The Effect of Different Organic Fertilization on Garlic (*Allium sativum* L.) in Bahía Blanca Region, Argentine

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Abstract

The work was carried out during the years 2007 and 2008, in a sandy soil located in the experimental field of the Agronomy Department of Universidad Nacional del Sur. The objectives of the work were: a) to study the effect of three organic fertilizations on garlic production, and b) to determine the macronutrient content in leaves during the crop cycle. The experiment was carried out in a completely randomized design with four replicates. The treatments were: T0, with inorganic fertilization (100 kg kg ha^{-1} of diamonic phosphate + 100 kg ha^{-1} of urea); T1, 16.071 kg ha^{-1} of Bovine manure-Onion compost (+ 50 kg ha^{-1} of phosphate rock); T2, 2000 kg ha^{-1} of BioOrganutsa Nitro Plus a commercial organic fertilizer, (+ 50 kg ha^{-1} of phosphate rock); and T3, BioOrganutsa Nitro Plus + vermicompost tea (same as T2 + 1,25 L vermicompost tea). During both years, the number of leaves, height and dry weight along the cycle were increasing in all treatments. T2 and T3 showed the highest values with respect to T1. Nitrogen and Potassium content in leaves decreased gradually in all treatments after the beginning of bulb formation. At harvest, T2 and T3 presented the highest yield, weight and diameter bulbs in 2008, while T1 obtained the lowest values of these parameters. In 2007 T3 showed significant differences with respect to T1 as regards the 3 parameters. The commercial organic fertilizer + phosphate rock incorporated alone or in combination with vermicompost tea, can be an alternative to inorganic fertilization in garlic crop. It will be necessary to try different doses of compost to prove if it has some value as a fertilizer.

INTRODUCTION

Organic agriculture in an integral aproach based on a group of processes that resulted in a sustaintable ecosystem, safe food, a good nutrition, animal welfare and social justice. Therefore, organic production is much more than a system of production which includes or excludes certain imputs (FAO, 2003). It is practiced in more than 138 countries in the world. Latin America participates with the 16 % of the world organic production and the countries wich great areas assigned to this kind of cultivation are Argentina, Uruguay and Brazil (Willer et al., 2008).

The area under organic certification reached in Argentine approximately 4 million hectares in 2008, being the area devoted to cattle production the most significant, and more than 360.000 hectares were assigned to vegetable production. The

main destination of these vegetables products is for export. The most important exported vegetables are onions, pumpkins, garlic and beans (SENASA, 2009).

Garlic is an important crop in Bahía Blanca area. Nitrogen and Potasium are very important in the development and the preservation of garlic (Burba, 1993). The foliar content of these nutrients can be used as a diagnosis technique that allows detecting nutricional factors that affect the yield (Gaviola de Heras et al., 1993).

Another important crop in this region for export is onion. A great amount of waste is produced during onion bulb conditioning in processing plants, consisting of cataphylls, roots, dry leaves and discarded bulbs with a high C/N ratio. The use of such waste for compost production is both ecological and economic (Martínez *et al*., 2005). This compost can be prepared using onion residues mixed with cattle manure and/or alfalfa (*Medicago sativa* L.), and when it is mature it can be used as organic soil amendment, organic fertilizer or as substrate for seedlings production (Miglierina *et al*., 2006).

Compost extracts or teas are watery preparations of organic material in process of composting or preferably composted. It can be applied with the irrigation water or pulverization that provides not only nutrients to plants but also favors the development of useful microorganism (Diver, 2002).

There is scarce information about the effect of organic fertilization on the red clon garlic crop production and nutrient contents in the semiarid Pampean region of Argentine.

The main objectives of this work were: a) To study the effect of three organic products on garlic production and b) To determine the macronutrient content in leaves during the crop cycle.

MATERIALS AND METHODS

During 2007 and 2008, two assays were curried out in the experimental field of the Agronomy Department of Universidad Nacional del Sur, Bahía Blanca, Argentina (38°41' Lat. S; 62° 15' Long. O). The soil was a sandy loam with organic carbon (OC) content of 8.9 g kg^{-1}, total nitrogen (TN) of 1.02 g kg^{-1} and pH 7.2. A completed randomized design was used, with four treatments and four replications. The treatments were: T0, control with inorganic fertilization (100 kg ha^{-1} of diamonic phosphate (DAP) + 100 kg ha^{-1} of urea); T1, onion-bovine manure compost (CCE) (16.071 kg ha^{-1} + 50 kg ha^{-1} of phosphated rock); T2, BioOrganutsa Nitro Plus (9-2-3) (BioONP) (2000 kg ha^{-1} + 50 kg ha^{-1} of phosphated rock) and T3, BioOrganutsa Nitro Plus + watery extract of vermicompost (EL) (ídem T2 + 1,25 L extract). The amount of BioONP used in T2 and T3 was the commercial dose recommended. In T1, the amount of bovine manure-onion compost added was equivalent in N to T0 (N 64 kg ha^{-1}), assuming a 40% of potential mineralization. The physicochemical analysis of the onion-bovine manure compost and the watery extract of vermicompost is shown in Table 1. These treatments were arranged in 2.5 m by 0.4 m plots. Two rows spaced out at 0.16 m were planted by hand, at 0.07 m and a depth of 0.04 m. Four parcels of 10 m by 0.4 m were used in order to evaluate yield. The variety used in both assays was Fuego INTA. The bulb seeds were planted on 24th May 2007 and on 9 th June 2008. The bulbs seeds were selected in order to achieve a uniform growth and development of the crop. A control of weeds was made manually. Pressurized drip irrigation system was used with dripers incorporated every 0.33 m and a water flow of 1.5 L h^{-1}.

Every 25-30 days, it was sampled 5 plants to determine the number of leaves, height and fresh weight of the aerial part. Then the plants were oven dried and ground to

determine dry weight and macronutrient contents in aerial part. Nitrogen was determined by Kjeldahl method; K, after digestion with HNO_3-$HClO_4$, was determined by spectrometry of plasma emission with a Shimadzu ICP 1000. The yield (kg ha^{-1}), fresh weight and diameter of the bulbs were determined in both harvests (24/12/07 and 23/12/08).

The data were evaluated using ANOVA completed randomized. The mean values of the treatments were compared using the Fisher`s LSD test at 5% (Infostat, U.N. de Córdoba, Argentine).

RESULTS AND DISCUSSION

During crop cycle

Among organic treatments, T2 and T3 had the highest values of the leaves number, height and dry weight of the aerial part respect to T1 in 2008 (Fig 1). The onion-bovine manure compost treatment produced the lowest values in all variables measured at the end of the crop cycle. The treatment with inorganic fertilization (T0) had a similar growth to T2 and T3 in 2007 but lower in 2008. Lee (2010) studying the effect of aplication of compost tea in a short-day onion during the growing season observed that the organic fertilization produced a similar growth as that of chemical fertilization in terms of plant height and number of leaves.

Nitrogen and Potassium contents in leaves decreased gradually in all treatments after the beginning of bulb formation (october) (Fig. 2). Gaviola de Heras et al., (1993) observed this decreasing tendency in the foliar levels for white and red garlic? clones cultivated inorganically. On the first date of sampling in both years, the N foliar content in all treatments was bigger than 4 %. This percentage is considered as a sufficient level by Benton Jones et al., (1991). At the bulbification stage, the N contents dropped until reach the deficiency range. Fertility and fertilizers management is not simple practice since the quantities which must be incorporated to the soil sometimes are different to those quantities exported by the crop because N is subjected to losses by lixiviation and volatilization (Burba, 1993).

Previous to bulbification, the K leaf contents were lower than those suggested by Benton Jones et al. (1991) in all treatments in both years of study. In 2007, at beginning of the bulbification stage, the inorganic fertilization (T0) and the application of commercial amendment (T2 and T3) showed sufficient level of K. Meanwhile in 2008 only T0 and T1 treatment overcame the range 3- 4.5 % suggested in the bibliography.

At Garlic Harvest

In 2008 the organic treatments, T2 and T3, presented the highest yield, weight and diameter bulbs , while T1 obtained the lowest values of these parameters. In 2007 T3 showed significant differences with respect to T1 as regards the 3 parameters (Fig. 3 and 4). Despite the difference of yields obtained in 2007 (4000-6000 kg ha^{-1}) respect 2008 (5500-8500 kg ha^{-1}), the pattern of production was similar. Among the three organic treatments, T2 and T3 were significantly bigger than T1. Similar results were found by Filippini *et al*., (2006) using organics amendments. Orell *et al.* (2005) combined the inorganic fertilization with vermicompost, and observed a sinergic effect due to the physicochemical and biologic advantages of the organic amendment. Suthar (2009) concluded that vermicompost manure constitute a potencial source of nutrients for the sustained production of garlic. Application of liquid organic fertilizar over mulch was effective in increasing the onion bulb yield compare with no mulch treatment.

CONCLUSION

The commercial organic fertilizer BioOrganutsa Nitro Plus + phosphate rock incorporated alone or in combination with vermicompost tea, can be an alternative to fertize organic garlic crop.

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Tables

Table 1: Physicochemical properties of compost and vermicompost tea

	pH	CE dS m^{-1}	$N\text{-}NO_3^-$ ppm	C	Nt	P	K	Ca	Mg	Na	S
				% (on dry weigth)							
onion-bovine manure compost (CCE)	8,0	2,38		6,83	0,923	0,20	0,97	2,16	0,71	0,21	0,13
vermicompost tea (EL)	7,7	1,27	55	--	--	--	0,01	--	--	--	--

Figures

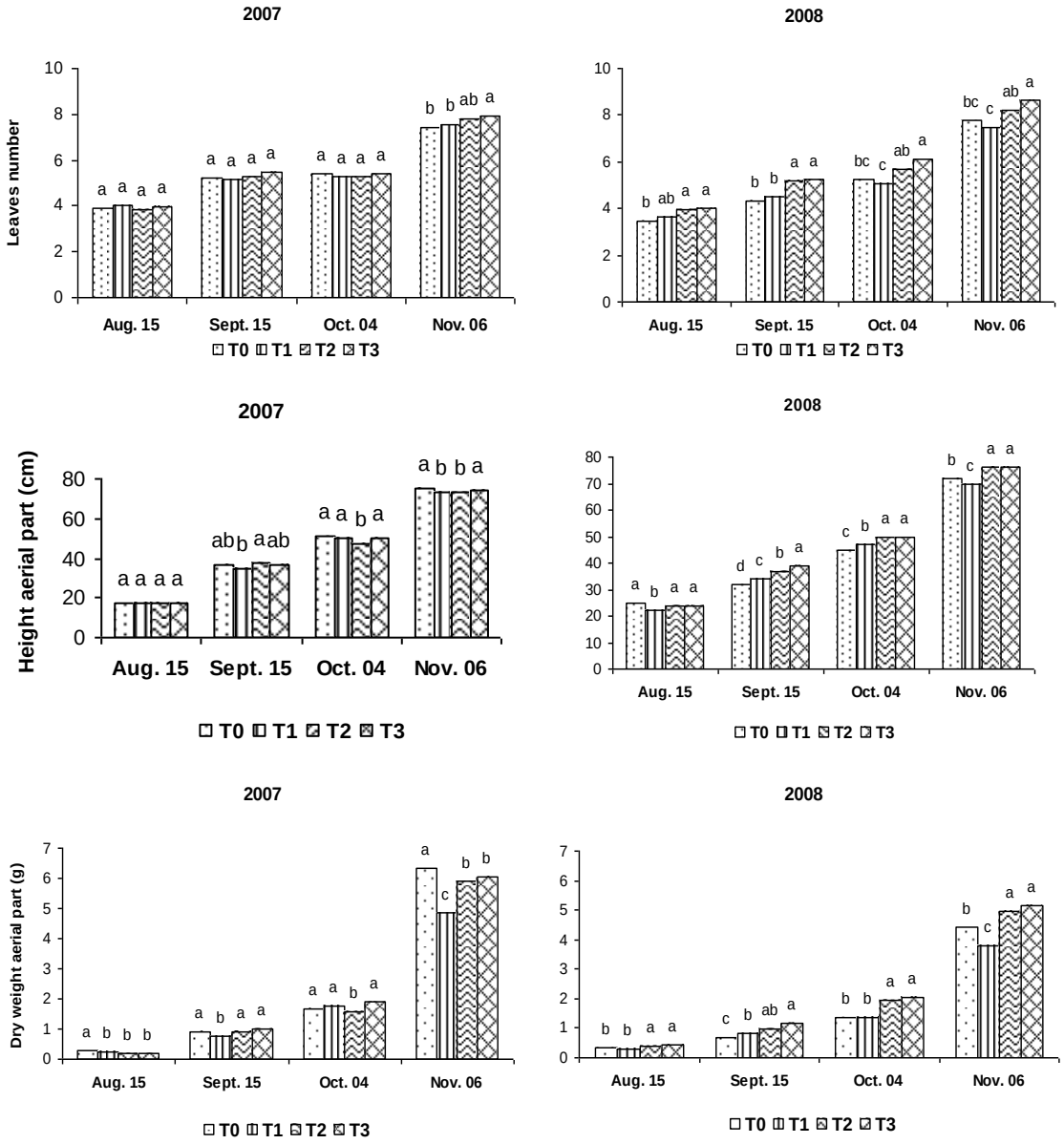


Fig. 1: Effect of the treatments on the leaves number, height (cm) and dry weight of the aerial part (g) on the sampling dates during the two years of the assay. For each year fassay, different letters among columns with the same motive show significant differences among treatments ($p<0.05$).

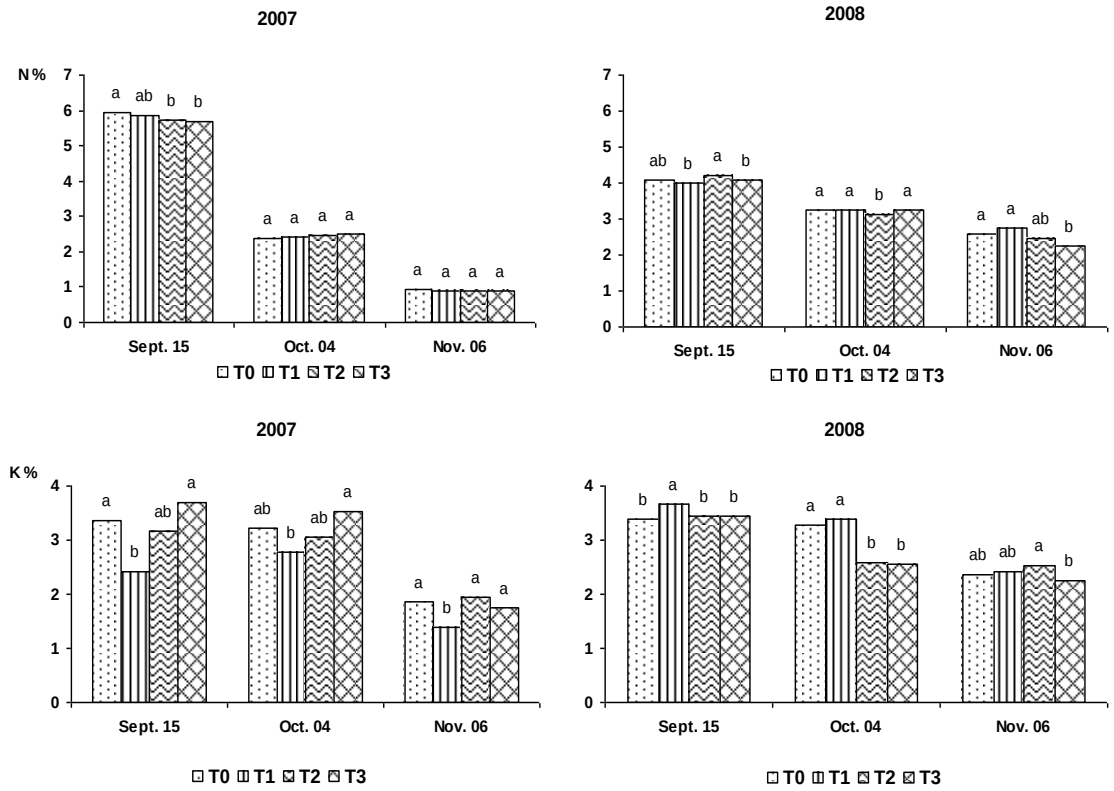


Fig. 2: Effect of the treatments on the contents of N and K in the aerial part of the garlic plants on the sampling dates during the two years of the assay. For each year of assay, different letters among columns with the same motive show significant differences among treatments ($p<0.05$).

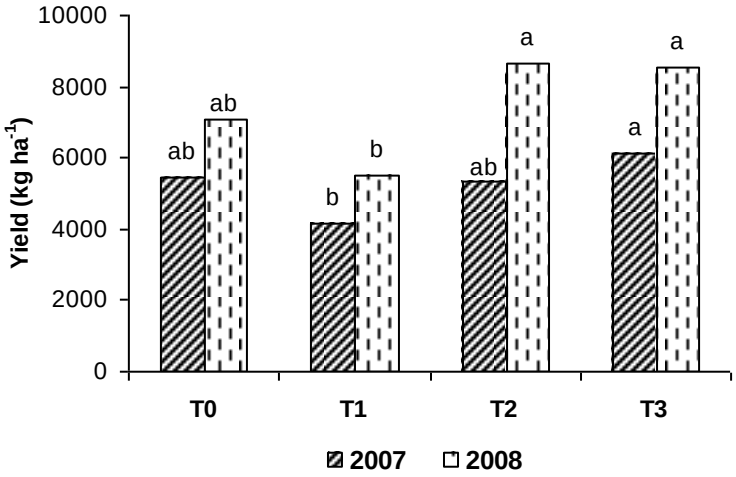
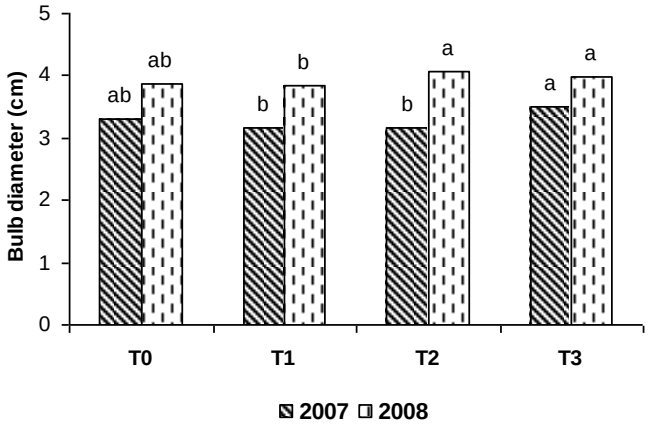


Fig. 3: Effect of the treatments on the yield during the two years of the assay. For each year of assay, different letters among columns with the same motive show significant differences among treatments ($p<0.05$).



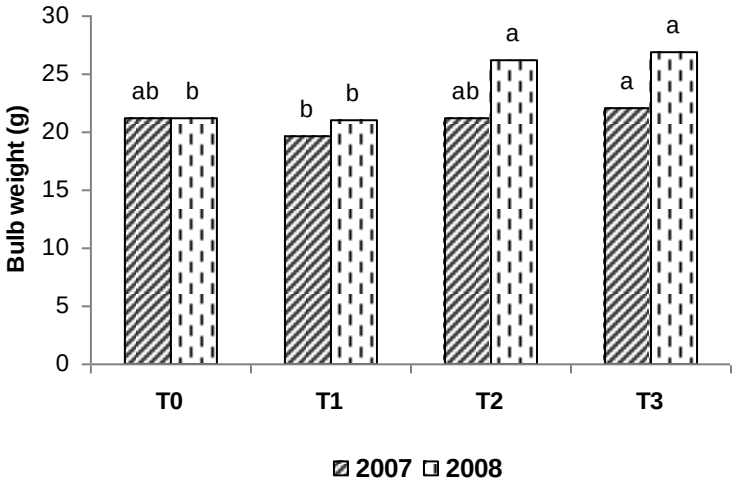


Fig. 4: Effect of the treatments on the diameter and the weight of the bulbs during the two years of the assay. For each year of assay, different letters among columns with the same motive show significant differences among treatments ($p<0.05$).