DOI: 10.17707/AgricultForest.62.1.08

George TSIAKARAS1,
Spyridon PETROPOULOS, Vasilios ANTONIADIS[1]

THE EFFECT OF ORGANIC AND INORGANIC FERTILIZATION ON THE DEVELOPMENT AND YIELD OF THREE BRASSICA SPECIE

SSUMMARY

In the present study the effect of organic and inorganic fertilization on the development and yield of three Brassica species was examined. The experiment was conducted at Servota, Trikala during 2012-2013 growing season. Three brassica were studied [Broccoli: Grande F1, Cauliflower: Rex F1, Cabbage: Torpedo F1], whereas fertilization was implemented with the application of organic and inorganic fertilizers with plants getting the same amounts of nutrients at both occasions. Seeds from the three species were sown in seed trays containing peat and young seedlings were transplanted directly in the soil within an unheated plastic greenhouse. At the day of harvest plant features regarding plant development, such as the number of leaves, flower heads and main and second order shoots, total plant fresh weight, fresh weight of leaves and main and second order flower head and shoots, were recorded. From the results it is suggested that the fertilization method did not affected marketable yield for any of the studied species. The only features that were affected by fertilization method was leaf fresh and dry weight for cabbage and leaf dry weight for cauliflower, as well as shoot fresh weight for the same species. In conclusion, the fertilization method (organic or inorganic) does not affect yield of the studied species as soon as the plant nutrient requirements are covered.

Keywords: broccoli, cabbage, cauliflower, organic fertilization, conventional fertilization

INTRODUCTION

The implementation of sustainable agricultural cultivation systems that are environmental friendly is a key factor for the increase of production of high nutritional value products, as well as the enhance in the added value of the final products that will allow the farmers for a higher profit. Moreover, it will contribute in the better and more rational management of natural resources that tend to be more and more scarce. In terms of nutritional value, Lima-Pallone et

[1] George Tsiakaras, Spyridon Petropoulos (corresponding author: fangio57gr@gmail.),, Vasilios Antoniadis, 1University of Thessaly, Department of Agriculture, Crop Production and Rural Environment, Fytokou Street, 38446, Volos, GREECE
Paper presented at the 6th International Scientific Agricultural Symposium "AGROSYM 2015".
Notes: The authors declare that they have no conflicts of interest. Authorship Form signed online.

al. (2008) report that the application of organic agricultural systems is beneficial for the folic acid content in brassica species, whereas Meyer and Adam (2008) report a similar effect on the glycobrassicin content. In addition, nitrogen supply form can result in differences in the content of phytochemical substances such as glucosinolates, flavonoids, carotenoids and chlorophylls (Fallovo et al., 2011).

The application of organic fertilizers has been suggested to have many beneficial effects, since it results in an improvement of soil properties and an enhance in the microbial content (Dauda et al., 2008; Suresh et al., 2004). The development of innovative organic fertilizers has allowed farmers to apply balanced fertilization regimes that are similar to conventional fertilizers with all the beneficial effects (Naeem et al., 2006). However, the main disadvantages of organic fertilizers are their high cost per nutrient unit and the fact that most of them are available in liquid form and therefore can only applied via irrigation water or in hydroponic systems.

In the present study we examined the effect of two fertilization regimes with the use of either organic or conventional fertilizers, on the yield and plant development of three brassica species (broccoli, cabbage and cauliflower).

MATERIAL AND METHODS

The plant material used in the experiments was three hybrids of brassica species, namely broccoli [*Brassica oleracea* L. var. *italica* Plenck(Grande F1)], cabbage [*Brassicaoleracea* L. convar. *capitata* (L.) Alef. var *capitata* (Torpedo F1)], and cauliflower [*Brassica oleracea* convar. *botrytis* (L.) Alef. var. *botrytis* L. (Rex F1)]. Seeds of the three species were sown in seed trays filled with peat on October 19th and transplanted in soil 35 days after sowing (November 24th). Cultivation was carried out in an unheated plastic greenhouse in order to avoid depletion of fertilizers due to unexpected rainfall. The fertilization regime for both organic and conventional fertilization is presented in Tables 1 and 2. The conventional fertilizers implemented were the following: potassium nitrate (13-0-46), potassium sulfate (0-0-50), calcium nitrate (15.5-0-0 + 19% Ca), ammonium nitrate(34.5-0-0), mono potassium phosphate (0-52-34), borax and iron chelate (6%). Similarly, the organic fertilizers were: Avant Natur (5.5-0-0; Compo Expert GmbH), Fish-Fert (2-4-0.5; Humofert S.A.), Acadian (1-1-16; Humofert S.A.), borax and iron chelate (6%).

Fertilizers were applied throughout the cultivation season via irrigation water (fertigation), whereas after harvest plant development and yield was assessed (number of leaves, head and 2nd order shoots, total plant fresh weight, fresh weight of leaves and 1st order heads and 2nd order shoots and heads). Harvest was carried out when flower and leaf heads (for broccoli, cauliflower and cabbage respectively) reached the standard commercial size (March 6th to April 9th for broccoli, March 7th to April 16th for cabbage and March 19th to April 16th for cauliflower).

Table 1. Nutritional solution composition for conventional fertilization

		Nutrients (mg per litre)							
Fertilizer type	Quantity (g per 10 L)	N	K_2O	P_2O_5	Ca	Mg	S	B	Fe
13-0-46	4.87	63.3	289	-	-	-	-	-	-
0-0-50	0.236	-	10.6	-	-	-	4.25	-	-
15.5-0-0 +19% Ca	0.98	15.2	-	-	18.75	-	-	-	-
34.5-0-0	6.42	221.5			-	-	-	-	-
0-52-34	1.92	-	65.3	100	-	-	-	-	-
Borax	0.02	-	-	-	-	-	-	0.22	-
Iron chelate (6%)	0.19	-	-	-	-	-	-	-	1.12
Total	-	300	300	100	18.75	-	4.25	0.22	1.12

Table 2. Nutritional solution composition for organic fertilization

		Nutrients (mg per litre)							
Fertilizer type	Quantity (g per 10 L)	N	K_2O	P_2O_5	Ca	Mg	S	B	Fe
Avant Natur (5.5% N)	43.5	239.8	-	-	-	-	-	-	-
Fish-Fert (2-4-0.5)	20.5	41.0	10.25	82.0	15.37	0.82	3.48	-	-
1-1-16	18	18.75	287.5	18.75	-	-		-	
Borax	0.02	-	-	-	-	-		0.22	-
Iron chelate (6%)	0.19	-	-	-	-	-	-	-	1.12
Total	-	299.5	297.75	100.7	15.37	0.82	3.48	0.22	1.12

The statistical design was a split-plot design, with main plots the fertilizer treatments and sub-plots the species. Each treatment was replicated four times (n=4) with 24 plots in total. Each plot was 4 m2 (2 x 2 m) and plant distances were 50 cm between rows and 40 cm within each row (50.000 plants ha-1). Statistical analysis was carried out with statistical package Statgraphics Centurion (Statpoint Technologies Inc., USA).

RESULTS AND DISCUSSION

From the results it is suggested that the application of either conventional or organic fertilizers did not result in significant differences in total biomass production as this is expressed by total plant fresh weight (Table 3). Similarly, yield features such as the 1st and 2nd order head fresh weight of broccoli did not differ significantly, whereas in the case of cauliflower the application of organic fertilizers resulted in higher weight for 2nd order heads without however obtaining a final marketable size (Table 4). Mohapatra et al. (2014) have also reported that the application of NPK fertilizers+bioinoculants, farm yard manure and vermicompost did not result in significant differences in the yield of broccoli

plants, whereas nutrient recovery was highest for vermicompost and the combination of vermicompost and farm yard manure.

Table 3. The effect of fertilizer regime (organic and conventional) on yield and morphology features of three brassica species

Species	Treatment	Total plant weight	2nd order shoots	Number of leaves	Leaves fresh weight	Leaves dry weight
Brocolli	Conventional	2651.04	5.21	69.68	1659.74	8.59
	Organic	2762.32	4.75	67.60	1748.01	8.58
	LSD	411.72	1.93	10.73	273.42	0.59
Cauliflower	Conventional	3450.46	1.33	19.8	2526.44	9.31b
	Organic	3431.51	1.00	19.8	2288.53	10.48a
	LSD	402.00	0.45	2.79	303.10	1.11
Cabbage	Conventional	4167.21	3.27	39.20	2843.82a	9.04a
	Organic	3822.01	2.31	35.55	2417.85b	8.48b
	LSD	429.79	1.27	8.43	354.02	0.47

*Different latin letters represent significant differences between means of the same column and the same species according to Least Significant Differences test (LSD) at p=0.05.

In contrast, Zaki et al. (2012) reported that the combination of organic and inorganic fertilizers at a ratio of 75:25 resulted in higher plant growth comparing to organic or inorganic fertilizers alone

Table 4. The effect of fertilizer regime (organic and conventional) on yield and morphology features of three brassica species

Species	Treatment	1^{st} order head fresh weight	2^{nd} order head fresh weight	Head dry weight	Shoot fresh weight	2^{nd} order shoot fresh weight	Shoot dry weight
Brocolli	Conventional	430.43	22.06	9.25	336.66	176.33	6.25
	Organic	435.99	21.82	9.49	344.08	191.20	6.41
	LSD	109.05	4.78	0.74	47.39	56.26	0.44
Cauliflower	Conventional	667.86	4.03b	8.14	398.98b	48.97	6.82
	Organic	523.32	15.30a	8.86	607.84a	48.90	7.27
	LSD	188.48	3.32	1.03	139.28	5.63	0.95
Cabbage	Conventional	998.26	-	8.06	273.91a	-	9.00
	Organic	1146.51	-	7.61	212.38b	-	9.92
	LSD	198.44		0.50	40.39		1.99

*Different latin letters represent significant differences between means of the same column and the same species according to Least Significant Differences test (LSD) at p=0.05.

These differences in the results may be due to the fact that they only used ammonium nitrate as an inorganic fertilizer plus the fact that they also applied bio-inoculation with various bacillus cultures.Moreover, Abou El-Magg et al.

(2014) reported that nitrogen rate combined with bio-nitrogen fertilizers can significantly affect brocolli yield as well as vegetative features such as plant weight, fresh weigh and number of leaves, dry matter content and mineral composition of heads, since bio-fertilizers can improve nitrogen fixation and consequently plant growth and development.

In general, the type of fertilizers (organic or conventional) did not affect most of the features assessed in our study, except for dry weight of leaves and shoot fresh weight of cauliflower and fresh and dry weight of leaves and shoot fresh weight of cabbage, with beneficial effect of organic and conventional fertilizers in the case of cauliflower and cabbage respectively (Tables 3 and 4). It could be suggested that as soon as plant nutrient requirements are sufficiently covered yield and plant growth potential could be fully expanded allowing for high yields regardless of fertilizer type. The fact that usually organic fertilization results in lower yields and plant growth comparing to inorganic fertilizers could be attributed to the fact that the used plant material has derived from conventional breeding programs where genotypes are evaluated under intensive farming systems and high input regimes. Therefore, there is a great need for crop breeding suitable for organic farming where usually inputs are low and plant requirements are not fully covered since sustainability and not the maximum yield is the ultimate goal (Lammerts van Bueren et al. 2011).

CONCLUSIONS

From our study it is concluded that the type of applied fertilizers does not affect plant development and yield of the three tested Brassica species, as soon as plant nutrient requirements are sufficiently covered. However, these results need to be confirmed in the long term since organic fertilizers are more environment friendly and ideal for sustainable farming and have been suggested to improve soil properties, despite their disadvantages. Therefore, further research need to be conducted in order to have sufficient results for a solid conclusion regarding the type of fertilizers that farmers should apply in their crops. Moreover, plant breeding for new cultivars suitable for low inputs organic farming as well as the production of new and more efficient organic fertilizers is imperative in order to reduce production cost.

REFERENCES

Abou El-Magd, M.M., Zaki, M.F., Abo Sedera, S.A. (2014). Effect of bio-nitrogen as a partial alternative to mineral-nitrogen fertilizer on growth, yield and head quality of broccoli (Brassica oleracea L. var. italica). World Applied Sciences Journal, 31 (5): 681-691.

Dauda, S.N., Ajayi, F.A. and Ndor, E. (2008). Growth and yield of water melon (Citrullus lanatus) as affected by poultry manure application. Journal of Agriculture and Social Sciences, 4: 121-124.

Fallovo, C., Schreiner, M., Schwarz, D., Colla, G., Krumbein, A. (2011). Phytochemical changes induced by different nitrogen supply forms and radiation levels in two

leafy Brassica species. Journal of Agricultural and Food Chemistry, 59: 4198-4207.

Lammerts van Bueren, E.T., Jones, S.S., Tamm, L., Murphy, K.M., Myers, J.R., Leifert, C., Messmer, M.M. (2011). The need to breed crop varieties suitable for organic farming, using wheat, tomato and broccoli as examples: A review, NJAS - Wageningen Journal of Life Sciences, 58 (3–4): 193-205.

Lima-Pallone, J.A., Catharino, R.R. and Godoy, H.T. (2008). Folates in conventional and organic broccoli and losses during cooking. Quimica Nova 31, (3): 530-535.

Meyer, M. and Adam, S.T. (2008). Comparison of glucosinolate levels in commercial broccoli and red cabbage from conventional and ecological farming. European Food Researchand Technology, 226 (6): 1429-1437.

Mohapatra, S.K., Mahapatra, P., Munsi, P.S. (2014). Effect of organic manures, bioinoculants and inorganic fertilizers on yield, nutrient uptake and nutrient recovery by broccoli. Indian Journal of Horticulture, 71 (4): 584-587.

Naeem, M., Iqbal, J. and Bakhsh, M.A.A. (2006). Comparative study of inorganic fertilizers and organic manures on yield and yield components of mungbean (Vigna radiata L.). Journalof Agriculture and Social Sciences, 2: 227-229.

Suresh, K.D., Sneh, G. Krishn, K.K and Mool, C.M. (2004). Microbial biomass carbon and microbial activities of soils receiving chemical fertilizers and organic amendments. Archives of Agronomy and Soil Science, 50: 641-647.

Zaki, M.F., Tantawy, A.S., Saleh, S.A., Helmy, Y.I. (2012). Effect of bio-fertilization and different levels of nitrogen sources on growth, yield components and head quality of two Broccoli cultivars. Journal of Applied Sciences Research, 8 (8): 3943-3960.