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Determination Effect of Mycorrhiza and Vermicompost on Accumulation of Seed Nutrient Elements in Maize (*Zea mays* L.) Affected by Chemical Fertilizer

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RESEARCH ARTICLE

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ABSTRACT

BACKGROUND: Nutrient management is one of the most important factors that affect the growth and production of maize.

OBJECTIVES: Current research was conducted to investigate the effect of Mycorrhizas and vermicompost on seed yield, its components and quantities traits such as concentration of protein, starch, zinc, potassium and nitrogen of corn seed.

METHODS: Current research was conducted via split split-plot arrangement based on randomized complete block design with three replications during the 2016-2017. Main plot included of chemical fertilizer at four level (Control, 33, 66 and 100%) also vermicompost at tow level (nonuse and use of vermicompost) belonged to subplot and mycorrhiza (nonuse and use of mycorrhiza) as a sub-subplot.

RESULT: Interaction effect of chemical fertilizer × vermicompost × mycorrhiza had a significant effect on zinc, nitrogen, potassium, starch and protein content. The highest seed yield and its components were obtained from interaction effects of 66% chemical fertilizer × vermicompost × mycorrhiza and the lowest one was for 33% chemical fertilizer × nonuse of vermicompost × nonuse of mycorrhiza, respectively. The highest zinc, nitrogen, potassium, starch, and protein in seed were obtained from interaction effects of 66% chemical fertilizer × vermicompost × mycorrhiza and the least yield and its components obtained from in 33% chemical fertilizer × without of using of vermicompost × nonuse of mycorrhiza, respectively. Vermicompost and mycorrhiza had a positive affect on seed yield and seed quality and seed nutrients had a better status in presence of vermicompost and mycorrhiza. Use of vermicompost and mycorrhiza with fertilizer levels significantly increased nutrient elements uptake, due to the added supply of nutrient and well-developed root system resulting in better absorption of water and nutrient.

CONCLUSION: The combined application of mycorrhiza and vermicompost fungi increased yield, its components and increases the absorption of food by the root and ultimately improves growth and nutrient transfer to seed.

KEYWORDS: *Corn, Nitrogen, Protein, Organic farming, Yield.*

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1. BACKGROUND

In organic agriculture, one management goal is to increase and maintain soil quality with a high biological activity. Organic cropping system often has to deal with a scarcity of readily available nutrients in contrast to high input cropping system which relies widely available on the soluble fertilizers (Soleimanzadeh and Ghooshchi, 2013). More recently, a real challenge faces the workers in the agricultural research field to stop using the high rates of agro-chemicals which negatively affect human health and environment (El-Kholy *et al*., 2005). Overuse of different chemical fertilizers is one of the causes for the degradation of environment and soil. Bio fertilizers are the newest and most technically advanced way of supplying mineral nutrients to crops. Compared to chemical fertilizers, their supply nutrient for plant needs, minimizes leaching, and therefore improves fertilizer use efficiency (Subbarao *et al.,* 2013). Fertilizer management is one of the most important factors in successful cultivation of crops affecting yield quality and quantity (Tahmasbi *et al.,* 2011). Chemical fertilizers are significant to succor nutrients in soil. Heavy doses of chemical fertilizers and pesticides are commonly used in order to enhance corn yields. Excessive nitrogen content in soil causes an inappropriate high uptake of this macronutrient by plants, which may result in inadequate growth and development due to the accumulation of nitrogen compounds in plant tissue (Szulc, 2013). Indiscriminate use of chemical fertilizers to achieve high yield and to compensate for lack of nutrients and consequently the increase of production costs and destruction of soil and water resources have made the specialists interested in healthy and stable crop systems in terms of ecology (Tilak *et al*., 1992). 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). Farming practices which involve heavy application of chemical fertilizers may cause depletion of certain nutrients in soil and certain others would generally accumulate in excess resulting in nutrient imbalance which affects the soil productivity. Some of these problems can be tackled by using bio-fertilizers, which are natural, beneficial and ecologically friendly. Among the means available to achieve sustainability in agricultural production, organic manure and bio-fertilizer play an important and key role because they possesses many desirable soil properties and exerts beneficial effect on the soil physical, chemical and biological characteristics of the soil. The application of bio-fertilizers has become of great necessity to get a sufficient yield with high quality to avoid environmental pollution (Shevananda, 2008). Biological fertilizers are obviously an important part of a sustainable agricultural system and have an important role in crop production by maintaining soil fertility (Chen, 2006). Soleimanzadeh and Ghooshchi (2013) reported that high input cropping system was the most productive treatment but organic cropping system with bio-fertilizers was the most economical treatment with respect to increasing net profit. Combination mycorrhiza and bacteria holds promise for the organic cropping system of maize. Therefore in organic and low input cropping systems, a combination of mycorrhiza and free-living bacteria performed satisfactorily. According to Zeid (2008) a compound organic fertilizer and urea or a combination of urea and polyamines significantly enhanced yield, growth, and the chlorophyll index. Jafari Haghighi and Yarmahmodi (2011) in conclusion for reach to high yield in corn stated biological fertilizer cannot sufficient but integrated application of fertilizers (Biological and chemical fertilizers) became causes significant increase in yield. Use of bio-fertilizers offers agronomic and environmental benefits to intensive farming systems in Egypt, and the data showed that using *Azospirillum brasilense* or commercial bio fertilizers in cereals with a half nitrogen rate (144 $kgN.ha^{-1}$) caused a significant increase in yield. Further, seed inoculation with Rhizobium, phosphorus solubilizing bacteria, and organic amendment increased the seed production of the crop (Panwar *et al*., 2006). Yazdani *et al*. (2009) demonstrated that use of growth stimulating bacteria and phosphate solute in combination with chemical fertilizer was able to reduce phosphorus fertilizer application by 50% without an occurrence of reduced corn yield. Nitrogen is a basic plant component, playing a decisive role in the intensification of plant production (Scharf, 2002). Nitrogen being the major constituent of chlorophyll therefore increases in nitrogen availability leads to increase in chlorophyll content. In chemical treatments, nitrogen is supplied more quickly and chlorophyll synthesis proceeds rapidly while in organic treatment nitrogen release slowly and supply required nitrogen during time. The significant differences between chemical and organic (whether full organic whether integrated) treatments may be attributed to the higher levels of nutrients besides growth stimulating substances (Enzymes, antibiotics and growth hormones) available in vermicompost (Vadiraj *et al*., 1998). Biofertilizers are more environmental friendly and in many cases, they have given the same or even better crop yields compared to mineral fertilizers (Saghir Khan *et al.,* 2007). So far considerable number of bacterial species, mostly associated with the plant rhizosphere, were tested and found to be beneficial for plant growth, yield and crop quality. They have been called 'plant growth promoting rhizobacteria (PGPR)' including the strains in the genera Azospirillium, Azotobacter, (Sudhakar *et al.,* 2000). PGPR participates in many key ecosystem processes, such as those involved in the biological control of plant pathogens, N fixation, solubilisation of nutrients and phytohormone synthesis (Vessey, 2003). Biological fertilizers release active precursors like gibberellin, auxin, cytokinine, vitamins, amino acids, polypeptides, anti-bacteria and anti-fungi especially exo polysaccharides to have a positive effect on yield of crops. Applied microorganisms as biological fertilizers have effects on growth of the plant to provide food elements by colonization in rhizosphere environment or in cooperation with symbiotic (Elanwar, 2010). On the other hand, these bacteria can produce fungi complexes that they can be used against plant diseases and improvement of germination and at last growth of the plant. These bacteria can reinforce performance of the plant by fixation of nitrogen and producing of materials causing growth stimulation, root growth and as a result water absorbent, reforming acidity of the soil and absorbing of food elements (Manfouz and Sharaf-Eldin, 2007). Ahmad *et al.* (2010) showed that higher yield under the effects of biologic fertilizers might be because of the increase in metabolic activities of biologic fertilizers and production of growth stimulating hormones by bacteria. Also Bahamin *et al*. (2014) showed that when seeds were in inculcation by Nitroxin biologic fertilizer seed yield reached 3840 kg per hectare, showing 28% increase compared to non-inculcation treatment. Seed yield of cereals is determined by two main components, seed number per unit area and mean seed weight. Seed yield is usually strongly associated with the number of seeds per unit area (Azimi *et al.,* 2013). While this association has been extensively reported for a relatively wide range of environments. The final seed number per unit area is set immediately after anthesis, while seed filling occurs during the remaining post anthesis period (Ugarte *et al.,* 2007). Vermicompost is an organic compound that is microbial active and rich in nutrients that results from the interaction of earthworms and microorganisms with organic matter decomposition. It has been shown that these pitched and homogeneous materials have high porosity, adequate ventilation and drainage, and high water retention capacity, and contain nutrients found in the plant's absorbable form (Koozehgar kaleji and Ardakani, 2017). One of the most important symbiosis relations in the world of life that emerged during the evolutionary period is the mycorrhizal symbiosis, in which the roots of the plant with the fungus act as a unit of life and benefit from each other and grow to Each other (Naseri *et al*., 2016). Several reports have been reported on the changes in nutrients resulting from bioactivity in the plant's rhizosphere and the increase in nutrient stores in the seeds, Song (2005) stated that by induction of mycorrhizal fungus, the environment around the plant root, the system. The roots develop and improve the absorption of water and nutrients. Mycorrhizal fungus helps to absorb nutrients by extending the root system of the plant and exploring the soil by external hair follicles in the hair roots and reducing the nutrients of that area (Khosrojerdi *et al*., 2013). Sharda Waman *et al*., 2009) showed that using inoculum fluid separately and in a combination of G. intaradices and G. mosseae increased potassium in the plant. Sajadi Nic *et al*. (2011) showed that chemical fertilizers, vermicompost, and biofertilizer absorb nutrients, proteins and seed yields. The results of these researchers showed that vermicompost consumption significantly increases the absorption of nitrogen, phosphorus and potassium elements. Darzi *et al*. (2011) stated that the addition of vermicompost to soil not only increased the nutrient content of the plant but also improved the physical and physical conditions of the soil, creating an appropriate growth medium the root causes increased shoot growth and dry matter production and finally improved seed yield. Application of vermicompost increases the total organic carbon, total nitrogen, phosphorus, potassium, and zinc and reduces the acidity of the soil. Vermicompost also improves porosity and soil compaction (Azarmi *et al*., 2008). By studying the role of mycorrhiza and vermicompost fungi on seed yield and its role in improving the quality of corn seed, useful results can be obtained on the accumulation of these elements.

2. OBJECTIVES

Current research was conducted to investigate the effect of mycorrhiza and vermicompost on seed yield, its components and quantities traits such as concentration of protein, starch, zinc, potassium and nitrogen of corn seed.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

Current research was conducted via split split-plot arrangement based on randomized complete block design with three replications at Sarpolzahab region in Kermanshah province (West of Iran) during the 2016-2017 cropping season. Main plot included of chemical fertilizer at four level (Control, 33, 66 and 100% recommended chemical fertilizer) also vermicompost at tow level (none consume of vermicompost or control and consume of vermicompost) belonged to subplot and mycorrhiza (without of using of mycorrhiza or control and using of mycorrhiza) as a sub-subplot.

3.2. Farm Management

Chemical fertilizer levels were based on soil test (Table 1) and expert advice and corn requirements. The maize variety used in this study was Simon cultivar. Fungus *Glomus* mosseae (powdered) was used in this research from Soil Biology Research Department, Soil and Water Research Institute of Iran. Before planting, in order to inoculate corn seeds, Glomus Mosse mushroom, each containing 150 live spores. After impregnating the seeds with Glomus Mosse mushroom continued for a few minutes until the inoculum with Arabic gum seed as well as the surface of the seeds. In order to prepare the soil and test the soil, at the first stage of sampling, the soil was sampled at a surface of 30 cm. Then the land was plowed and the fields were ready. Plots with dimensions of 5 × 4m, spacing rows of 75 cm (in each plot of 4 planting lines) and seedling spacing on 18 cm rows were considered. The distance between repetitions is 2 meters and between plots is 1 meter. To inoculate the seeds with a mycorrhizal fungus, after creating a cavity on the ground, 5 grams of inoculum of the mycorrhizal fungus were added to the cavity and then seed was planted. After planting rain irrigation seeds were immediately carried out. In the critical period of growth, weeds were mechanically controlled. Irrigation was done weekly by the rainy method.

Table 1. Soil physical and chemical properties of experimental site

Phosphorus (ppm)	Potassium (ppm)	Nitrogen (%)	Organic Carbon (%)	Electrical conductivity ($ds.m^{-1}$)	pH
5.40	240	0.12	0.82	0.97	7.66

3.3. Measured Traits

To determine the number of rows in the ear, in the middle part of the ear, in diameter, the number of rows was counted in 5 randomly selected earls, and then the mean of them was calculated. A number of seeds per row of the ear, seeds were counted in 5 rows of 5 different randomly selected earlets and their average was calculated. 4 seed samples were counted and for each treatment, their mean value was calculated and considered as 100 seed weight. At the time of physiological examination for measuring seed yield, the ear tags of each treatment were removed after removal of two lateral lines and two plants from the beginning and the end of each plot. The performance of each treatment was measured by a balance. To measure the amount of zinc, dry digestion and combustion with HCl were used. Initially, the extract of the powder was prepared. The elements were then measured by atomic absorption method of flames using the model G BCAventa, Ver.1.31 (Emami, 1996). Nitrogen measurements were determined by digesting the seeds with sulfuric acid, salicylic acid and oxygenated water by Kjeldahl method. Potassium was measured by the photometric method. The DA7200 was used to measure starch content by Near Infra-Red device. Kejeldal method was used to measure protein content of the seeds.

3.4. Statistical Analysis

The data were normalized by using SPSS software (Ver.21). The analysis of variance and mean comparison were done with using SAS software (Ver.8) and Duncan's multiple range test at 5% probability level. The figures were drawn by using Excel software.

4. RESULT AND DISCUSSION

4.1. Seed Yield and Its Components

According result of analysis of variance effects of chemical fertilizer, vermicompost and mycorrhizal fungus on the seed yield and its components were significant (Table 2). Mean comparison result revealed vermicompost consumption and mycorrhiza had the highest amount of number of rows in the ear with the use of 66% chemical fertilizer treatments with 18 rows per ear and only significantly (33%) without use of mycorrhiza and vermicompost (Fig. 1).

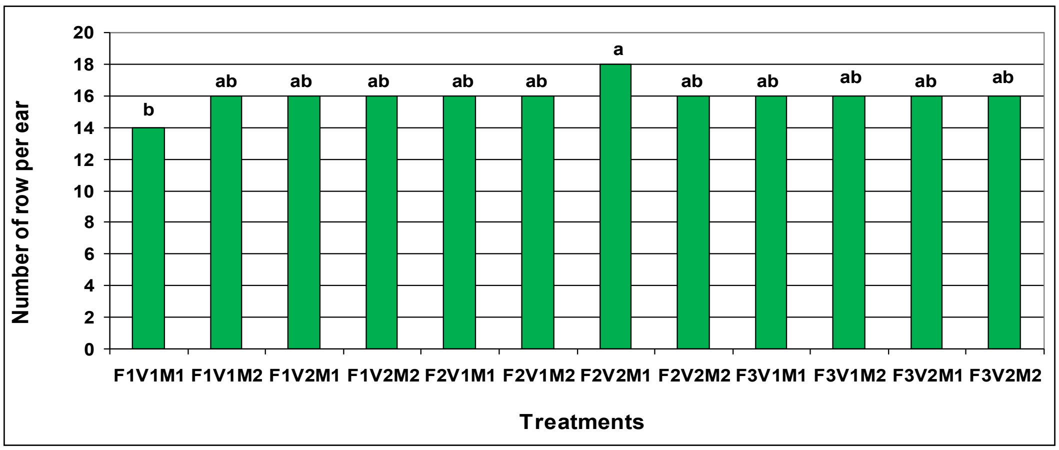

Fig. 1. Mean comparison interaction effect of chemical fertilizer, vermicompost and mycorrhiza on number of row per ear via Duncan test at 5% probability level. F_1, F_2 and F_3= Application of 33, 66 and 100 % recommended chemical fertilizer, respectively. V_1 and V_2= nonuse and use of vermicompost, respectively. M_1 and M_2= nonuse and use of mycorrhiza, respectively.

Table 2. Analysis of variance of yield and its components affected chemical fertilizer, vermicompost, and mycorrhiza

S.O.V	df	Number of row per ear	Number of seed in row	100-seed weight	Seed yield
Replications	2	122.07*	1452.4*	325641.07**	566322.8**
Chemical fertilizer (CF)	2	165.02*	986.7*	271421.6**	653788.2**
Error I	4	42.1	348.2	28953.4	52693.06
Vermicompost (V)	1	264.01*	456.08*	452896.6**	489652.4*
CF×V	2	239.5*	341.4*	286954.9**	758964.1**
Error II	6	52.3	112.2	17896.9	3658.2
Mycorrhiza (M)	1	124.5*	652.1*	325473.1**	854299.8**
CF×M	2	165.4*	563.3*	470361.8**	677801.3**
V×M	1	182.4*	542.2*	563287.8*	928893.7*
CF×V×M	2	256.9*	1652.1*	896325.3**	983280.2**
Error III	12	58.2	143.7	51230.6	47723.1
C.V (%)	-	10.4	9.3	14.2	16.7

^{ns}: non-significant, * and **: significant at 5% and 1% probability level, respectively.

The highest number of seeds in the row of the ear in two treatments consisted of 66 or 100% chemical fertilizer plus mycorrhiza and vermicompost with a mean of 45 seeds per row. The lowest number of seeds in the row of ears with an average of 39 seeds in the chemical fertilizer and mycorrhizal fungus (Fig. 2). The highest 100 seed weight was obtained in the treatment of 100% chemical fertilizer with mycorrhizal fungus and vermicompost with an average of 36 g (Fig. 3). The highest seed yield was observed in the application of organic and organic fertilizers with 66% chemical fertilizer with an average of 17 tons per hectare, which was not significantly different from that of organic fertilizer and biofertilizer with 100 percent fertilizer, but its superiority was significantly higher than other treatments. The lowest seed yield was observed at the level of 33% fertilizer, without compost and no use of Mycorrhiza fungi with an average of 15 $t.ha^{-1}$ (Fig. 4).

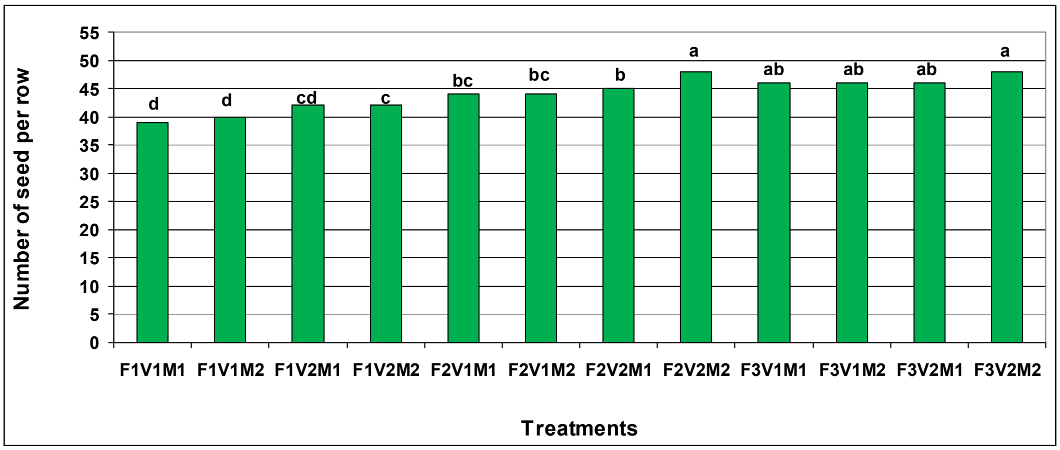

Fig. 2. Mean comparison interaction effect of chemical fertilizer, vermicompost and mycorrhiza on number of seed per row via Duncan test at 5% probability level. F_1, F_2 and F_3= Application of 33, 66 and 100 % recommended chemical fertilizer, respectively. V_1 and V_2= nonuse and use of vermicompost, respectively. M_1 and M_2= nonuse and use of mycorrhiza, respectively.

Regarding the interpretation of the interaction between vermicompost and mycorrhizal fungus on the weight of 100 seeds, it can be stated that there was a synergistic and execratory relationship between vermicompost and mycorrhizal fungus that caused the participation and increase of microorganisms activity in the soil and then through increasing The absorption of mineral elements and the amount of photosynthesis of the plant can improve the weight of the seeds. Naseri *et al*. (2017a) showed that mycorrhizal fungus increases the weight of the seeds. The Glomus Musa mushroom provides improved growth of the air organs by increasing the root system and absorbing the nutritious nutrients, increasing the amount of leaf chlorophyll (Naseri *et al*., 2017b), which subsequently increases the plant's green surface and causes more material to be stored. Photosynthesis toward seeds and increasing the weight of one thousand seeds. Biofertilizers seem to have provided more seed filling time with the production of growth hormones and the supply of nutrients while increasing the filling speed of the seed (Naseri *et al*., 2017a). The higher seed yield in the inoculations of Glomus mosaicism and Vermicompost in corn can be attributed to high yield components, ie number of rows per ear, number of seeds per row and 100-seed weight.

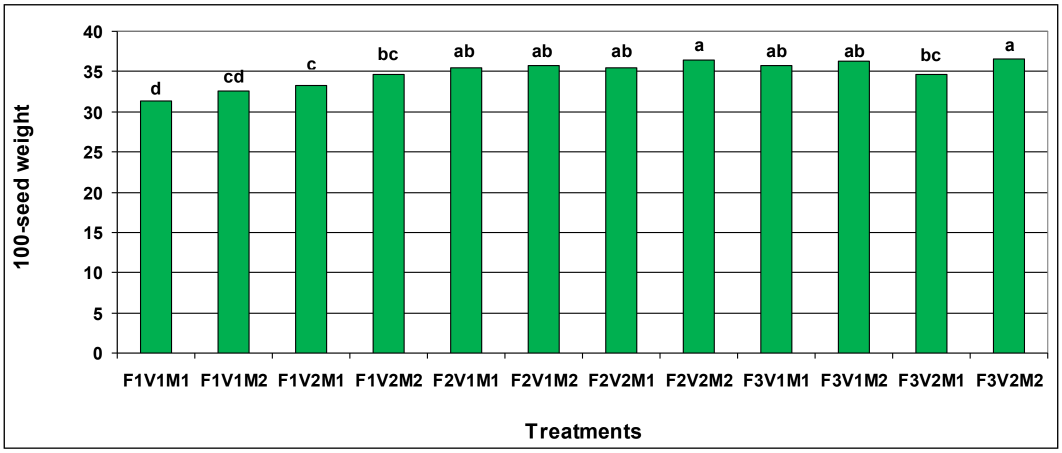

Fig. 3. Mean comparison interaction effect of chemical fertilizer, vermicompost and mycorrhiza on 100-seed weight via Duncan test at 5% probability level. F_1, F_2 and F_3= Application of 33, 66 and 100 % recommended chemical fertilizer, respectively. V_1 and V_2= nonuse and use of vermicompost, respectively. M_1 and M_2= nonuse and use of mycorrhiza, respectively.

It seems that inoculation of seeds with microorganisms and possibly the creation of suitable conditions for germination cause faster seedling establishment (Amiri *et al*., 2013) and more efficient than environmental sources by the plant (Ehteshami *et al*., 2014). This situation causes the plant to have more suitable conditions for filling the seeds, which increases with increasing seed yield. Other studies have shown that some microorganisms can also directly increase plant growth through the production of plant growth regulator and increasing the absorption capacity of water and nutrients (Sharma, 2002). Sajadi Nic *et al*. (2011) showed that chemical fertilizers, vermicompost, and biofertilizer absorb nutrients, proteins and seed yields. The results of these researchers showed that vermicompost consumption significantly increases the absorption of nitrogen, phosphorus and potassium elements. The addition of vermicompost to soil contributes to the nutrient requirements of the plant, as well as the improvement of the physical and physical condition of the vital soil and creates a suitable bed for root growth, increases the growth of shoot and dry matter production, and ultimately improves the seed yield (Darzi *et al*., 2011). The increase of barley seed weight in the treatment of vermicompost was also significantly reported in other reports (Mahmoud *et al*., 2012).

4.2. Qualitative Traits and Seed Elements Accumulation

The results of variance analysis for qualitative traits are presented in Table 3. As the analysis of variance table shows the traits measured in the seeds, nutrients are influenced by the triple interaction of mycorrhiza × fertilizer × vermicompost. The use of mycorrhiza and vermicompost has a significant effect on nutrients and qualitative characteristics of seed protein and starch. The highest percentage of protein content was observed in treatment with 66% fertilizer and 100% chemical fertilizer with mycorrhiza and vermicompost consumption with a mean of 8.1% (Fig. 5). The highest percentage of starch was obtained in treatment with 66% fertilizer requirement with vermicompost consumption and mycorrhiza with a mean of 72% (Fig. 6). The highest amount of zinc in the seeds was in the treatment of 33% chemical fertilizers with vermicompost and mycorrhiza, 66% chemical fertilizer without vermicompost consumption and with or without mycorrhiza (Fig. 7).

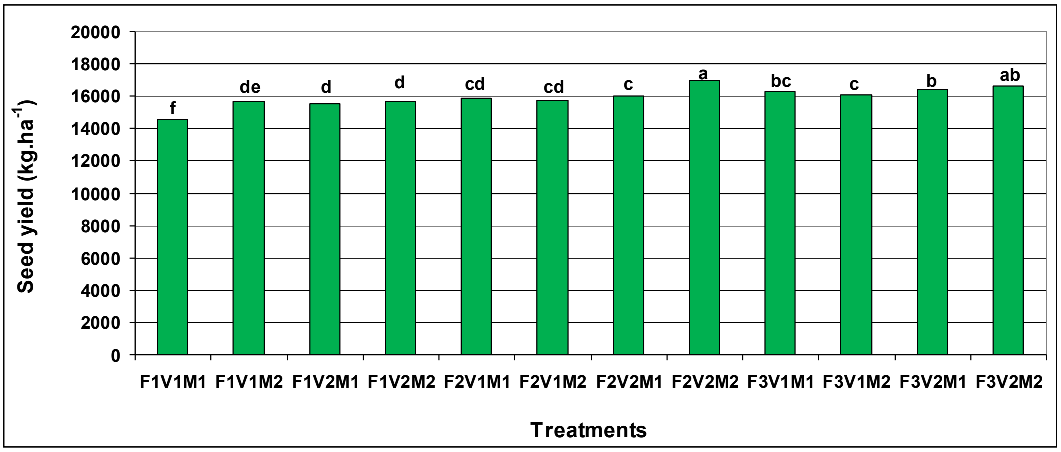

Fig. 4. Mean comparison interaction effect of chemical fertilizer, vermicompost and mycorrhiza on seed yield via Duncan test at 5% probability level. F_1, F_2 and F_3= Application of 33, 66 and 100 % recommended chemical fertilizer, respectively. V_1 and V_2= nonuse and use of vermicompost, respectively. M_1 and M_2= nonuse and use of mycorrhiza, respectively.

Table 3. Analysis of variance of nutrients element and quantities traits affected application of chemical fertilizer, vermicompost and mycorrhiza

S.O.V	df	Protein	Starch	Zinc	Potassium	Nitrogen
Replications	2	432.8^{*}	842.03^{*}	1.2^{ns}	1.3^{*}	4.5^{*}
Chemical fertilizer (CF)	2	871.3^{*}	735.9^{*}	2.2^{*}	1.8^{*}	5.2^{*}
Error I	4	85.9	154.1	0.81	0.22	1.03
Vermicompost (V)	1	596.2^{*}	432.1^{*}	2.1^{ns}	0.91^{ns}	6.2^{*}
CF×V	2	685.2^{*}	615.8^{*}	4.8^{*}	2.3^{*}	7.1^{*}
Error II	6	44.1	101.2	1.09	0.57	1.3
Mycorrhiza (M)	1	692.5^{*}	342.7^{*}	1.2^{ns}	2.1^{*}	6.2^{*}
CF×M	2	933.9^{**}	568.2^{*}	2.2^{*}	2.2^{*}	6.9^{*}
V×M	1	1025.3^{**}	396.1^{*}	2.8^{*}	3.7^{**}	7.7^{**}
CF×V×M	2	1468.7^{**}	954.6^{**}	4.1^{**}	4.3^{**}	8.3^{**}
Error III	12	141.1	91.08	0.63	0.81	2.01
C.V (%)	-	7.3	6.1	3.4	4.6	3.2

^{ns}: non-significant, * and **: significant at 5% and 1% probability level, respectively.

The highest amount of potassium belonged to 66% chemical fertilizers, as well as mycorrhiza and vermicompost, as well as 100% organic fertilizer with average of 167 $mg.kg^{-1}$ (Fig. 8). 100% chemical fertilizer with vermicompost and mycorrhiza or without mycorrhiza had highest nitrogen content (Fig. 9). So increased access to nutrients such as nitrogen, vermicompost and mycorrhizal fungi increased protein seed content. The mentioned results are consistent with findings of Esmaielpour and Amani (2014); Mahjen Abadi and Sepehri (2014). They indicated use of mycorrhizal significantly increased concentration of zinc in air organs. Improve production in mycorrhizal relate to higher concentrations of non-moving nutrients such as phosphorus, zinc, and copper (Ghazi and John Zak, 2003). It has been shown mycorrhizal fungus, due to its stronger root level, could use a higher level of soil rhizosphere by absorbing its nutrients and transferring it to air organs, increased its concentration in the seed (Naseri *et al*., 2017c).

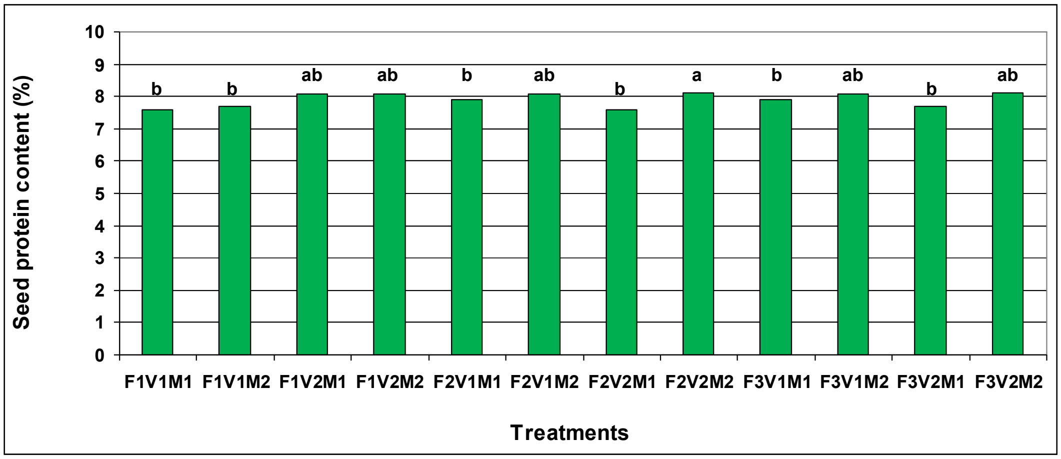

Fig. 5. Mean comparison interaction effect of chemical fertilizer, vermicompost and mycorrhiza on seed protein content via Duncan test at 5% probability level. F_1, F_2 and F_3= Application of 33, 66 and 100 % recommended chemical fertilizer, respectively. V_1 and V_2= nonuse and use of vermicompost, respectively. M_1 and M_2= nonuse and use of mycorrhiza, respectively.

Other researchers reported that the length and number of roots in water absorption and nutrients were of particular importance (Feiziasl *et al*., 2014). Reports (Khosrojerdi *et al*., 2013) state that mycorrhiza fungus absorbs nutrients through the development of the root system of the plant and explores the soil by external hyphen in the hair roots and decreases the iron absorption region It helps. The researchers (ILbas and Sahin, 2005) also observed a significant improvement in the protein content of the seeds containing mycorrhizal inoculation in their study on soybean plants. In their interpretation of the result, the increase in protein content and growth stimulation of the organs Plant aerial is associated with increased phosphorus intake. Therefore, the effect of mycorrhizal fungus on the amount of protein, possibly indirectly, is due to the improvement of mycorrhizal phosphorus status. The researchers (Arriagada *et al*., 2007) attributed the increase in protein content to the improvement in the growth, development, and leaf chlorophyll content, followed by the dry weight of the plant resulting from mycorrhizal symbiosis.

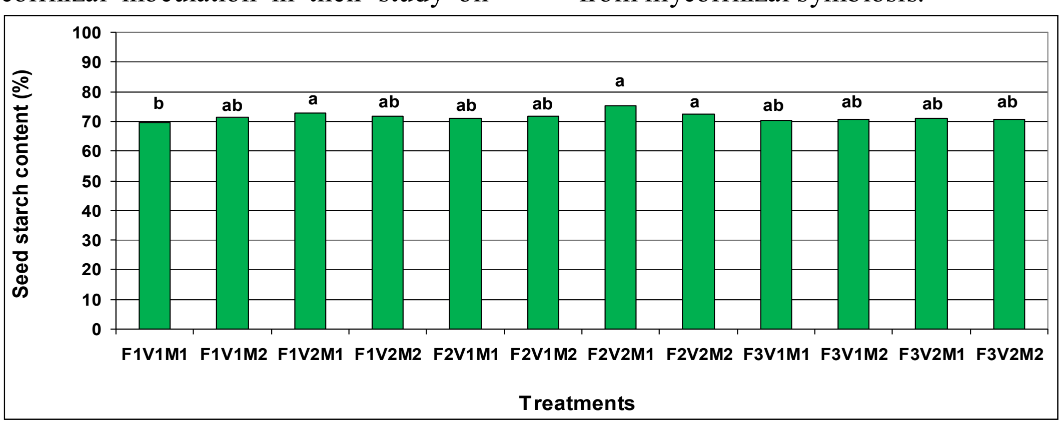

Fig. 6. Mean comparison interaction effect of chemical fertilizer, vermicompost and mycorrhiza on seed starch content via Duncan test at 5% probability level. F_1, F_2 and F_3= Application of 33, 66 and 100 % recommended chemical fertilizer, respectively. V_1 and V_2= nonuse and use of vermicompost, respectively. M_1 and M_2= nonuse and use of mycorrhiza, respectively.

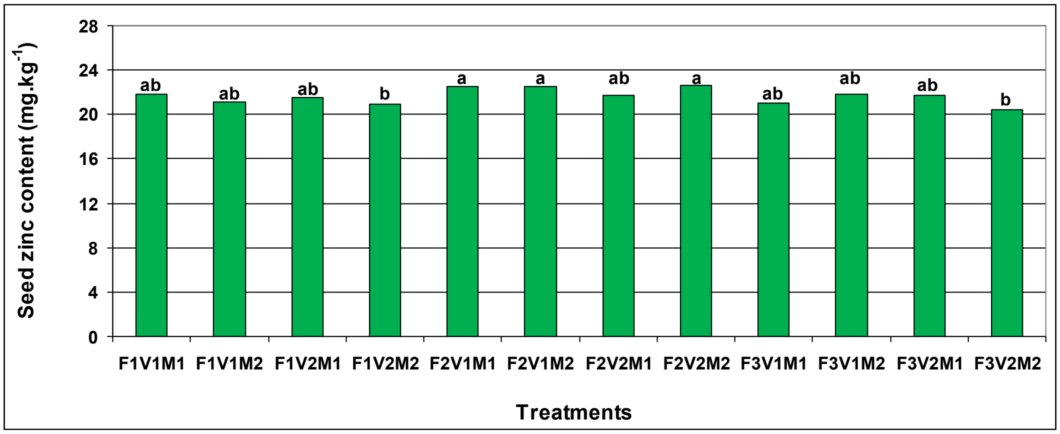

Fig. 7. Mean comparison interaction effect of chemical fertilizer, vermicompost and mycorrhiza on seed zinc content via Duncan test at 5% probability level. F_1, F_2 and F_3= Application of 33, 66 and 100 % recommended chemical fertilizer, respectively. V_1 and V_2= nonuse and use of vermicompost, respectively. M_1 and M_2= nonuse and use of mycorrhiza, respectively.

It seems that increasing the absorption of nutrients such as phosphorus due to propagation of mycobacterium mycobacteria associated with the root tissues and the formation of an extra absorption system complementary to the root system of the plant, which utilizes more soil volume it, is possible that the feed roots do not have access to it (Paras-Motlagh *et al*., 2011). Researchers (Augé *et al*., 2001) reported that zinc concentrations and protein content increased in mycorrhizal plants. It has been reported in other researchers that mycorrhizal fungus contributes to absorption through nutrient uptake by extending the root system of the plant and exploring the soil by external hair follicles in the hair roots and reducing its potassium (Khosrojerdi *et al*., 2013). The researcher (Zuccarini, 2007) reported that the use of mycorrhiza fungi increased potassium uptake.

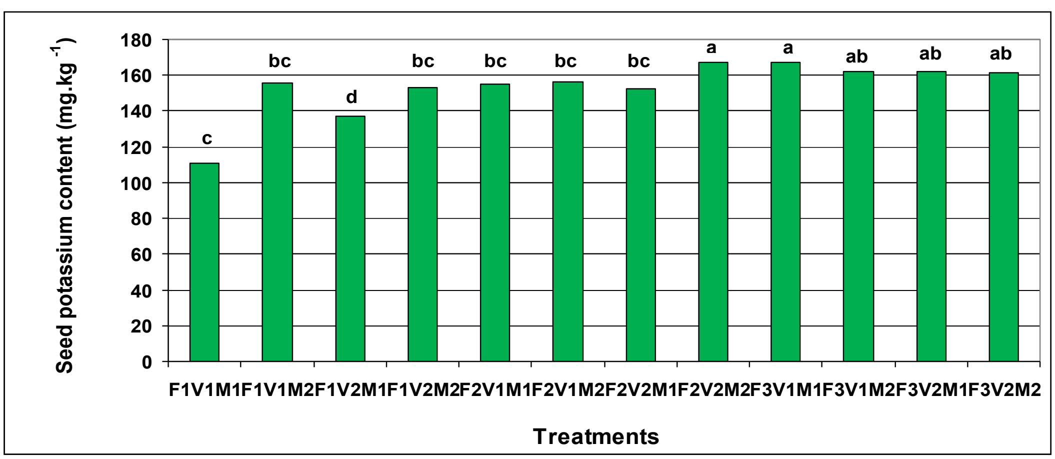

Fig. 8. Mean comparison interaction effect of chemical fertilizer, vermicompost and mycorrhiza on seed potassium content via Duncan test at 5% probability level. F_1, F_2 and F_3= Application of 33, 66 and 100 % recommended chemical fertilizer, respectively. V_1 and V_2= nonuse and use of vermicompost, respectively. M_1 and M_2= nonuse and use of mycorrhiza, respectively.

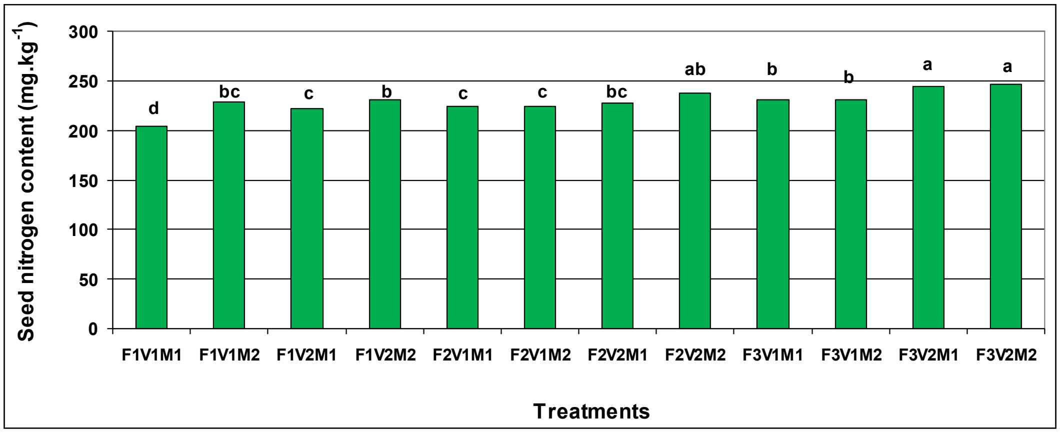

Fig. 9. Mean comparison interaction effect of chemical fertilizer, vermicompost and mycorrhiza on seed nitrogen content via Duncan test at 5% probability level. F_1, F_2 and F_3= Application of 33, 66 and 100 % recommended chemical fertilizer, respectively. V_1 and V_2= nonuse and use of vermicompost, respectively. M_1 and M_2= nonuse and use of mycorrhiza, respectively.

Subramanian and Charest (1997) observed that number of potassium elements in corn seeds increased significantly in corn plants infested with mycorrhizal fungi. In biodegraded inoculants, increasing dry weight of plant could be due to increased absorption of nutrients such as nitrogen and potassium as a result of root expansion (Rouzbeh *et al*., 2009).

5. CONCLUSION

Combined application of mycorrhiza and vermicompost fungi increased the yield and its components. This increase in seed yield due to increasing and accelerating the absorption of low-consumption and high-consumption nutrients and the presence of a microbial population in the rhizosphere of the root caused by the production of Mycorrhizal mycelial mycelia that increases the absorption of food by the root and ultimately improves growth and Corn yield and nutrient transfer to seed.

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