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Response of Seed Yield, Its Components and Leaf Area Index of Spring Corn to Consume Vermicompost and Iron Nano fertilizer

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ABSTRACT

BACKGROUND: Organic farming has emerged as important priority area globally in view of growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals. Nano fertilizers can be easily absorbed by crops and may exhibit a prolonged effective duration of nutrient supply in soil/crop compared to the conventional fertilizers.
OBJECTIVES: Evaluate effect of different level of vermicompost and Nano iron fertilizer on seed yield, its components and leaf area index.
METHODS: Current research was carried out via split plot experiment based on randomized complete blocks design with three replications along 2018 year Main plot included three level of vermicompost (V_0: nonuse of vermicompost or control, V_1: 5 $t.ha^{-1}$ vermicompost, V_2: 10 $t.ha^{-1}$ vermicompost) was consumed at planting stage. Also subplots consisted four level of Nano iron fertilizer (F_0: Nonuse of Nano iron fertilizer or control, F_1: 0.002 $L.ha^{-1}$, F_2: 0.004 $L.ha^{-1}$ and F_3: 0.006 $L.ha^{-1}$ Nano iron fertilizer) was used at 3 to 4 leaves stage.
RESULT: According result of analysis of variance effect of different level of vermicompost and Nano iron fertilizer on all measured traits was significant at 1% probability level also interaction effect of treatments (instead biologic yield) was significant at 5% probability level. Mean comparison result of interaction effect of treatments indicated the maximum amount of number of rows per ear (20), number of seed per row (49), 1000 seeds weight (545 gr), seed yield (6000 $gr.m^{-2}$), biological yield (1939 $gr.m^{-2}$), harvest index (30%) and leaf area index (5.81) belonged to 10 $t.ha^{-1}$ vermicompost with 0.006 $L.ha^{-1}$ iron Nano fertilizer, also lowest amount of measured traits was for nonuse of vermicompost and iron Nano fertilizer or control treatments.
CONCLUSION: Consume 10 $t.ha^{-1}$ vermicompost with 0.006 $L.ha^{-1}$ iron Nano fertilizer led to achieve highest amount of yield, its components, harvest index and leaf area index and can be advice to farmers.

KEYWORDS: *Zea mays, Organic farming, Micro elements.*

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1. BACKGROUND

Corn is one of the important crops of cereal family with short growing period and high yield. Corn is high expectation plants and also is considered strategic crop for Iran country (Ghazvineh and Yousefi, 2012). On the other hand, soil fertility is an important factor, which determines the growth of plant. Soil fertility is determined by the presence or absence of nutrients i.e. macro and micronutrients, which are required in minute quantities for plant growth (Zayed *et al*., 2011). Maize is the third most important cereal grain worldwide after wheat and rice. It is referred to as the cereal of the future for its valuable nutritional facts in human diet (Enyisi *et al*., 2014). Annual production of cereals in 2014 was more than 2.4 billion tons. The 872 million tons of cereal production was maize production. According to the reports, Iran's share of world maize production is only1.250 million tons (FAO, 2014). Suitable and useful usage of different kind of fertilizers is the main way for reformation and potential of soil fertility and increasing of crops yield (Talaei, 2012). Addition of fertilizers to supplement the natural soil fertility is essential for modern crop production, and precise management of nutrient elements is essential for a sustainable agriculture production (Barker and Pilbeam, 2006). In developing countries, different agricultural organic wastes are created after harvest, which can be converted to vermicompost or compost and applied to the soil as organic fertilizers to increase soil fertility and reduce the application of chemical fertilizer. This not only helps to reduce environmental pollution but also better nutrient cycling and sustainability of agricultural systems. Compost and vermicompost are organic fertilizers containing various plant nutrients that become available to plants after microbial decomposition. The nutritional value of these organic fertilizers depends to a large extent on the type and nature of the raw materials used to produce those (Atiyeh *et al*., 2000a). Worms Composting of organic wastes would increase the availability of nutrients within the organic wastes, will increases photosynthesis (chlorophyll and pigments) and plant biomass. In an experiment the application of vermicompost increased the amounts of anthocyanin and flavonoids in plants (Joshi *et al*., 2014). In several studies, the importance of organic wastes in the preparation of compost and vermicompost and the role of these organic fertilizers in sustainable agriculture and the growth, yield and macro- and micronutrient content of plants have been discussed (Hernandez *et al*., 2015). The high humic acid content of the vermicompost causes plants to produce more phenolic compounds which make them as a nutrient chelator (Bevacqual and Mellama, 1993). According to the results of Stanchova and Mitova (2002), also vermicompost had a significant effect on the number of leaves per plant and leaf area index. The effect of vermicompost on plant growth depends on the source of organic materials used for vermicompost preparation and its nutrient content (Nadi and Golchin, 2011). The effect of vermicompost on plant growth is significant and increases the growth potential, yield and yield components of different plants (Atiyeh *et al.,* 2000b). Vermicompost, along with chemical fertilizers, improves the usefulness of low-energy elements and their absorption in plants compared with the use of chemical fertilizers alone (Jabin and Ahmad, 2017). Each plant needs to certain fertilizers according to its needs and soil analyze results. Also microelements are the critical elements for plants; however, microelements play the important role in crop productivity where it is used in low rate. Optimum plant nutrition and maximum yield is achieved when nutrient elements are available for plant during the growing season (Malakooti and Tabataei, 1998). Organic farming has emerged as an important priority area globally in view of the growing demand for safe and healthy food and long term sustainability and concerns on environmental pollution associated with indiscriminate use of agrochemicals. Though the use of chemical inputs in agriculture is inevitable to meet the growing demand for food in world, there are opportunities in selected crops and niche areas where organic production can be encouraged to tape the domestic export market (Venkatash-Warlu, 2008). Materials that are smaller than 100 nm, at least in one dimension, are generally classified as Nano-materials. Applications of this new technology have been found in agriculture, and Nano-technologies are already applied to production, processing, storage, packing and transportation of agricultural products (Wiesner *et al*., 2006). Nanotechnology is the developing technology during recent years and operating in all fields of agriculture. Nano micronutrients fertilizers stand out as one of the most useful materials, due to their high efficiency, functionalities, convenient and easy applications (Janmohamadi *et al*., 2016). Nano-formulated fertilizers can release nutrients more slowly in cooperation with other fertilizers which may lead to improvement of nutrient use efficiency. Application of Nano-fertilizers may improve solubility and dispersion of insoluble nutrients in soil, reduce nutrient immobilization and increase bio-availability (Naderi and Danesh-Shahraki, 2013). Many problems in different fields of science and industry have been solved using Nano-technologies (Scott and Chen, 2003), which are currently used for production, processing and application of Nano-scale complexes. Nano-fertilizers can be more efficient, decreasing soil pollution and other environmental risks that may occur when using chemical fertilizers (Naderi *et al*., 2011). One of the advantages of using Nano-fertilizers is that application can be done in smaller amounts than when using common fertilizers (Subramanian *et al*., 2015). Nano-fertilizers can be easily absorbed by crops and may exhibit a prolonged effective duration of nutrient supply in soil/ crop compared to the conventional fertilizers (Rameshaiah and Jpallavi, 2015). Zhang *et al*. (2006) investigated the effects of slow/controlled release fertilizers cemented and coated by nanomaterial on crop. It was found that these Nano composites were safe for wheat seed germination, emergence and growth of seedlings and they can provide a regulated, responsive and on time delivery of nutrients to plants. Also several studies show that exogenous application of some nanoparticle can significantly improve plant growth (Song *et al*., 2013). In the last few years, some researchers tried to examine the potential of nanotechnology to improve fertilizer use efficiency. These efforts led to design and development of Nano-fertilizer. Nano-technology-based fertilizers could be more soluble or more reactive than their bulk counterparts (Nair *et al*., 2010; De Rosa *et al*., 2010). Micronutrient deficiency can greatly disturb plant yield and quality, and the health of domestic animals and humans (Welch, 2003). The role of microelements in maintaining balanced plant physiology is becoming clearer every day as a result of studies on their reactions and the disturbances caused by their deficiency. Micronutrients are essential elements for life (Malakouti, 2008). Micronutrients also play key roles in the release of carbon dioxide, and in optimizing the function of vitamin A and the immune system (Marschner, 1995).

2. OBJECTIVES

This research was conducted to evaluate effect of different level of vermicompost and Nano iron fertilizer on seed yield, its components and leaf area index.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

Current research was carried out via split plot experiment based on randomized complete blocks design with three replications along 2018 year in research farm of Islamic Azad University of Ahvaz Branch. Place of research was located in Vis city at longitude 48°40'E and latitude 31°20'N in Khuzestan province (Southwest of Iran). Main plot included three level of vermicompost (V_0: nonuse of vermicompost or control, V_1: 5 $t.ha^{-1}$ vermicompost, V_2: 10 $t.ha^{-1}$ vermicompost) was consumed at planting stage. Also subplots consisted four level of Nano iron fertilizer (F_0: Nonuse of Nano iron fertilizer or control, F_1: 0.002 $L.ha^{-1}$, F_2: 0.004 $L.ha^{-1}$ and F_3: 0.006 $L.ha^{-1}$ Nano iron fertilizer) was used at 3 to 4 leaves stage.

3.2. Farm Management

Each sub plot included the six planting lines with a length of 5 m. The distance between row and seed on the row were 75 and 18 cm respectively. Irrigation process was done every 3 or 4 days and after the plant establishment it was done every 7 to 10 days if necessary. The weeds bushes were controlled via Cruise herbicide by 2 $L.ha^{-1}$ at 4-to-5-leaf stage and Krakrown pesticide used by 1 $L.ha^{-1}$ against leaf and stem borer larvae.

3.3. Measured Traits

The final harvest area of each plot was 1.5 m^2. Seed yield, its components and LAI were estimated after physiological maturity. After separating seed from selected plants and weighing them, seed yield was calculated based on 14% moisture. To estimate 100 seed weigh, 10 samples of seed containing 10 seed were separated and means was calculated. The number of seed per unit area was obtained from number of plants per unit area (m^2) and number of seed per ear. To calculate number of rows per ear, from each plot, 10 rows were randomly selected and its number was counted and mean was considered as this attribute. Harvest index (HI) was calculated according to formula of Gardener *et al.* (1985) as follows: **Equ.1.** HI= (Seed yield / Biologic yield) ×100. LAI (leaf area index): After separating leaves, at flowering stage leaves area was measured in the samples by using the leaf area meter, model IM-300.

3.4. Statistical Analysis

Analysis of variance and mean comparisons were done via MSTAT-C software and Duncan multiple range test at 5% probability level.

4. RESULT AND DISCUSSION

4.1. Number of Row per Ear

According result of ANOVA effect of different level of vermicompost and Nano iron fertilizer on number of row per ear was significant at 1% probability level also interaction effect of treatments was significant at 5% probability level (Table 1). Mean comparison result of interaction effect of treatments revealed maximum number of row per ear (20) was noted for 10 $t.ha^{-1}$ vermicompost with 0.006 $L.ha^{-1}$ iron Nano fertilizer and the lowest one (11) belonged to nonuse vermicompost with 0.002 $L.ha^{-1}$ iron Nano fertilizer (Fig. 1).

Table 1. Result analysis of variance of vermicompost and iron nano fertilizer on measured traits

S.O.V.	df	Number of rows per ear	Number of seed per row	1000 seeds weight	Seed yield
Replication	2	0.583^{ns}	4.375^{ns}	82.889^{ns}	348.857^{ns}
Vermicompost (V)	2	22.750^{**}	196.988^{**}	16509.389^{**}	229766.563^{**}
Error I	4	0.333	12.862	52.609	1085.941
Iron nano Fertilizer (I)	3	7.444^{**}	64.154^{**}	1442.903^{**}	32518.706^{**}
V*I	6	0.972^{*}	45.560^{*}	40.166^{*}	1961.823^{*}
Error II	18	0.380	10.673	16.838	546.401
CV (%)	-	4.15	9.46	2.59	6.71

ns, * and **: no significant, significant at 5% and 1% of probability level, respectively

Continue Table 1.

S.O.V.	df	Biological yield	Harvest index	Leaf area index
Replication	2	51481.219^{ns}	2.777	0.116^{ns}
Vermicompost (V)	2	821004.543^{**}	330.28^{**}	1.642^{**}
Error I	4	33034.146	3.694	0.125
Iron nano Fertilizer (I)	3	162554.166^{*}	46.026^{**}	0.457^{**}
V*I	6	37762.313^{ns}	4.015^{*}	0.194^{*}
Error II	18	33631.239	1.147	0.068
CV (%)	-	10.83	18.11	13.29

ns, * and **: no significant, significant at 5% and 1% of probability level, respectively

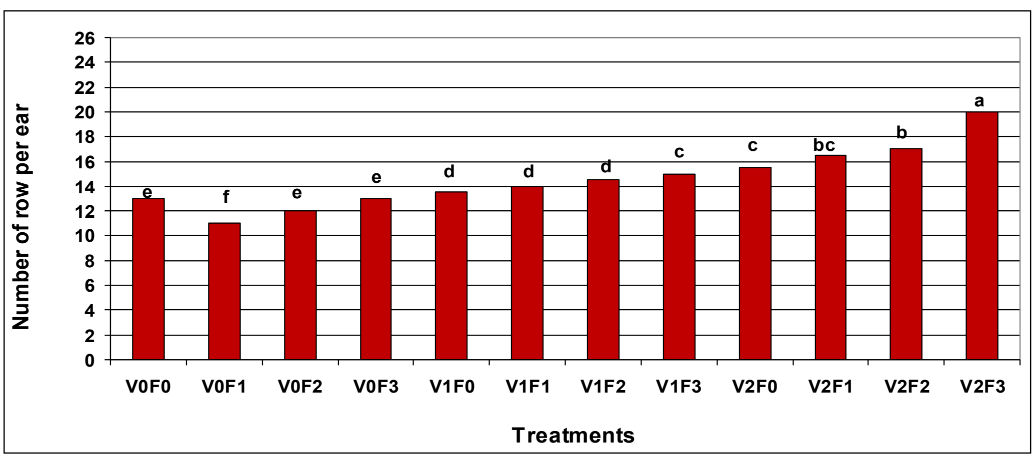

Fig. 1. Mean comparison interaction effect of different level of vermicompost and iron Nano fertilizer on number of row per ear via Duncan test at 1% probability level.
V_0: nonuse of vermicompost, V_1: 5 $t.ha^{-1}$ vermicompost, V_2: 10 $t.ha^{-1}$ vermicompost, F_0: nonuse of iron Nano fertilizer, F_1: 0.002 $L.ha^{-1}$ iron Nano fertilizer, F_2: 0.004 $L.ha^{-1}$ iron Nano fertilizer, F_3: 0.006 $L.ha^{-1}$ iron Nano fertilizer.

Some researchers such as Sujatha *et al.* (2008) confirmed mentioned result, because they showed that the application of vermicompost by improving the physical properties of the soil to increase absorption elements, improve the production led to increase the number of seeds per row and number of rows per ear.

4.2. Number of Seed per Row

Result of analysis of variance showed effect of different level of vermicompost and Nano iron fertilizer on number of seed per row was significant at 1% probability level also interaction effect of treatments was significant at 5% probability level (Table 1). According result of mean comparison of interaction effect of treatments maximum of number of seed per row (49) was obtained for 10 t.ha^{-1} vermicompost with 0.006 L.ha^{-1} iron Nano fertilizer and minimum of that (29) was for nonuse of vermicompost and iron Nano fertilizer or control treatments (Fig. 2).

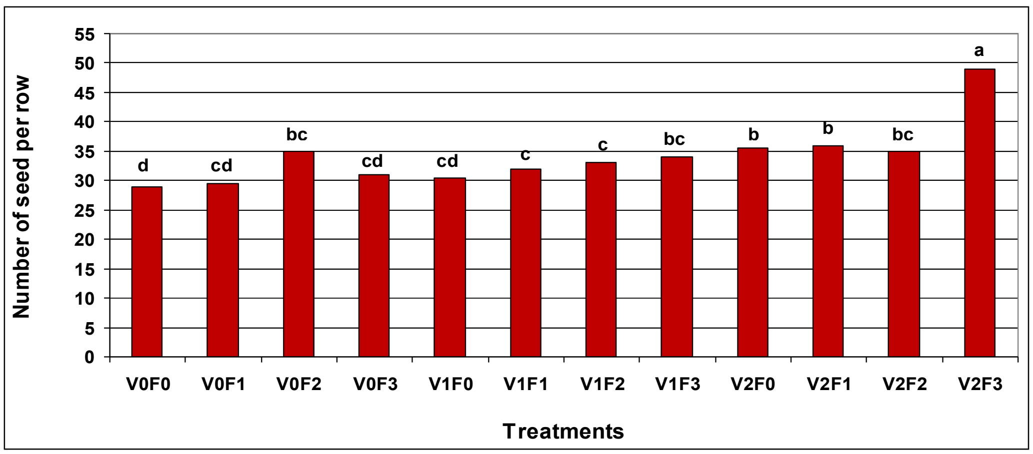

Fig. 2. Mean comparison interaction effect of different level of vermicompost and iron Nano fertilizer on number of seed per row via Duncan test at 1% probability level.
V_0: nonuse of vermicompost, V_1: 5 t.ha^{-1} vermicompost, V_2: 10 t.ha^{-1} vermicompost, F_0: nonuse of iron Nano fertilizer, F_1: 0.002 L.ha^{-1} iron Nano fertilizer, F_2: 0.004 L.ha^{-1} iron Nano fertilizer, F_3: 0.006 L.ha^{-1} iron Nano fertilizer.

Sinha *et al.* (2010) reported application vermicompost increased length and diameter of ear, the number of seeds per ear and number of rows per ear in corn. Other researchers also reported that the application of vermicompost on rice led to an increase in seed yield and rice cluster (Eftekhari *et al*., 2006).

4.3. 1000-Seed Weight

According result of analysis of variance effect of different level of vermicompost and Nano iron fertilizer on 1000 seed weight was significant at 1% probability level also interaction effect of treatments was significant at 5% probability level (Table 1). Mean comparison result of interaction effect of treatments showed maximum 1000 seed weight (545 gr) was noted for 10 t.ha^{-1} vermicompost with 0.006 L.ha^{-1} iron Nano fertilizer and lowest one (189 gr) belonged to nonuse vermicompost with nonuse of iron Nano fertilizer or control treatments (Fig. 3). 1000 seed weight showed condition and length of reproductive period of plant, and by initiation of flowering and clear number of seeds per plant, seeds begin to receive and store some of photosynthetic materials.

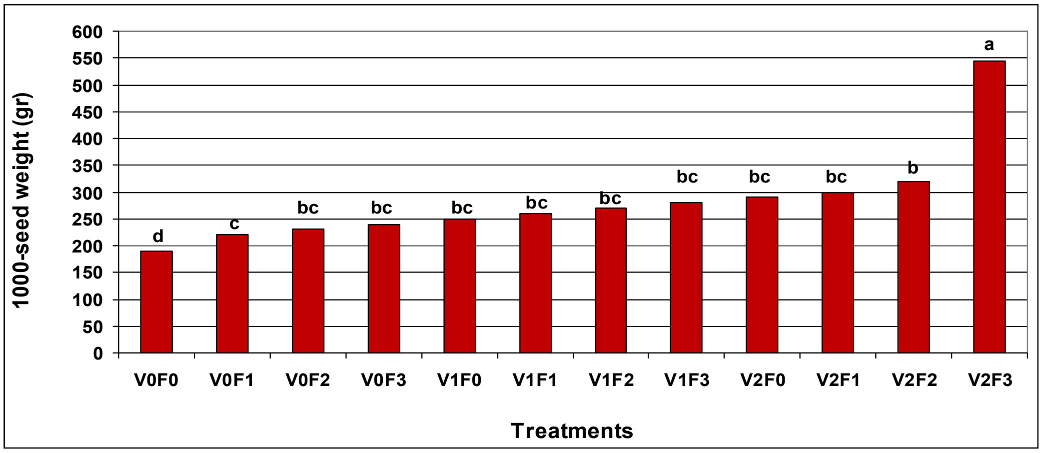

Fig. 3. Mean comparison interaction effect of different level of vermicompost and iron Nano fertilizer on seed weight via Duncan test at 1% probability level.
V_0: nonuse of vermicompost, V_1: 5 $t.ha^{-1}$ vermicompost, V_2: 10 $t.ha^{-1}$ vermicompost, F_0: nonuse of iron Nano fertilizer, F_1: 0.002 $L.ha^{-1}$ iron Nano fertilizer, F_2: 0.004 $L.ha^{-1}$ iron Nano fertilizer, F_3: 0.006 $L.ha^{-1}$ iron Nano fertilizer.

The increase of 1000 seed weight due to increase in seed filling period is justifiable and shows positive effect of vermicompost on seed yield by increasing amount of photosynthetic traits stored during period of seed filling. The researchers stated 1000-seed weight as a result of use vermicompost fertilizer showed positive effect of vermicompost on seed yield, resulting in increase in amount of photosynthesis stored, resulting in increase in weight of one thousand seeds, and application of vermicompost fertilizer led to increased yield and seed weight of sesame (Ghosh and Mohiuddin, 2000). In research on wheat, it was determined that application of vermicompost fertilizer would increase the seed weight of wheat (Bar-Tal *et al*., 2004). Some researchers reported increase 1000 seed weight due to application of iron Nano fertilizer due to optimal combination of micronutrient and main nutrient elements in reproductive stages of plant. Available main elemental led to improve accumulation of assimilates in seeds and produce heavier seeds (Bybordi and Mamedov, 2010). Increasing seed iron concentrations could result of improving production of assimilates from current photosynthesis and desirable remobilization of materials to seeds, which was consistent with results of this study. Some researchers reported application of vermicompost resulted in increased seed yield and seed weight in rice (Eftekhari *et al*., 2006). Other researchers reported that use of iron Nano fertilizers on sesame seeds resulted in an increase in the seed weight (Sheykhbaglou *et al*., 2010).

4.4. Seed Yield

Result of ANOVA showed effect of different level of vermicompost and Nano iron fertilizer on seed yield was significant at 1% probability level also interaction effect of treatments was significant at 5% probability level (Table 1). According result of mean comparison of interaction effect of treatments maximum seed yield (6000 $gr.m^{-2}$) was obtained for 10 $t.ha^{-1}$ vermicompost with 0.006 $L.ha^{-1}$ iron Nano fertilizer and minimum of that (1331 $gr.m^{-2}$) was for control treatments (Fig. 4).

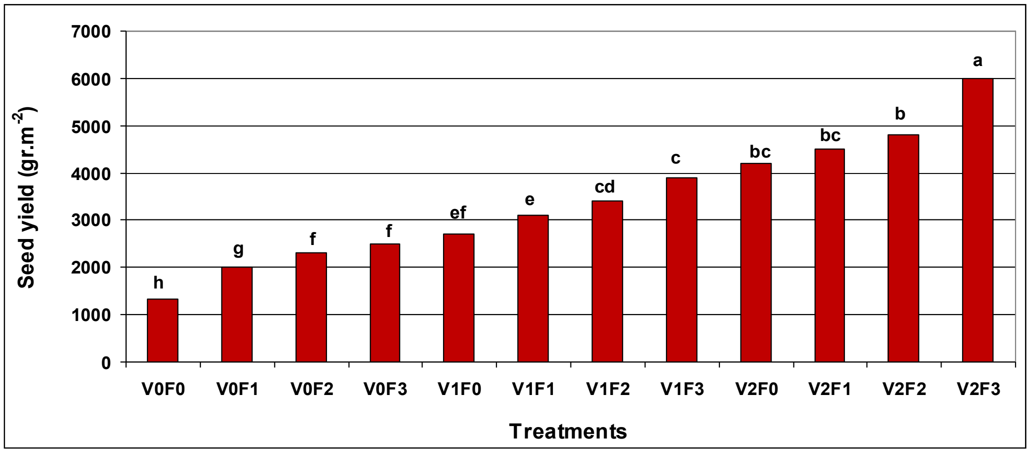

Fig. 4. Mean comparison interaction effect of different level of vermicompost and iron Nano fertilizer on seed yield via Duncan test at 1% probability level.
V_0: nonuse of vermicompost, V_1: 5 t.ha^{-1} vermicompost, V_2: 10 t.ha^{-1} vermicompost, F_0: nonuse of iron Nano fertilizer, F_1: 0.002 L.ha^{-1} iron Nano fertilizer, F_2: 0.004 L.ha^{-1} iron Nano fertilizer, F_3: 0.006 L.ha^{-1} iron Nano fertilizer.

Considering the importance of chlorophyll in production and direct relationship between this trait and seed yield, researchers believe increasing amount of organic fertilizers and vermicompost in soil leads to increase in nutrients such as nitrogen, iron and magnesium, so mentioned nutrient have important role for chlorophyll production, more availability of nutrient for sink (seeds) and improve crop production. The effect of vermicompost from 0 to 10 t.ha^{-1} on seed yield of corn showed seed yield increased significantly had positive effect vermicompost on crop production because of stored assimilates (Amyanpoori *et al*., 2015). The most important effect of iron application is increasing in rate of photosynthesis and improving LAI, which results in increased seed yield compared with control (Singh, 2000). Bybordi and Mamedov (2010) reported iron Nano fertilizer application on canola led to improve seed yield. Also Nazari *et al*. (2006) reported consume organic fertilizer led to increase corn yield, which consisted result of current research.

4.5. Biologic Yield

According result of analysis of variance effect of different level of vermicompost and Nano iron fertilizer on biologic yield was significant at 1% and 5% probability level, respectively, but interaction effect of treatments was not significant (Table 1). Among different level of vermicompost maximum biologic yield (1939 gr.m^{-2}) was obtained for 10 t.ha^{-1} vermicompost and minimum of that (1418 gr.m^{-2}) was for control treatment (Fig.5). Compare different level of Nano iron fertilizer showed the maximum and minimum amount of biologic yield belonged to use 0.006 L.ha^{-1} iron Nano fertilizer (1810 gr.m^{-2}) and control treatment (1504 gr.m^{-2}) (Fig.6). Application of vermicompost on wheat increased content of nutrients in leaf and resulted in improved photosynthesis and biological yield (Anwar *et al*., 2005). The addition of vermicompost to soil increased availability of the nutrients, and also improves the physical and vital processes of the soil, and provides optimum environment for root growth to increase biological yield.

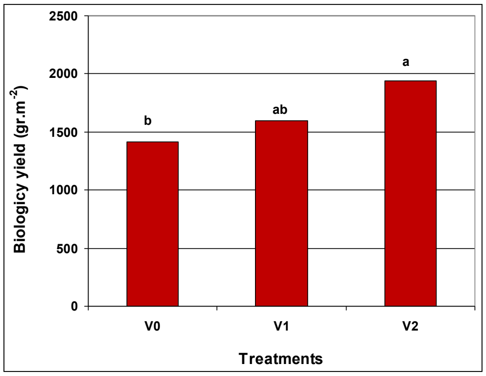

Fig. 5. Mean comparison effect of different level of vermicompost on biologic yield via Duncan test at 1% probability level. V_0: nonuse of vermicompost, V_1: 5 $t.ha^{-1}$ vermicompost, V_2: 10 $t.ha^{-1}$ vermicompost.

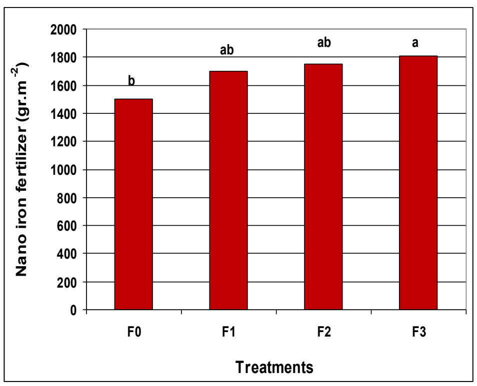

Fig. 6. Mean comparison effect of different level of iron nano fertilizer on biologic yield via Duncan test at 5% probability level. F_0: nonuse of iron Nano fertilizer, F_1: 0.002 $L.ha^{-1}$ iron Nano fertilizer, F_2: 0.004 $L.ha^{-1}$ iron Nano fertilizer, F_3: 0.006 $L.ha^{-1}$ iron Nano fertilizer.

Some researchers reported that the use of vermicompost (due to the presence of fungi, bacteria, yeast, and actinomycetes that have microbial activity) improves the nutritional elements through hormones such as auxin, gibberellin, cytokinin and ethylene, have a positive effect on growth and yield, so the use of 10 $t.ha^{-1}$ vermicompost increased the biological yield (Singh, 2000). Some researchers stated Nano iron fertilizer by increase the seed weight and have a positive effect on plant height, which leads to increased biological yield in sunflower (Ebrahimian and Bybordi, 2011).

4.6. Harvest Index

Result of analysis of variance showed effect of different level of vermicompost and Nano iron fertilizer on harvest index was significant at 1% probability level also interaction effect of treatments was significant at 5% probability level (Table 1). Mean comparison result of interaction effect of treatments indicated the maximum harvest index (30%) was noted for 10 $t.ha^{-1}$ vermicompost with 0.006 $L.ha^{-1}$ iron Nano fertilizer and lowest one (12%) belonged to nonuse vermicompost with nonuse of iron Nano fertilizer or control treatments (Fig. 7). Harvest index indicates the rate of photosynthetic distribution between the reproductive and vegetative organs, and indicating the transfer of dry matter to a part of the plant that is harvested. The application of vermicompost fertilizer led to an increase in harvest index in sorghum because of vermicompost has positive effect on soil micro flora and increased soil Mycorrhiza activity (Cavender *et al.*, 2003). Zhang *et al.* (2008) reported application iron Nano fertilizer leads to improve harvest index.

4.7. Leaf Area Index (*LAI*)

According result of analysis of variance effect of different level of vermicompost and Nano iron fertilizer on leaf area index was significant at 1% probability level also interaction effect of treatments was significant at 5% probability level (Table 1). Mean comparison result of interaction effect of treatments indicated that the maximum and the minimum amount of leaf area index belonged to 10 $t.ha^{-1}$ vermicompost with 0.006 $L.ha^{-1}$ iron Nano fertilizer

(5.81) and control treatments (1.82) (Fig.8). Providing nutrients needed for the plant and further developing the root system of the plant to absorb nutrients as well as modifying the soil fertility by using vermicompost fertilizer increases the leaf area index (Maghsudi *et al*., 2012). Sainz *et al*. (2008) reported the application of vermicompost led to increase leaf area index, chlorophyll and yield of strawberry, also another researchers Nazari *et al*. (2006); Sinha *et al*. (2010) and Bybordi and Mamedov (2010) reported same result. Singh (2000) reported the application of iron Nano fertilizer on canola resulted in an increase in plant height.

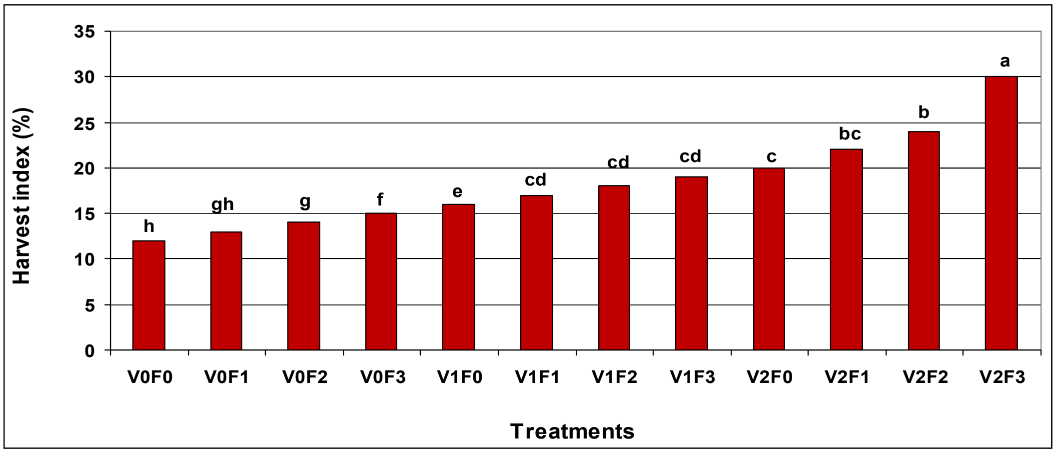

Fig. 7. Mean comparison interaction effect of different level of vermicompost and iron Nano fertilizer on harvest index via Duncan test at 5% probability level. V_0: nonuse of vermicompost, V_1: 5 t.ha^{-1} vermicompost, V_2: 10 t.ha^{-1} vermicompost, F_0: nonuse of iron Nano fertilizer, F_1: 0.002 L.ha^{-1} iron Nano fertilizer, F_2: 0.004 L.ha^{-1} iron Nano fertilizer, F_3: 0.006 L.ha^{-1} iron Nano fertilizer.

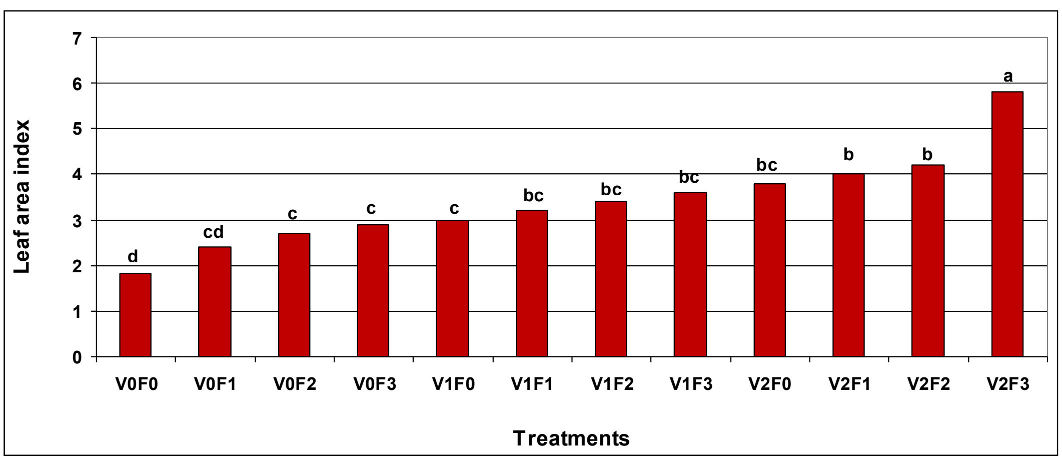

Fig. 8. Mean comparison interaction effect of different level of vermicompost and iron Nano fertilizer on leaf area index via Duncan test at 1% probability level. V_0: nonuse of vermicompost, V_1: 5 t.ha^{-1} vermicompost, V_2: 10 t.ha^{-1} vermicompost, F_0: nonuse of iron Nano fertilizer, F_1: 0.002 L.ha^{-1} iron Nano fertilizer, F_2: 0.004 L.ha^{-1} iron Nano fertilizer, F_3: 0.006 L.ha^{-1} iron Nano fertilizer.

One of the reasons for improving the plant height, iron availability in the growth stages is led to improve leaf area index and photosynthesis, which is consistent with the findings of current research. Bar-Tal *et al*. (2004) reported application of vermicompost fertilizer led to increase leaf area index and chlorophyll index in wheat, also Mousavi *et al*. (2009) reported same result.

5. CONCLUSION

Consume 10 $t.ha^{-1}$ vermicompost with 0.006 $L.ha^{-1}$ iron Nano fertilizer led to achieve highest amount of yield, its components, harvest index and leaf area index and can be advice to farmers.

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FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

CONFLICT OF INTEREST: Authors declared no conflict of interest.

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