Soil Water Journal
toprak su dergisi

Toprak Su Dergisi, 2016, 5 (1): (16-21)

Effects of Different Organic Soil Amendments on Yield Parameters of *Brassica rapa* L. subsp. *sylvestris*

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Received date (Geliş tarihi) : 09.03.2016
Accepted date (Kabul tarihi) : 05.05.2016

Abstract

Brassica rapa L. subsp. *sylvestris* is one of the widely consumed vegetable in Puglia region of Italy. An experiment was conducted in experiment field of CHIEAM The Mediterranean Agronomic Institute of Bari (IAMB) to assess the effects of different organic amendments on yield parameters of turnip. Amendments used (a) coffee chaff compost, (b) coffee chaff (raw material), (c) control, (d) the commercial organic fertilizer. The rates of application were 6.3 tons ha^{-1} for coffee chaff compost, 7.5 tons ha^{-1} for coffee chaff and 9.3 tons ha^{-1} for the commercial organic fertilizer. The result indicated that the commercial organic fertilizer had highest values on number of leaves, plant height, fresh weight, dry weight and marketable yield ($p<0.05$) and there were no significant difference between other soil amendments. The commercial organic fertilizer was suitable in short term for turnip production when compared with compost and coffee chaff. It is recommended that *Brassica rapa* L. subsp. *sylvestris* can be grown successfully using the commercial organic fertilizer.

Key Words: *Brassica rapa* L. subsp. *sylvestris*, coffee chaff, compost, organic applications, yield

Farklı Organik Toprak İyileştiricilerinin Şalgam (*Brassica rapa* L. subsp. *sylvestris*) Bitkisinin Verim Parametreleri Üzerindeki Etkileri

Öz

Brassica rapa L. subsp. *sylvestris*, İtalya'nın Puglia bölgesinde yaygın olarak tüketilen sebzelerden biridir. Deneme, farklı organik toprak iyileştiricilerinin şalgam bitkisinin verim parametreleri üzerindeki etkilerini değerlendirmek için CHIEAM Bari (IAMB) Akdeniz Tarımsal Enstitüsü'nün deneme alanında yürütülmüştür. Toprak iyileştirici olarak (a) kahve samanı kompostu, (b) kahve samanı (ham şekilde), (c) kontrol ve (d) ticari organik gübre kullanılmıştır. Uygulama oranları kahve samanı kompostu için 6,3 ton ha^{-1}, ham kahve samanı için 7,5 ton ha^{-1} ve ticari organik gübre için 9,3 ton ha^{-1}'dur. Sonuçlar, ticari organik gübre uygulamasının yaprak sayısı, bitki boyu, yaş ağırlık, kuru ağırlık ve pazarlanabilir verim açısından en yüksek değerlere sahip olduğunu ($p<0,05$) ve diğer uygulamalar arasında istatiksel olarak önemli fark olmadığını göstermiştir. Ticari organik gübre, kahve samanı kompostu ve kahve samanı uygulamalarıyla karşılaştırıldığında şalgam üretimi için kısa vadede uygundur Ticari organik gübrenin *Brassica rapa* L. subsp. *sylvestris* bitkisinde kullanımı başarılı bir yetiştiricilik için tavsiye edilmektedir.

Anahtar Kelimeler: *Brassica rapa* L. subsp. *sylvestris*, kahve samanı, kompost, organik uygulamalar, verim

INTRODUCTION

Successful crop cultivation mostly depends on proper plant nutrition (Hernández et al., 2010). Conventional farming still relies heavily on chemical inputs such as synthetic fertilizers and pesticides (Lampkin, 1990). This is because, they are easy to use, quickly absorbed and utilized by crops. However, negative impacts of excessive use of chemical products in agriculture have been appeared, especially, on human health. Besides human health, intensive chemical uses decreased soil fertility and caused serious environmental problems such as oil and groundwater pollution, salinization and desertification (Hernández et al., 2010).

The organic materials include livestock manure, city waste, poultry manure and industrial waste (Ibrahim et al., 2008). If these materials are accumulated in the environment and will lead to serious problems due to lack of proper treatments.

In 2010 European countries imported over 3 million tons of green coffee (ECF, 2011). A two third amount of green beans are roasted and the rest are considered as main organic waste (coffee chaff.) at company level. Also, this solid waste is disposed as other urban refuse (Ceglie et al., 2009).

However, these materials contain high amounts of organic matter and nutrients that could produce organic fertilizers by composting, vermicomposting and be used in agricultural activity (Hernández et al., 2010). Composting provides an effective management of organic wastes (Millner et al., 1998), because it is more economical and beneficial for environment. It also conserves natural resources and improves cycling of non-renewable resources. Therefore, it could be used in agriculture in order to meet nutrient demand of crops, reduce the use of synthetic fertilizers (Kowalchuk et al., 1999; Rodríguez et al., 2008), and increases soil fertility without polluting the soil, as well as the quantity and quality of harvested products (Castillo et al., 2002).

The objective of this study is to assess the effects of different organic applications (coffee chaff compost, raw coffee chaff and the commercial organic fertilizer) on yield of "cima di rapa" turnip plant (*Brassica rapa* L. subsp. *sylvestris*).

MATERIALS AND METHODS

The experiment was conducted in an experiment field of CHIEAM The Mediterranean Agronomic Institute of Bari (IAMB) located in Valenzano (BA), southern Italy (41°03'N, 16°52'E, 72 m above sea level) in 2011. The region characterized by a Mediterranean climate with hot dry summer and rainy mild winter. Total rainfall of 5 months (Jan-May) is about 320 mm, distributed mostly during march. Whether data, including daily values of air temperature and humidity, wind speed and precipitation, were collected at the agro-meteorological station of CHIEAM-Bari Institute.

At the beginning of each cultivation cycle, soil samples from the experimental area (at 30 cm depth) were taken and then prepared for physical and chemical analysis. Each sample was air-dried, thoroughly mixed and grounded to pass through a sieve. Soil samples analysis has been done according to selected soil characteristics (Table 1).

The pH in 1: 2,5 (weight/volume) soil/water suspensions, using a glass electrode pH–meter. Organic carbon content was analyzed by means of Walkley and Black method (Nelson and Sommers, 1982). Total nitrogen was analyzed according to Kjeldahl method (Bradstreet, 1965). Available phosphorus was determined by using Olsen method (Olsen, et al., 1954).

The experiment comprised of four treatments laid in a Randomized Complete Block Design (RCBD), replicated three times. Each plot dimensions 4.5 m x 6 m (30 m^2) and there were 12 plots. The intra spacing was 30 cm, the row spacing was 50 cm. The variety used was ''cima di rapa'' (*Brassica rapa* L. subsp. *sylvestris*) which is local variety of turnip in Puglia region of Italy. They

Table 1. Chemical and physical analysis of soil samples

Cizelge 1. *Toprak örneklerinin kimyasal ve fiziksel analizleri*

Stone and gravels ($g\ kg^{-1}$)	pH (1:2.5w/vH_2O)	pH (1:2.5w/v$CaCl_2$)	Organic Carbon ($g\ kg^{-1}$)	Total Nitrogen ($g\ kg^{-1}$)	Available P ($g\ kg^{-1}$)	Available P_2O_5 ($mg\ g^{-1}$)	C/N
206.00	8.10	7.60	10.70	0.70	9.00	21.00	15.30

Table 2. Chemical and physical analysis of organic soil amendments

Cizelge 2. *Toprak iyileştiricilerinin kimyasal ve fiziksel analizleri*

Soil Amendments	Humidity (%)	pH	Organic Carbon (g kg^{-1})	Total Nitrogen (g kg^{-1})	C/N
Compost	68.28	9.20	431.33	40.70	10.59
Coffee Chaff	8.00		475.20	31.50	15.10
Comm.Org. Fertilizer	16.00	7.00	380.00	28.00	13.57

were transplanted on 12 March 2011 (40 days after applications). There were three organic amendments used. Soil treatments were a) coffee chaff compost (as 6.3 tons ha^{-1}) b) raw coffee chaff (as 7.5 tons ha^{-1}) c) control d) the commercial organic fertilizer (as 9.3 tons ha^{-1}). Coffee chaff compost was made from coffee chaff (36 %) and olive pruning materials (64 %). The composting process was managed through wetting and turning operations to keep moisture between 60 and 70 % and temperature at 65 ^{O}C average during the active phase (Ceglie et al., 2009). The commercial organic fertilizer was made from processed manure. They were applied 40 days before transplanting. Applications of organic amendments have been done based on nitrogen (N=250 kg ha^{-1}) requirement of crop. Contents of amendments were given in Table 2. In order to adjust moisture levels of applications to 70 %, water has been applied to each amendments according to their moisture level and weight.

Data were collected from six sample plants from inside of rows per plot in 27 April. The experiment included the following parameters: plant height, number of leaf, marketable yield, fresh weight and dry weight. Sensitive balance was used to measure the fresh weight and some procedure was followed in order to measure other parameters which are dry weight and marketable yield. After measurement of the fresh weight, damaged and low quality leaves were eliminated in order to get marketable part then sensitive balance used to find weight of marketable part. Elimination was done by hands. Following, measurement of marketable yield, eliminated leaves were collected which belong to certain plants. They were put together into the same fireproof boxes which numbered before measurement then all samples were put inside of oven in order to remove their water from tissues. Oven temperature was set 55 ^{O}C and it was worked one week with same temperature degree. After this process sensitive balance was used again to measure the dry weight of samples.

The collected data were analyzed using JMP 2008 statistical package. Analysis of variance (ANOVA) was undertaken on collected data so as to determine if there were any significant differences among treatments. Mean separation where significant differences were detected was done by Tukey-Kramer HSD test.

RESULTS AND DISCUSSION

The results indicated significant differences in growth parameters among treatments. The highest mean plant height was exhibited a significant ($p<0.05$) difference with 39.22 cm in the commercial organic fertilizer treatment (Figure 1). However, there were no significant differences among coffee chaff treatment, compost treatment and control.

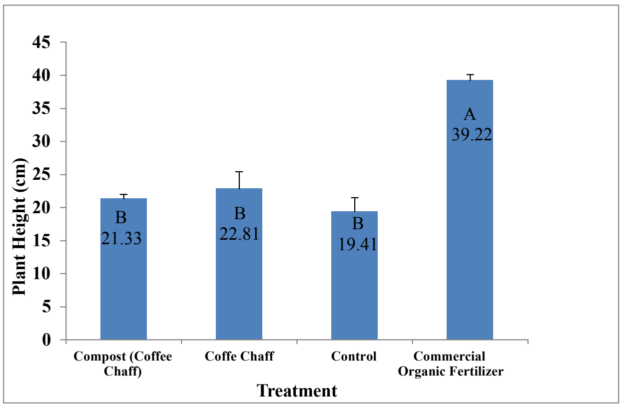

Figure 1. Mean values for plant height (cm) of collected samples, 46 days after transplanting ($p<0.05$)

Şekil 1. *Dikimden 46 gün sonra toplanan örneklerin bitki boyu (cm) ortalama değerleri ($p<0.05$)*

Plants treated with the commercial organic fertilizer had the highest average number of leaves per plant with 35.44 and followed by coffee chaff with 18.78. The lowest value for average number of leaves per plant was obtained for the compost and the control treatments. The coffee chaff, compost and control treatments exhibited a nonsignificant difference in terms of average number of leaves per plant (Figure 2). The fresh weight data are given in Figure 3. There were significant differences among the treatments. The maximum fresh weight was recorded with the commercial organic fertilizer with 464.33 g. Similar trend was observed in dry weight with 39.55 g (Figure 4).

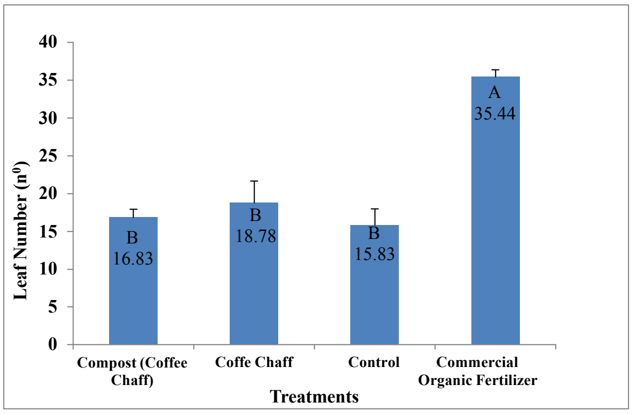

Figure 2. Mean values for number of leaf of collected samples, 46 days after transplanting ($p<0.05$)

Şekil 2. *Dikimden 46 gün sonra toplanan örneklerin yaprak sayısı ortalama değerleri (p<0.05)*

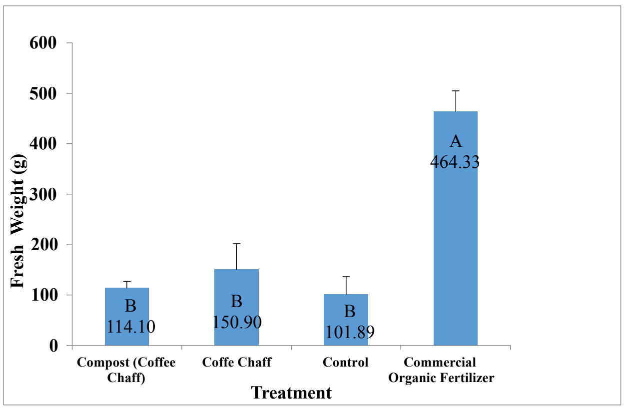

Figure 3. Mean values for fresh weight (g) of collected samples, 46 days after transplanting ($p<0.05$)

Şekil 3. *Dikimden 46 gün sonra toplanan örneklerin yaş ağırlık (g) ortalama değerleri (p<0.05)*

However, there were no significant differences in terms of fresh weight and dry weight among coffee chaff, compost and control treatments. Lastly, as presented in Figure 5 the commercial organic fertilizer had the highest marketable yield with 369.33 g and followed by coffee chaff (87.84 g), control (42.55 g) and compost (41.09 g) applications.

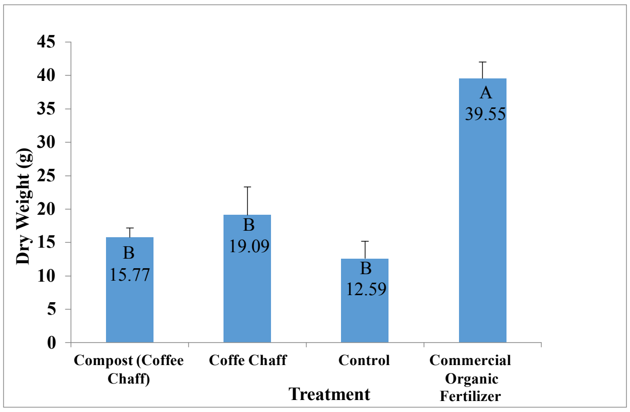

Figure 4. Mean values for dry weight (g) of collected samples, 46 days after transplanting ($p<0.05$)

Şekil 4. *Dikimden 46 gün sonra toplanan örneklerin kuru ağırlık (g) ortalama değerleri (p<0.05)*

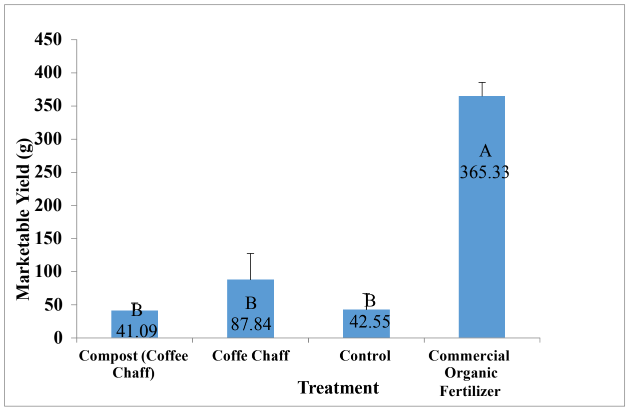

Figure 5. Mean values for marketable yield (g) of collected samples, 46 days after transplanting ($p<0.05$)

Şekil 5. *Dikimden 46 gün sonra toplanan örneklerin pazarlanabilir verim (g) ortalama değerleri (p<0.05)*

The maximum values were obtained from the commercial organic fertilizer treatment for all parameters. Likewise, the lowest values for all parameters were observed with control application and there was no significant difference among coffee chaff, compost and control treatments for all parameters. The result of this study showed that three organic amendments depending on total N content had different effects on turnip plant. In order to understand reasons of the differences comprehensively, it is necessary to assess mineralization amounts of the applications and to determine effects of soil, temperature and moisture on mineralization process.

In many studies, a relation between N mineralization and biochemical characteristics of organic materials has been reported. Mostly, total

N content and C/N ratio of organic materials were strongly correlated to their mineralization (Pansu and Thuries, 2003; Chaves et al., 2004). However, other factors such as lignin and carbon content or their ratio with total N content are also very important for the mineralization process and mineral N release (Fox et al., 1990; De Neve et al., 2004). Organic N mineralization, mostly depends on the nature of the organic matter and other parameters such as soil type, soil water content and temperature (Agehara and Warncke, 2005). Therefore, Chadwick et al., (2000) concluded that there is no single parameter that could entirely and quantitatively effect N release and availability.

Chèneby et al., (1994), Hadas and Portnoy (1997) stated that organic compost derived from animal manure, it is assumed that the total N-mineralization in the first year is between 24 and 35 %. In this study, commercial organic fertilizer was the only one application which has been produced from animal manure. Therefore, this assumption prove that commercial organic fertilizer treated soils produced more yields than soils treated with other plant based applications. This shows that total N with the commercial organic fertilizer has become available to the plant throughout the growth period.

As a consequence, growth and yield parameters of the turnip plant were significantly improved with the commercial organic fertilizer treatment. It could be explained by its rapid availability of nutrients and especially its N release patterns and mineralization kinetics. The compost and the coffee chaff treatments were not showed any significant difference in terms of growth and yield parameters. The reason might be that the time required for a suitable decomposition and mineralization has not been sufficient in one growing season.

CONCLUSIONS

Turnips were grown with the commercial organic fertilizer exhibited significantly better growth (plant height, fresh weight, number of leaves, dry weight and marketable yield) than other organic amendments in short term. It might be recommended that the commercial organic fertilizer is suitable for crop production which has short cycle. Furthermore, the experiment must be performed several years through future projects in order to observe long term effect of applied amendments.

Acknowledgments

I would like to thank my supervisor Francesco Ceglie for his fruitful guidance and continuous follow up throughout the whole research period both in the field and theoretical concepts. This experiment was funded by the CHİEAM Mediterranean Agronomic Institute of Bari (IAMB).

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