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EFFECT OF ORGANIC AND BIO FERTILIZATION IN YIELD CHARACTERS AND FRUIT QUALITY OF STRAWBERRY *FRAGARIA X ANANASSA* DUCH RUBY GEM

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Abstract

Garden strawberry *Fragaria x ananassa* Duch. Ruby C seedlings were subjected to treatments of soil incorporation with organic fertilizer (wheat remains compost) at three levels (0, 15 or 30 g/plant) and/or bio fertilization with *Azospirillum* or *Azotobacter* at concentration of 10 ml/Plant, individually or in combination, beside the water sprayed control plants during the 2017 and 2018 growing seasons. The results showed that the strawberry yield characters and fruit nutritional components were affected at different level by different treatments. Compared to the control treatment, the combined treatment of organic fertilizer (30 g/plant) with the two bio-fertilizers (*Azospirillum* and *Azotobacter*) among all the other treatments resulted in significantly higher values in number of fruits.plant^{-1}, fruit weight, yield.plant^{-1}, fruit content of total sugars, ascorbic acid, anthocyanin pigment and lowest content of total acidity.

Key words: Strawberry, plant compost, Bio-fertilizer, *Azotbacter*, *Azospirillum*, Ruby Gem.

Introduction

Garden strawberry *Fragaria x ananassa* Duch with its small soft fruits is an important fruit plants and widely distributed over the world. This plant includes a number of up to 45 species, including wild and cultivated strawberry (Al-Saeedi, 2000). Strawberry is commercially grown and produced in many Asian and European countries such as China, Turkey, Japan, Koria, Spain, Italy, Poland and Austria. Its origin is believed to be in North America as USA is the world biggest producer followed by Canada, Fenzwilla, Peru, Brazil, Bolivia, Chile and Ecuador. It is believed that North America is the strawberry origin, where the United States of America is ranked first among the producing countries then Canada, followed by Venezuela and then Peru, Brazil, Bolivia, Chile, Ecuador and the African continent (Egypt and South Africa) (Samra *et al*., 2005). As consumption and favorability, strawberry is the fourth fruit after apples, oranges and bananas (Crespo, 2010).

The plant is distinguished by its high ability to adapt to the different environmental conditions, perennial, can be renewed annually and have several varieties and fruits on several forms. Strawberry cultivation Iraqi lands is facing unavialability of microelements especially Iron and some other elements. This problem has encouraged farmers to nourish their plants using organic fertilizers and developing chemical fertilizers alternatives. Such practice can lessen environmental pollution and health problems from one hand and upgrading soil fertility by increasing its contents of nutritional elements and soil microorganisms biodiversity from the other. This will lead not only to higher plant productivity but also to safer and healthier food products and agricultural practices (Akanabi *et al*., 2010 and Ainika *et al*., 2012). Bio-fertilizers, whether bacterial or fungal, were also used in plant nutrients programs (Saharan and Nehra, 2011). They can be used as soil or seed treatment to increase plant nutrients in general and improve plant hormones secretion which is positively reflected by higher growth and production (Ali *et al*., 2003). Thus the objective of this study was to evaluate the effect of organic fertilizer (wheat remain compost) and biofertilizer (*Azospirillum* and *Azotobacter*) on yield characters and fruit nutritional components of strawberry fruits cultivar Ruby Gem.

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Table 1: Physical and chemical characteristics of the greenhouse soil before planting.

Soil particle	Unit	Value
Clay	$g.kg^{-1}$	88
Silt	$g.kg^{-1}$	204
Sand	$g.kg^{-1}$	708
Soil texture		Sandy silt
Analysis	**Unit**	**Value**
E.C.	dSm^{-1}	3.56
Ph	-	7.6
N	$mg.L^{-1}$	39.6
P	$mg.L^{-1}$	8.2
K	$mmol.L^{-1}$	5.41
Na	$mmol.L^{-1}$	3.4
Mg	$mmol.L^{-1}$	9.5
SO_4^{-2}	$mmol.L^{-1}$	5.2
CO_3^{-2}	$mmol.L^{-1}$	Nil
HCO_3^-	$mmol.L^{-1}$	0.87
Organic matter	%	1.51
Fe	$mg.L^{-1}$	5.19
B	$mg.L^{-1}$	0.26

Materials and Methods

The experiment was carried out in a nursery plastic house belongs to the Horticulture and Forestry Division at Department of Agronomy/ Al-Najaf Agriculture Directorate in the province of Najaf. The plastic house was 9 m in width and 56m in legth (with an area of 504 m^2). The soil of the plastic house was tilled twice, ripped, leveled and left to sun solarization. Before planting, the plastic house soil was divided into furrows and soil samples were taken for chemical and physical properties analysis (Table 1), as well as the wheat remain compost used in the study (Table 2). Two purified and identified bacterial isolates (*Azospirillum brasilense* and *Azotobacter chroococcum*) used in this study were obtained from the Soil microbiology laboratory/Dept. of Soil Sciences and Water Managements. The bacterial isolates were cultured and propagated in the graduate Plant Pathology laboratory/Dept. Plant Protection. In a series of dilution, both bacterial species were diluted to be 4.5×10^7/ml (cfu) for the isolate *Azospirillum brasilense* and 6.5×10^7/ml (cfu) for *Azotobacter chroococcum* (Al-Hadithi, 1983). The experiment was RCBD factorial with two factors with tree replicates. The main factor was wheat remain compost added to the soil at three density levels (0, 15 or 30 $g.plant^{-1}$) while the second factor was the biofertilizer (bacterial isolates) applied at 10ml/plant by injection to plants soil 10 days post planting. Thus, the experiment included 12 treatments consisting of two bacterial isolates (bio-fertilizer), three density levels of organic fertilizer and all their possible interactions, beside the negative control. Treatment applications of the two factors were repeated 75 days post the first application. The same treatments applications were applied in the following growing season. At harvesting, the quantitative and qualitative plant yield parameters measured included number of fruits/plant, fruit weight, yield/plant, fruit content of total sugar and acidity, fruit content of ascorbic acid and fruit content of anthocyanin.

Table 2: Chemical properties of the organic fertilizer (wheat remain compost) used in the study.

Available macro-elements $g.\ kg^{-1}$			Ca mmol. $100g^{-1}$	pH	EC dSm^{-1}	Organic matter $g.kg^{-1}$
N	P	K				
3.5	0.81	9.7	14.75	6.3	1.60	161.5

For data analysis, a computing GenStat 12th Edition (2010) program was used. Data were subjected to analysis of variance ANOVA and means were compared according least significant difference L.S.D. at $P\leq0.05$.

Results and Discussion

Results (Table 4) showed that different treatment of organic and bio-fertilizers had different effects on yield characters and nutrition components of strawberry fruits. In case of yield characters, the highest number of fruits per plant (29.78 and 33.00 fruits $plant^{-1}$) were recorded in the combined treatment of 30 g/plant-*Azosperilium-Azotobacter* which significantly differed from the control (20.00 and 20.00 $fruits.plant^{-1}$) for the both seasons, respectively. The same treatment combination resulted in significant increase in fruit weight and $yield.plant^{-1}$ to be 24.72 and 24.69 g and 662.0 and 814.7 $g.plant^{-1}$ compared to fruit weight of 15.20 or 15.30 g and $yield.plant^{-1}$ of 304 and 306 $g.plant^{-1}$ resulted from the control treatment for the two seasons, respectively.

The nutrients components of strawberry fruits were also affected by different fertilization treatments (Table 5). Similar to the results of yield characters, the treatment of organic fertilizer at 30 g/plant combined with *Azosperillum* and *Azotobacter* resulted in the highest values of nutrient components of strawberry fruits. The highest rates of fruit content of total sugar (7.88 and 8.05 g. $100g^{-1}$FW) and lowest total acidity (3.96 and 3.90g. $100g^{-1}$FW) were recorded in this treatment with significant difference from the control which resulted in 4.17 and 4.22 g. $100g^{-1}$ FW for the first and 5.4 and 5.10 g. $100g^{-1}$FW for the second in both seasons, respectively. The same combined treatment resulted also in the heist values of fruit content of ascorbic acid (23.26 and 38.86 mg. $100g^{-1}$FW) and anthocyanin pigment (26.89 and 34.81mg. $100g^{-1}$FW) which significantly differed from the control results that

Table 4: Effect of organic and bio-fertilization on yield characters of strawberry *Fragaria x ananassa* 'Ruby Gem' fruits.

Treatments	Number of fruits (fruit.plant^{-1})		Fruit weight (g)		Yield per plant (g.plant^{-1})	
	2017	2018	2017	2018	2017	2018
Control	20.00	20.00	15.20	15.30	304.00	306.00
Azotobacter	22.00	23.60	17.05	17.70	375.10	417.72
Azospirillum	21.01	22.32	16.70	16.80	350.86	374.97
Azotobacter + Azospirillum	24.23	27.44	21.70	18.19	525.79	499.13
15g OF	26.00	27.60	22.20	18.22	577.20	502.87
15g OF+*Azotobacter*	25.80	28.30	24.33	19.18	627.71	542.79
15g OF+*Azospirilum*	23.00	24.45	23.20	18.19	533.6	444.745
15g OF+*Azotobacter*+*Azospirillum*	24.22	29.60	25.30	21.59	612.76	639.06
30g OF	27.00	29.00	23.70	20.63	639.90	598.27
30 g OF+*Azotobacter*	30.31	32 .00	24.13	23.66	731.38	598.27
30 g OF+*Azospirilum*	25.00	30 .25	23.50	23.00	587.50	695.75
30g OF+*Azotobacter*+*Azospirillum*	29 .78	33 .00	24.72	24.69	662.00	814.77
L.S.D $_{(P \leq 0.05)}$	2.98	1.18	1.44	4.81	127.27	42.11

Values are means of four replicates from data recorded at two growing seasons (2017 and 2018). Wheat remain compost was used as organic fertilizer (OF).

of 14.98 and 15.30 mg. 100g^{-1}FW and 15.17 and 15.63 mg. 100g^{-1}FW resulted from both seasons, respectively. Findings of this study showed that both types of fertilization, the organic (wheat remain compost) and the biological (*Azosperillum* and *Azotobater*) were substantially effective in increasing yield characters and nutrients components of strawberry fruits.

In general, the higher concentration (30 ml/L) of the organic fertilizer was better than the lowest ones in reducing fruits content of total acidity and increasing all the other studied characters (number of fruits.plant^{-1}, fruit weight, yield.plant^{-1}, fruit content of total sugars, ascorbic acid and anthocyanin). This mostly because the organic matter at higher rate improved soil fertility and chemical and physical properties beside increasing nutrients available to plant roots and thus increasing overall plant growth. The fertilizer type is also important as a rich source of nutrients necessary to plant. Our findings came in line with findings by Carsofschi and Iancu, (1994) where the addition of organic fertilizer (plants remain compost) to apricot orchards increased soil content and availability of N, P and K. This was also in agreement with Pang and Letey, (2000), Boiteau, (2004) and Osman, (2007) where they found that soil treatment with organic fertilizer increased the rate of soil nitrogen, which in turn, increased plant growth and productivity.

The bacterial inoculum in the biofertilizers (*Azosperillium* and *Azotobater*) in this study found to have positive effect on treated strawberry plants indicated by increasing values of all the studied yield and nutritional characters. This can be attributed to the roles of biological agents (bacterial isolates) in producing more nitrogen to the soil and increasing phosphorous availability as well as some other compounds produced as result of their

Table 5: Effect of organic and bio-fertilization on strawberry fruits contents of some nutrient components.

Treatments	Fruit content of total sugars (g.100g FW^{-1})		Fruit content of total acidity (g.100g FW^{-1})		Fruit content of ascorbic acid (g.100g FW^{-1})		Fruit content of anthocyanin (g.100g FW^{-1})	
	2017	**2018**	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
Control	4.17	4.22	5.14	5.10	14.98	15.30	15.17	15.63
Azotobacter	4.76	4.80	5.05	5.00	17.22	19.25	16.33	17.73
Azospirillum	4.60	4.54	5.11	5.07	15.37	17.27	16.03	16.35
Azotobacter + Azospirillum	5.66	5.71	5.01	4.91	19.58	23.48	17.73	20.45
15g OF	5.99	6.00	4.80	4.61	20.79	24.44	17.88	20.92
15g OF+*Azotobacter*	6.64	5.95	4.56	4.75	23 .07	29 .42	19.71	23.41
15g OF+*Azospirilum*	6.49	5.65	5.00	4.78	20 .15	27.61	18.75	22.99
15gOF+*Azotobacter*+*Azospirillum*	6.95	6.45	4.05	4.32	25 .35	34 .66	22.22	30.55
30g OF	6.47	6.77	4.46	4.28	23 .46	29 .67	25.63	25.49
30 g OF+*Azotobacter*	7.13	6.04	4.04	4.07	25 .69	34 .84	26.00	28.84
30 g OF+*Azospirilum*	7.00	5.55	4.16	4.14	23 .00	31 .83	24.87	27.12
30gOF+ *Azotobacter*+*Azospirillum*	7.88	8 .05	3.96	3.90	26. 23	38.86	26.89	34.81
L.S.D $_{(P \leq 0.05)}$	0.11	0.58	0.63	0.06	0.15	0.68	2.02	2.17

Values are means of four replicates from data recorded at two growing seasons (2017 and 2018). Wheat remain compost was used as organic fertilizer (OF).

biological activities (Bilal *et al.*, 2009). Such increase in nutrients was reflected by increase in plant bioactivities especially the photosynthesis process leading to improvement in plant vegetative growth which positively reflected the increase in number of fruits per plant and fruit weight and eventually total yield (Mengel, 2001). The increase in plant vegetative growth will increase the overall biological activities in the plant body and this will increase metabolic compounds including plant hormones and active enzymes especially those involved in sugar synthesis and leveling up the transpiration which accelerates nutrients movement from the source (leaves) to the fruits (Watson *et al.*, 2002).

Our findings also agreed with El-Araby *et al.*, (2003) regarding the combined treatment of biological fertilizer and organic fertilizer (plant remain compost) showed additive effect in improving plant growth with clear positive effect on yield quantitative characters, such as number of fruit per plant, fruit weight and yield.plant^{-1}. This findings agreed with previous studied on strawberry plants (Esitken *et al.*, 2010; Bannelos and Hanson, 2010; Tomic *et al.*, 2015). In terms of yield and quality, best results were obtained from the interaction of the highest rate of organic compost (30 g/plant) with the bio-fertilization (*Azospirillum* and *Azotobacter*) applied for two growing seasons. Similar results wre found by Iqbal *et al*., (2009) where using *Azotobacter* on strawberry plants resulted in the highest fruit weight compared to the untreated control. It was also reported that using interacted (combined) treatment of two bacterial types (*Azospirillum* and *Azotobacter*) on strawberry recorded the highest values of fruit weight, total yield, fruit content of total sugars and ascorbic acid with significant difference from the untreated plants (Singh and Singh, 2009). Our results also agreed with Dadashpor and Mohammad, (2012) study in which strawberry planting soil treated with *Azotobacter* had significant reduction in total acidity and increase in fruit content of total sugars and yield per plant.

References

Ainika, J.N., C.O. Amans and E.Y. Dodo (2012). Effect of organic and inorganic fertilizer on growth and yield of *Amaranthus caudatus* L. in Northern Guinea Savanna of Nigeri, *World J. of Engineering and Pure and Applied Sci.*, **2(2):** 26-30.

Akanbi, W.B., A.O. Togun, J.A. Adediran and E.A.O. llupeju (2010). Growth, dry matter and fruit yield components of okra under organic and inorganic sources of nutrients. *American-Eurasian Journal of Sustainable Agriculture*., **4(1):** 1-13.

Al-Saeedi, A.H.M. (2000). Production of small fruits. Dar-Alkotub for printing and publication, Mosul University, Iraq, 212-232.

Ali, Y., M. Iqbal, S.Z.A. Shah and M.J. Ahmed (2003). Effect of different combinations of nitrogen, phosphorous and farm yard manure on yield and quality of strawberry. *Sarhad Journal of Agriculture (Pakistan). Sarhad J. Agric*., **19(2):** 185-188.

Al-Hadithi, H.T. (1983). Practical laboratory book in the basics of bacteriology. University of Basrah Press, Basrah, Iraq, 112 .

Banuelos, G.S. and B.D. Hanson (2010). Use of selenium-enriched mustard and canola seed meals as potential bioherbicides and green fertilizer in strawberry production. *Hort. Science*., **45(10):** 1567-1572.

Bilal, A.P., D.B. Singh and M.F. Ahmad (2009). Response of strawberry to biofertilizers under sub-tropical conditions of Allahabad. *Prog. Hort*., **41(1):** 94-97.

Boiteau, G. (2004). Assessing CPB control options and N fertility in organic potato production. Organic Agriculture Centre of Canada, Final Research Report E2007-10.

Carsofschi, I. and M. Iancu (1994). Research of some agrochemical alteration indices in apricot orchard on sandy soils at Dabuleni. AGRIS 1995-1996. Plantelor-pe-Nisipuri. **8:** 177-182 (Romania).

Crespo, P.V.A.S. (2010). Variability of health and taste promoting compounds in strawberry (*Fragraria x ananassa*) fruits. PhD. Thesis, ETH Zurich.

Dadoshpor, A. and J. Mohammad (2012). Impact of integrated organic nutrient handling on fruit yield quality of strawberry. *J. Ornam. Hort*., **2(4):** 251-256.

EI-Araby; S.M., I.M. Ghoneim, A.l. Shehata and R.A. Mohamed (2003). Effect of Nitrogen, organic manure and Biofertilizer application on strawberry plants. *J. Agric. & Envi. SCI., Alex. Univ. Egypt.*, **2:** 36-62.

Esitken, A.H.E.Y., S. Ercisli, M.F. Donmez, M. Turan and A. Gunes (2010). Effects of plant growth promoting bacteria (PGPB) on yield, growth and nutrient. *Scientia Horticulturae.*, **124:** 62-66.

Iqbal, U., V.K. Ravikher and M. Jamwal (2009). Effect of FYM, urea and *Azotobacter* on growth, yield and quality of strawberry cv. Chandler. Notulae Botanicae, *Horti Agrobotanici, Cluj-Napoca*., **37(1):** 139-143.

Mengel, K., E.A. Kirkby, H. Kosegarten and T. Appel (2001). Principles Plant Nutrition. Kluwer Academic Publishers.

Osman, J.Y. (2007). Studying the effect of using organic fertilizer on potato cultivation and production as a contribution to clean organic production. Master Thesis, Faculty of Agriculture-Department of Horticulture. Tishreen University, Lattakia, Syria.

Pang, X.P. and J. Letey (2000). Organic farming: challenge of timing nitrogen availability to crop nitrogen requirements. *Soil Sci. Soc. Am. J.*, **64:** 247.253.

Saharan, B.S. and V. Nehra (2011). Plant growth promoting rhizobacteria: a critical review. *Life Sci. Med. Res*., **21(1):** 30. http://astonjournals.com/Ismr.

Samra, B., N. Zhoui and G. Nassour (2005). Effect of planting method on growth and production of Strawberry *Grandiflora fragaria* planted in an organic medium in greenhouses. *Tishreen University Journal of Studies and Scientific Research, Biological Sciences Series.,* **27(1):** 153- 167.

Singh, A. and J.N. Singh (2009). Effect of biofertilizers and bioregulators on growth, yield and nutrient status of strawberry *cv*. Sweet Charlie. *Indian J. Hort*., **66(2):** 220-224.

Tomic, J.M., J.M. Milivojevic and M.I. Pesakovic (2015). The response to bacterial inoculation is cultivar-related in strawberries. *Turkish Journal of Agriculture and Forestry.*, **39(2):** 332-341.

Watson, R., C.J. Wright, T. McBurney, A.J. Taylor and R.S.T. Linforth (2002). Influence of harvest date and light integral on the development of strawberry flavour compounds. *J. Exp. Bot*., **53(377):** 2121-2129.