were very close during all seasons and well above the weight mean obtained with the T0 treatment.

In terms of flower head diameter (Table 4), the superiority of treatment in which the contribution was fractionated compost (T1, T2 and T3) was very different from the control , but the differences between T3, T2 and T1 were much lower than those for weight.

Table4: Weight mean (g) and diameter (cm) of the heads at harvest periods based on fertilization treatments applied

Treatment / Period	T0	T1	T2	T3
Heads mean weight (g)				
Before Jan. 15	210,8 ± 20,6 ^{b}	251,4 ± 34,4 ^{ab}	259,3 ± 11,7 ^{a}	272,5 ± 19,9 ^{a}
Jan.16 - Mar. 15	273,1 ± 17,2 ^{b}	308,1 ± 30,9 ^{ab}	323,4 ± 05,5 ^{a}	350,6 ± 30,8 ^{a}
After Mar. 15	209,1 ± 07,8 ^{b}	209,2 ± 08,2 ^{b}	222,2 ± 05,6 ^{b}	243,8 ± 07,8 ^{a}
Heads diameter (cm)				
Before Jan. 15	7,01 ± 0,30 ^{b}	7,38 ± 0,35 ^{ab}	7,48 ± 0,24 ^{ab}	7,81 ± 0,29 ^{a}
Jan.16 - Mar. 15	7,63 ± 0,40 ^{b}	8,39 ± 0,21 ^{ab}	9,06 ± 0,23 ^{a}	8,80 ± 0,75 ^{a}
After Mar. 15	6,63 ± 0,33 ^{b}	7,66 ± 0,03 ^{a}	7,70 ± 0,10 ^{a}	7,80 ± 0,38 ^{a}

NB :The values for the same period in the same line and assigned by the same index are not significantly different at 5% risk of error.

- Harvest Calibration

The distribution of final yield by class size (Table 5) shows that the T3 treatment is by far the most advantageous to allow the production of heads of large caliber (diameter ≥ 11cm) with a yield of 4.87 ± 0.14 t/ha. The treatment T2, T1 and T0 allowed to perform in this class caliber respective yields of 2.20 ± 0.15 t/ha; 1.72 ± 0.40 t/ha and 0.91 ± 0.10 t/ha . For the average size (≤ 7.5 cm diameter <11cm), which constitutes the major part of the harvest treatments are classified as follows: T0 (68%)> T1 (66%)> T2 (59%)> T3 (52%). The small size (≤ 6 cm diameter <7.5 cm), is represented in the harvest of the 4 treatments very similar to the order of 20% proportions.

Table5: Final yield distribution (t/ha) by caliber class rating based on fertilization treatments applied

Treatment / Diameter (D)	T0	T1	T2	T3
D = 13 cm	0,15 ± 0,04 ^{c} 21%**	0,54 ± 0,03 ^{b} 4%	0,58 ± 0,01 ^{b} 5%	0,94 ± 0,02 ^{a} 5%
11cm = D < 13 cm	0,76 ± 0,06 ^{b} 8%	1,18 ± 0,38 ^{ab} 10%	1,62 ± 0,28 ^{a} 12%	3,93 ± 0,12 ^{a} 22%
9 cm = D < 11cm	3,4 ± 0,23 ^{b} 25%	3,89 ± 0,33 ^{b} 22%	3,89 ± 0,07 ^{b} 21%	4,44 ± 0,37 ^{a} 27%
7,5 cm = D < 9 cm	3,2 ± 0,18 ^{b} 33%	4,22 ± 0,26 ^{a} 36%	3,64 ± 0,05 ^{b} 28%	4,42 ± 0,44 ^{a} 25%
6 cm = D < 7,5 cm	2,20 ± 0,06 ^{b} 22%	2,52 ± 0,05 ^{b} 20%	2,85 ± 0,06 ^{b} 22%	3,68 ± 0,21 ^{a} 21%

NB : * The values in the same line assigned by the same index are not significantly different at 5% risk of error

** Percentage of the final yield for the treatment in the class caliber specified in column 1

- Harvest classification according to UNECE Standard (UNECE, 2003) for the commercial quality of artichokes

Categorization of the harvest according to UNECE Standard (UNECE, 2003) on commercial quality artichokes (Table 6) reveals that 47% to 52 % of the crop is in the Extra Class regardless of fertilization treatment applied. Class II , which is the least interesting , accounts for all treatments less than 20 % of the total harvest. However, given the difference in yield obtained between treatments , T3 is confirmed to be the most advantageous with more than 8 T/ha in Extra Class and more than 15 T/ha by combining the two categories Extra and I (Table 6). T1 and T2 treatments allow very similar yields of about 10 T/ha considering both categories Extra and I together, but the proportion of the Extra Class is slightly higher in the harvest on the T1 treatment .

If we associate with this assessment of heads quality, the precocity test (Table 7) , we find that the two treatments T2 and T3 have produced the most heads in the category extra and that T2 is even higher than T3 if the two classes Extra and I are combined together for the harvest made before January 15. This superiority of T2 is not preserved if we consider the mean early yield harvested between January 16 and March 15 , since it is T3 which produces the most heads in higher quality classes with 2.9 t/ha in Extra Class and 1.6 t/ha in Class I; and T1 and T2 treatments achieved only 2.9 t/ha for both categories Extra and I combined.

Table6: Final yield distribution (t/ha) according to UNECE standards (2003)

Treatment / Quality classes	T0	T1	T2	T3
Class Extra	4,53 ± 0,42 ^{d} 47%	6,68 ± 0,16 ^{b} 56%	5,88 ± 0,27 ^{c} 47%	8,85 ± 0,35 ^{a} 52%
Class I	3,37 ± 0,19 ^{d} 36%	3,72 ± 0,11 ^{c} 30%	4,43 ± 0,06 ^{b} 35%	6,35 ± 0,34 ^{a} 36%
Class II	1,79 ± 0,41 ^{d} 19 %**	1,93 ± 0,48 ^{c} 16%	2,28 ± 0,11 ^{a} 18%	2,22 ± 0,49 ^{b} 12%

NB : * The values in the same line assigned by the same index are not significantly different at 5% risk of error.
** Percentage of the final yield for the treatment in the class caliberspecified in column 1

Table7: Yield distribution (t/ha) according to precocity and the quality defined by UNECE standards (2003)

Period / Classes \ Treatment		T0	T1	T2	T3
Before Jan. 15	Class Extra	0,01 ± 0,06 ^{c}	0,17 ± 0,01 ^{b}	0,46 ± 0,01 ^{a}	0,45 ± 0,01 ^{a}
	Class I	0,13 ± 0,01 ^{c}	0,24 ± 0,01 ^{b}	0,47 ± 0,02 ^{a}	0,13 ± 0,01 ^{c}
	Class II	0,09 ± 0,01 ^{d}	0,14 ± 0,01 ^{c}	0,24 ± 0,01 ^{a}	0,23 ± 0,01 ^{b}
Jan. 15 - Mar. 15	Class Extra	1,03 ± 0,01 ^{d}	1,72 ± 0,06 ^{b}	1,45 ± 0,02 ^{c}	2,94 ± 0,04 ^{a}
	Class I	0,66 ± 0,02 ^{d}	1,24 ± 0,01 ^{c}	1,47 ± 0,02 ^{b}	1,61 ± 0,01 ^{a}
	Class II	0,62 ± 0,01 ^{d}	0,59 ± 0,01 ^{c}	0,79 ± 0, 01 ^{a}	0,79 ± 0,01 ^{b}
After Mar. 15	Class Extra	3,39 ± 0,05 ^{d}	4,86 ± 0,02 ^{b}	3,91 ± 0,05 ^{c}	5,44 ± 0,04 ^{a}
	Class I	2,62 ± 0,01 ^{d}	2,18 ± 0,01 ^{c}	2,46 ± 0,03 ^{b}	4,61 ± 0,02 ^{a}
	Class II	1,12 ± 0,01 ^{d}	1,19 ± 0,04 ^{c}	1,31 ± 0,03 ^{a}	1,19 ± 0,03 ^{b}

NB :The values in the same line assigned by the same index are not significantly different at 5% risk of error.

Monitoring the growth of artichoke from 13thWAP until the end of crop shows that the splitting of compost (T1 , T2 and T3) improves in all cases the height growth plants (Figure 1) compared to control (T0) for which 100 % of the requirements were made before planting. Nevertheless,

the principle of splitting alone does not explain the significant differences observed between treatments T1 , T2 and T3 , where the form and method of compost application during cultivation were varied. Indeed , the best results of plant development were obtained for the T3 treatment in which was combined foliar application and fertigation making use of compost tea, the positive effects of compost has been proven on the growth of stems, roots and leaf size (Berova and Karanatsidis, 2009). . This was mainly visible across the foliage diameter (Figure 2), the top bud height (Figure 3) and the number of shoots per plant (Figure 4).

The evaluation of the fresh weight of different plant parts during out pulling made every month between November and April confirms these results. The superiority of T3 treatment was clearly demonstrated in the fresh weight of leaves, stem and roots (Figures 5 ,6, 7). The treatments T1 and T2 have been similar for most of the growth parameters (Figures1 ,3, 4 , 5, 6) , except for the wet weight of the strain which was better for T2 wherein 50 % of compost during cultivation was brought with fertigation compared to T1 in which the inputs of compost during cultivation were made only in solid form around the plants and compost tea applied to the foliage .

The differences observed in the growth and development have resulted in differences in yield and earliness of harvest. T3 has achieved the best final yield (Figure 8) and also the best precocity (Table 3). Treatments T1 and T2 were similar to the final yield and early yield earned before March 15. The control T0 had a relatively low yield which did not exceed 56% of the T3 and 78% those of T1 and T2,The splitting of compost and compost tea by foliar spray and fertigation could be the source of increasing humic acid concentrations and of improving the precocity and head size and total yield (Karakurt *et al*, 2009; OzdamarUnlu *et al*, 2011) , quality (El-Hefny, 2010), root growth and flowering(Norman *et al*, 2009).

The quality of the heads was also quite sensitive to different fertilization programs applied. Indeed, the caliber of heads harvested was significantly improved in all three treatments T1 , T2 and T3, compared to the control . The best caliber was obtained with T3 since over 27 % of the crop had a diameter greater than or equal to 11 cm, against 18% with T2, T1 and 14% with only 10% with T0 (Table 5). Categorization of the harvest according to quality standard UNECE (UNECE, 2003) also revealed a significant improvement in treatments T1 , T2 and T3, compared to control (Table 6). The best quality was obtained in the T3 treatment that allowed 88% of heads are classified among class Extra and class I, against 84% for T1, 82% for T2 and 81% for T0 . These rates reported in the final weight of crops, are very significant since the yield on the two classes extra and I rises at over 15 t/ha in T3 and 10 t/ha in T1 and T2, but does not exceed 7.5 t /ha in T0 .

Conclusion

Splitting of compost (T1 , T2 and T3) in all cases enhances the growth and development of plants relative to control (T0) for which 100 % of the compost requirements were made before planting. The best results were obtained with T3 , wherein treatment of the compost tea was made by foliar and also by fertigation . T1 treatment that uses only foliar and T2 using fertigation alone were similar for most parameters. Improving growth and development at T3 resulted in an incontestable superiority at the early harvest, the quality of the heads and the final yield. Treatments T1 and T2 were very similar for most of these parameters, and always superior to the control. The input of compost tea by foliar seems to allow slightly better than the input of compost tea through fertigation, but the combination of the two methods is the best alternative. The contribution of compost once before planting (T0), which is the most common method currently used in organic farming has clearly shown its limits.

This work has demonstrated that splitting compost is more effective than its incorporation in full in the soil before planting, that the combination of foliar spray and fertigation with compost tea gives better results than the use of each method of application lonely and very effective results can be achieved with artichoke led by organic methods in yield (17.4 t/ha) , precocity (3.5 t / ha harvested before March 16) and the quality of the heads (15 t/ha were classified between Class Extra and class I). The results of this work may be further refined in subsequent work especially research regarding the proportion of compost into the soil before planting , and the distribution of the fractions to be dispensed by either foliar application or by fertigation .

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