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INFLUENCE OF NANO-IRON FERTILIZER AND VERMICOMPOST SUPPLEMENT ON THE PHYSIOLOGICAL AND VEGETATIVE PARAMETERS OF BLACK RASPBERRY IN IRAN

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ABSTRACT

Black Raspberry is one of the most important perennial fruit in Iran. Studies were conducted to determine the effect of nano-iron fertilizer and vermicompost on flower diameter and fruit weight, yield, acidity, sugar, vitamins C and iron content of *Rubus occidentalis*. For this, 3 levels of iron-nano fertilizer (0, 500, 1,000 mg L⁻¹) and 4 levels of vermicompost (0, 100, 200 and 400 kg ha⁻¹) were supplemented as balance fertilizer requirement of black *Rubus occidentalis* in Mazandaran province of Iran. The experiments was carried out as a factorial experiment based on randomized complete block design with 2 factors in 12 treatments, 3 replications and 36 experimental plots. The iron-nano fertilizer and vermicompost were incorporated into top 10 cm layer of soil, which was supplemented on the basis of chemical analysis calculated to equalize the recommended dose of nutrients. Iron-nano and vermicompost application significant increase fruit yield (45.73g) and fruit weight (11.05g) at levels of 1000 mg L⁻¹ of iron-nano fertilizar plus 100 kg ha⁻¹ of vermicompost.

KEY WORDS

Rubus occidentalis, growth parameter, fruit features, fertilizer.

Black raspberry is one of the most important species of fruit plants in temperate climate zone. Black raspberries are mostly popular in Iran. The area of raspberry cultivation still increases and develops also the processing industry. The consumer usefulness and processing of fruits determined the taste and chemical composition (Rao et al., 2010).black raspberries as well as blackberry fruits are abundant in dietary phytochemicals such as flavonols, phenolic acids, E, ellagitannins, vitamins C and folic acid and β -sitosterol (Boivin D. et al., 2007 & Bowen-Forbes, 2010)

An important component of sustainable organic agriculture is vermicompost fertilisers, which have been used in many countries. Vermicompost is rich in plant nutrients. Vermicompost is a microbiologically active organic material formed from the interactions between earthworms and microorganisms during the decomposition of organic material (Domínguez, 2004). Vermicompost is considered as a rich source of macro/micro elements, vitamins, enzymes and growth stimulating hormones which accelerate the growth of small fruit plants (Prabha et al., 2007). Vermicompost has some beneficial influences on horticultural and agronomic crops (Goswami et al., 2001; Roy et al., 2010).

Nano-fertilizers are new generation of the synthetic fertilizers which contain readily available nutrients in nano scale range.(DeRosa M. C et al., 2010). micronutrients, iron is essential for vegetative and reproductive index of small fruit plants. Iron is involved in the production of chlorophyll, photosynthesis, mitochondrial respiration, hormone biosynthesis(ethylene, gibberellic acid, jasmonic acid), production and scavenging of reactive oxygen species and osmoprotection (Hänsch and Mendel, 2009). Iron Nano-fertilizers can be easily absorbed by plants and they may exhibit prolonged effective duration of nutrient supply in soil or on plant (Rameshaiah and Jpallavi, 2015). Also several studies show that

exogenous application of some nanoparticle can significantly improve plant growth (Mandeh et al., 2012; Song et al., 2013).

The aim of the present study was to investigate the effects of different concentrations of Nano-iron fertilizer and Vermicompost on the vegetative and physiological traits of Black Raspberry (*Rubus occidentalis*).

MATERIALS AND METHODS OF RESEARCH

This experiment was performed in a factorial experiment in the basis of a completely randomized design by 2 factors of iron nano-fertilizer with 3 levels (0, 500, 1000 mg/L) and Vermicompost in 4 levels (0, 100, 200 and 400 kg/ha) in 12 treatments and 3 replications. Noted that the size of each plot was a 4-liter plastic pot. Seedlings with 4 to 5 real leaves and disinfected were used. Control media was garden soil and for other levels mixture of garden soil and Vermicompost with specific levels were used. Foliar application with iron nano fertilizers was performed monthly. Measured traits included: Flower diameter in all flower stage, fruit sugar with a Manual refractometer (N-1 α Manufacturing Company ATAGO in Japan), fruit weight and size, fruit acidity (pH), vitamin C with the method of Diclofenal IndufenI (Ranagana, 1997) and leaf iron was evaluated by Atomic absorption. Data analysis was performed by SAS statistical software and means comparison by LSD test.

RESULTS AND DISCUSSION

Variance analysis of the foliar application of iron nano fertilizer and vermicompost showed that the main effect of iron nano fertilizer and vermicompost and interaction effects of these two factors on fruit yield, sugar, fruit vitamin C and leaf iron was significant but fruit weight was just affected by interaction effects of experimental factors (Table 1). Means comparison of the main effects of iron nano fertilizer on fruit yields showed that the highest fruit yield was associated with 100 and 500 mg/L iron nano fertilizer (Table 1). Also, the main effect of vermicompost showed that the highest fruit yield related to 100 kg per ha vermicompost. Means comparison of interaction effects of these two factors showed that the highest fruit yield related to 1000mg/L iron nano fertilizer+100 kg/ha vermicompost treatment and the lowest was observed in control treatment. All treatments had acceptable performance than control, so superior treatment produced yield more than three times than control. Means comparison of interaction showed that the highest fruit weight of *Rubus occidentalis* was under 1000 mg/L iron nano fertilizer + 100 kg/ha vermicompost and the lowest was related to control treatment (Table 2). Differences between both mentioned treatments were about 42.8%. Means comparison of the main effect of iron nano fertilizer revealed that the highest fruit sugar was related to no application of nano fertilizer treatment and the lowest was related to applying 500 mg/L iron nano fertilizer. Also, means the comparison of the main effect of vermicompost showed that the highest fruit sugar related to 400 kg/ha vermicompost application and the lowest was observed in control treatment for vermicompost application. Comparison of the mean value of interaction revealed that the highest value for *Rubus occidentalis* fruit sugar content was obtained by applying without iron nano fertilizer with 400 kg/ha vermicompost and the lowest content observed in 500 mg/L iron nano fertilizer + 200 kg/ha vermicompost treatment (Table 2). Better treatment rather than control had 45% increment in sugar content. Means comparison the main effect of iron nano fertilizer showed that applying 500 and 100 mg/L iron nano fertilizer with producing four fruit had the most fruit number (Table 2). Means comparison pf interactions demonstrated that, the highest fruit numbers (5 fruits) belonged to applying 500 mg/L iron nano fertilizer+100kg/ha vermicompost treatment and the lowest number with 2 fruit was observed in control treatment (Table 2). The best treatment in comparison to control had bear 1.5-time increase in fruit number.

Means comparison of interactions also showed that the highest *Rubus occidentalis* flower diameter associated to applying 1000 mg/L iron nano fertilizer without vermicompost and the lowest was observed in control treatment (Table 2). Above mentioned treatment

increase 68.14% in flower diameter than control. According to this research, iron nano fertilizer effects on flower diameter was more than with or without applying vermicompost.

Comparison of the main effects of vermicompost also revealed that the highest fruit acidity related to no applying of vermicompost treatment and the lowest was observed in applying 200 kg/ha vermicompost (Table 2). In addition, means the comparison of interaction showed that the highest amount of pH obtained in control treatment and the lowest value was in zero iron nano fertilizer with 100 kg/ha vermicompost (Table 2). These results confirmed that using vermicompost decreased fruit acidity. Control treatment had 35% pH increase than recent treatment. Means comparison of main effects of iron nano fertilizer application showed that the highest vitamin C content of *Rubus occidentalis* belongs to 100 mg/L iron nano fertilizer and the lowest was earned in without applying of this treatment. Comparison the main effects of vermicompost application on vitamin C also showed that the highest amount of vitamin C was earned in applying 400 kg/ha vermicompost. Means comparison of interaction showed that highest value for vitamin C belong to applying 1000mg/L iron nano fertilizer +400kg/ha vermicompost and the lowest was in zero iron nano fertilizer application with 100 kg/ha vermicompost. The best treatment produced 30.5% increment in vitamin C than control. Comparison the main effects of iron nano fertilizer showed that the most iron content of leaf associated with applying 500 and 1000 mg/L iron nano fertilizer and the lowest was in zero iron nano fertilizer application treatments. Also, the main effect comparison of vermicompost showed that the highest leaf iron obtained by applying 200 and 400 kg vermicompost per ha and the lowest was earned in no vermicompost application. Means comparison of interaction showed that the highest iron content of leaf belonged to 1000 mg/L iron nano fertilizer + 200 kg/ha vermicompost and 500 mg/L iron nano fertilizer +200 kg/ha vermicompost and the lowest iron content was in control treatment (Table 2). Our treatments had 45% increase than control. Above mentioned treatments increased iron content 4 times than control.

Table 1 – Variance analysis of iron nano fertilizer and vermicompost effects on measured traits

Mean square									
S.O	df	Leaf iron	Vitamin C	Fruit acidity (pH)	Flower diameter	Fruit number	Fruit sugar	Fruit weight	Fruit Yield
Nano fertilizer (N)	2	18328**	22.15**	0.001ns	0.286ns	4**	4.72*	0.0338ns	268*
Vermicompost (V)	3	172831**	65.15**	1.001**	0.034ns	0.972ns	4.41**	2.167ns	129**
N×V	6	16107**	3.07**	0.169**	0.851**	2.19*	4.05**	5.38*	275**
Error	24	2385.773	0.608	0.01	0.161	0.76	0.909	1.793	58.181
CV (%)		11.742	3.285	2.571	13.446	23.615	13.418	15.949	23.661

Table 2 – Means comparison of interaction effects of iron nano fertilizer and vermicompost on measured traits

Treatments	Fruit yield (g.plant)	Fruit weight (mg/100g)	Fruit sugar (%)	Fruit number (number)	Flower diameter (cm)	Acidity (pH)	Vitamin C (mg/100 g)	Leaf iron (ppm)
N0V0	15/00d	7/23d	6/53cde	2/02e	2/21d	4/683a	23/28f	158e
N0V1	22/22cd	9/12abc	5/93de	2/73de	3/08bc	3/523g	24/15cd	241d
N0V2	32/21bc	8/02abcd	8/17abc	4/00abcd	3/31ab	3/617g	19/78g	273d
N0V3	34/03abc	9/63a	9/70a	3/38bcde	2/55cd	4/071cd	25/18b	323cd
N1V0	26/11cd	9/29abcd	5/96de	3/00cde	2/81bcd	4/253b	21/67ef	357cd
N1V1	38/16ab	8/903abcd	7/10bcde	5/00a	3/21ab	3/788ef	24/02bc	443b
N1V2	38/01ab	11/01ab	5/66e	4/00abcd	2/96bcd	3/651fg	22/09def	574a
N1V3	30/03bc	7/55bcd	6/86cde	4/00abcd	3/266ab	4/126bc	27/81a	523ab
N2V0	40/26ab	8/60abcd	6/10de	4/66ab	3/80a	4/046cd	21/64ef	445b
N2V1	45/73a	11/05a	9/63ab	5/32abc	3/85bcd	4/036de	28/15a	448b
N2V2	22/13cd	7/00cd	7/48bcd	3/31bcde	2/48cd	3/646fg	22/68cde	577a
N2V3	31/02bc	8/63abcd	7/34bcd	3/68abcd	2/97bc	4/263b	28/18a	523ab

N0= without iron nano fertilizer, N1: 500 mg/L iron nano fertilizer, N2: 1000mg/L iron nano fertilizer, V0: without vermicompost, V1: 100 kg.ha vermicompost, V2: 200 kg.ha vermicompost, V3: 400 kg.ha vermicompost.

Singh et., al (2008) reported that the lowest pH in strawberry fruit observed in vermicompost medium that confirm our results. So expected that during after harvest period, fruit acidity decrease (Sereno et al, 2003). In another research on blackberry observed that

heavier and larger fruits were earned by higher content iron treatment (and sometimes other essential elements)(Wang. et.al, 2000) Supplying iron and other essential elements for plants, photosynthesis and assimilation increase and fruit size and weight become further in red raspberry (Mazur S.P et.al. 2014). Bacha et., al (1995) evaluated the foliar application of Zinc, iron, and manganese in different times on quality and quantity traits of grape seed and resulted that, while increasing crop yield, weight, size and other seed characteristic increased significantly. This increment could be due to the availability of iron and another essential nutrient, which increased photosynthesis and dry matter accumulation, and also fruit size and weight (Bassil et.al., 2012). Gutiérrez-Miceli , et.al (2007) also reported that medium including compost increase soluble solid matters of fruits. It seems that increasing vermicompost to culture bed induced potassium content and since this element play key role in various carbohydrate biosynthesis (sucrose, starch, and glucose), therefore had a critical role on plant growth, development and quality (Singh, R et.al, 2008) which confirm our results. Sing et al (2008) also claimed that strawberry fruit cultured in vermicompost included bed, had higher soluble dry matter which is inconsistent with the results of this research. Another experiment which conducted by Kim H.-S.et.,al (2011) within several years on black raspberry (*Rubus coreanus* Miquel) product resulted that using iron increase fruit vitamin C significantly.

CONCLUSION

Our results demonstrated that applying iron nano fertilizer solely increase fruit sugar content, fruit number, vitamin C, leaf iron and fruit yield significantly. But vermicompost, which it's valuable property is different enzyme, microorganisms and hormones performance, induce yield increase due to containing enzymes such as protease, amylase, lipase, Cellulase, and ketinase which plays key roles in soil organic matter decomposition and availability of plant essential nutrients and produce better growth condition for *Rubus occidentalis*. Results of interaction effects showed that 1000 mg/L iron nano fertilizer with 100 kg/ha, vermicompost produced the best yield in all treatments. So it could be stated that interaction effects of two studied factors showed increase yield and *Rubus occidentalis* fruit characteristic improvement.

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