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Effect of Different level of Nitrogen and Vermicompost on Quantitative and Qualitative Traits of Bread Wheat (*Triticum aestivum* L.)

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ABSTRACT

BACKGROUND: Wheat produces more than 50 percent of requirements protein and calorie for human nutrition in Iran. Management of nitrogen fertilizing is important to increasing wheat production. So, among chemical fertilizer a high correlation reported between nitrogen and yield. Also to improve physical, chemical and biological properties of soil, organic fertilizer such as vermicompost can be applied.

OBJECTIVES: This research was carried out to assessment effect of different level of nitrogen fertilizer and vermicompost on crop production, concentration of protein and nitrogen in seed and straw and nitrogen harvest index of wheat.

METHODS: Current study was conducted according factorial experiment based on randomized complete blocks design with three replications along 2013-2014 agronomic years. The Main plot included nitrogen fertilizer at four level (0 or control, 50, 100 and 150 $kg.ha^{-1}$) and vermicompost at four level (nonuse of vermicompost or control, 2.5, 5 and 10 $t.ha^{-1}$) belonged to sub plot.

RESULT: According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on all studied traits was significant at 1% probability level. Evaluation mean comparison result revealed in different level of nitrogen the maximum seed yield (6484 $kg.ha^{-1}$) seed nitrogen content (3.95%) seed nitrogen yield (18.42 $gr.m^{-2}$) seed protein content (18.4%) Straw nitrogen content (1.51%) straw nitrogen yield (16.1 $gr.m^{-2}$) and nitrogen harvest index (66.95%) was noted for 150 $kg.ha^{-1}$ and minimum of measured traits belonged to control treatment. Also compare different level of vermicompost showed that the maximum and the minimum amount of studied traits belonged to 10 $t.ha^{-1}$ and control, respectively. Assessment mean comparison result of interaction effect of treatments indicated the highest amount of all measured traits were noted for 150 $kg.ha^{-1}$ nitrogen with 10 $t.ha^{-1}$ vermicompost and lowest ones belonged to control treatment.

CONCLUSION: Finally according result of current study application 150 $kg.ha^{-1}$ nitrogen fertilizer and 10 $t.ha^{-1}$ vermicompost led to achieve highest amount of crop production, seed nitrogen and protein content, straw nitrogen content and nitrogen yield and nitrogen harvest index, so it can be advised to producers.

KEYWORDS: *Harvest index, Protein, Seed, Straw, Yield.*

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1. BACKGROUND

The most basic material need of humanity is the access to resources including air, food, and water in sufficient amounts. Although the use of chemical fertilizers adds large amounts of nutrients to the soil, plants are not able to absorb all these nutrients and materials so that the material accumulation over years has led to the current acute problems such as erosion, soil destruction, environmental pollutions, salt accumulation, and changes in pH of the soil and thus reduced fertility, creation of undesirable complexes, reduced levels of organic carbon, biodiversity loss, genetic erosion, and finally the disruption of the food chain (Dastmozd *et al*., 2015). Growth and yield of plants affected by deficient or extreme amount of the essential nutrients (Ting-Hui *et al.*, 2006). Nitrogen is known as an essential element from vegetative stage to physiological maturity (Ali, 2011) and one of the main inputs of wheat agriculture with expecting optimum yield. Nowadays, the use of nitrogen fertilizers is increasing continuously. According to the research conducted by Good and Beatty (2011), the total nitrogen application estimated 5.8 million tons in 1987 and will rise to approximately 6.151 million tons in 2050. Availability of nitrogen is important for growing plants. It is a main constituent of protein and nucleic acid molecules. It is also a part of chlorophyll molecules. It is well known that the use of fertilizer helps in production and is a quick method resulted in the best yields (Farooqui *et al*., 2009). The most effective environmental factor on wheat quality is nitrogen fertilization. At the same time, the degree of influence is affected by annual weather conditions and by residual soil nitrogen (López-Bellido *et al*., 2001). Therefore, proper management of N fertilizer is essential to ensure high quality wheat production. Design of fertilizer application regimes should combine rate, timing, splitting, and source of application, with a view to optimizing wheat yield and its quality (Abedi *et al*., 2010). Nitrogen fertilization increases the total quantity of flour proteins, resulting in an increase in both gliadins and glutenins (Johansson *et al*., 2004). Nitrogen is the most important element in producing quality and quantity of crops, especially corn vital plant plays an important role. On the other hand economic and environmental problems caused by the indiscriminate use of chemical fertilizers nitrogen and attention to the innate potentials very interesting and varied soil organisms, especially microorganisms. One of the most important and most functional areas of research in the scientific studies, is trying to bio-fertilizers. In recent decades with the increasing use of chemical fertilizers has serious environmental problems and economic burden on the society. In this regard, extensive efforts to find appropriate solutions to improve the soil, crops, and removing pollutants is started (Zaremanesh *et al*., 2017). Mature wheat grains contain 8–20% protein, which are divided into two major categories: prolamins including gliadins and glutenins and non-prolamins consisting of water-soluble albumins and salt-soluble globulins (Singh and

Skerritt, 2001). Grain quality is a complex trait resulting from the interactions between numerous protein components (Daniel and Triboi, 2000). The protein composition of wheat seeds is important in determining bread-making quality (Johansson *et al*., 2001). The protein content in the wheat grain is dependent on genotype but it is also clearly influenced by environmental variables such as nitrogen application, water access and temperature during growth especially through the grain filling period (Tea *et al*., 2004). These factors influence the rate and duration of wheat grain development, protein accumulation and starch deposition (Dupont and Altenbach, 2003). Nitrogen increases leaf area, tiller formation and number, leaf area index and greenness duration and as well as, it led to more dry matter accumulation and seed yield (Alazmani, 2015). Giambalwo *et al.* (2010) in a study on durum wheat genotypes at low nitrogen amount declared that nitrogen use efficiency had no considerable significant difference among genotypes. There are some evidence demonstrating correlation between available nitrogen and accumulation biomass, but it is so tough to quantify that. A comparing experiment was carried out on durum wheat, bread wheat and barley during years 2004/2005/2006/2007. The result showed that nitrogen uptake correlated with grain yield and final biomass at maturity advent (Cossani *et al.,* 2012). Montemuro *et al.* (2006) in their study on wheat reported that nitrogen accumulation and remobilization from vegetative parts to grain is the main source of seed yield quality. In all plants, leaves stem and pods are the most important sources of nitrogen remobilization to grains. Moosavi *et al*. (2013) recommended to apply 225 $kg.ha^{-1}$ nitrogen with the minimum density of 50 plants m^{-2} to obtain economical yield of grain sorghum had the positive effect to increase grain yield. Increase protein percentage with using bio-fertilizers is due to the effect of bacterial inoculation that increased the effective regulation of the growth, physiological and metabolic activity of the plant (Eidy Zadeh *et al*., 2012). In a study on the effect of different nitrogen fertilization rates on different cultivars of grain sorghum, Asghari *et al*. (2006) reported that the increase in fertilization rate from 0 to 150 kg ha^{-1} led to increase grain yield (8.56 $kg.ha^{-1}$) significantly. Almodares *et al*. (2009) suggested applying 200 $kg.ha^{-1}$ urea because the highest biomass and protein content and the lowest fiber content will be achieved with at this amount of nitrogen fertilizer. Although, this amount of nitrogen will decreased soluble carbohydrates content but it seems this reduction dose not effect on forage palatability and digestibility considerably. Considering the environmental pollution related to excess use of nitrogen fertilizer, needs of an alternative approach based on biological origin, safe for use and less expensive generated for the management of nitrogen. Replacement of nitrogen fertilizer in the soil through application of vermicompost can caused reduction in the environmental pollution developed by washing nitrate from the soil (Namazi *et al*., 2015). The use of bio-products for plant nutrition purposes is taken as a basic approach so that Food and Agriculture Organization (FAO) recently has taken some measure to implement the Integrated Plant Nutrition Management (IPNM) systems for the development of sustainable agriculture in developing countries. In addition, the International Conference on Food Importance and its role in Soil Stability (Rome, 26-28 March 2003) was held to discuss the quality and quantity improvement of foodstuff per unit area through the integration of mineral and organic nutrition of crops as a fundamental challenge facing the realization of World Food Security (WFS). Adequate Input Sustainable Agriculture (AISA) is currently practiced based on the integrated use of chemical and organic fertilizers, especially bio-fertilizers as an approach to alternative agriculture for producing and maintaining yield at an acceptable level (Dastmozd *et al*., 2015). To improve physical, chemical and biological properties of soil, organic fertilizer can be applied (Mengi *et al*., 2016). Vermicompost is much valued for arable and gardening soil improvement and is demanded by professionals. Since the 1990s, a raging wave of recycling fans was observed around the world. Since worms are able to eat organic waste equivalent to about half of their weight (an average of seven milligrams) each day, they are frequently used in landfill sites in many regions of the world. Based on what was mentioned, the aim of the present study is to evaluate the effect of vermicompost fertilizer as compared to the biological fertilizer on yield and yield components of wheat (Dastmozd *et al*., 2015). Use of vermicompost in the sustainable agriculture caused significant increases in the population of beneficial microorganism such as mycorrhizal fungi and phosphate dissolving bacteria and fungi in the soil. Production of nutritious elements such as nitrogen, transferable phosphor, magnesium, dissolved potassium required for the plants and causes improvement in the growth and function of the agricultural plants (Srivastava *et al*., 2002). Jayanthi *et al*. (2002) suggested that application of vermicompost and manure together showed a positive and meaningful improvement in the maize and oat seed's functioning. Findings of these researches clearly indicated that the use of vermicompost not only causes better plant's growth but also effects the crop functioning. Vermicompost affects on soil physical properties. It improves soil structure, texture, aeration, and water holding capacity. Vermicompost includes plant-growth regulators which increase growth and yield. Excreta of earthworm were rich of Micro-organism especially bacteria and contain large amounts of plant hormones (auxin, gibberellin and cytokinin) which affect plant growth and development (Atiyeh *et al*., 2001; Canellas *et al*., 2002; Wang *et al*., 2010). The application of vermicompost favorably affects soil pH, microbial population and soil enzyme activities which all of them can affect biosynthesis of compounds. Vermicompost and organic fertilizers increased protein content of peanut and vitamin C in Marion berry, strawberry, and corn (Maheswarappa *et al*., 1999; Asami *et al*., 2003; Basu *et al*., 2008). Atiyeh *et al*.

(2000) found that compost was higher in ammonium, while vermicompost tended to be higher in nitrates, which is the more plant-available form of nitrogen. In vermicomposting process, earthworms are used to enhance the process of residue conversion. Vermicomposting is faster than composting and the resulting earthworm castings are rich in microbial activity and plant growth regulators, and fortified with pest repellence attributes as well. Vermicomposting reduces the C:N ratio and retains more N than the traditional methods of preparing composts. It can improve seed germination, growth and yield of crops (Nagavallemma *et al*., 2004). Edwards and Arancon (2004) reported that the vermicompost applications suppressed the incidence of the disease significantly. Manivannan *et al*. (2009) indicated that application of vermicompost with inorganic fertilizers improved yield and protein of *Phaseolus vulgaris* seeds. Vermicompost can provide all nutrients in readily available form and also enhances uptake of nutrients by plants. The uptake of nitrogen can improve when was applied in combination with vermicompost (Jadhav *et al*., 1997). Chaoui *et al*. (2003) found that wheat yield and shoot biomass were less in fertilizer treatment than in compost treatment. In addition, some symptoms of salinity were observed in these two treatments but not in vermicompost treatment. It was also noted that K and P availability and uptake by wheat were higher in vermicompost and compost treatments than in the control treatment and chemical fertilizers. In fact, the application of vermicompost is preferred over compost due to non-moving nitrogen, salinity effects, levels of pathogens, as well as the risks of environmental pollutions in the long term use of these fertilizers (Eskandari and Starayei, 2007). Ahmadinejad *et al*. (2013) studied the impact of organic and nitrogen fertilizers on water use efficiency and yield and growth properties of wheat and reported that application of 150 and 300 $kg.ha^{-1}$ urea significantly improved grain yield, biological yield, plant height, stem diameter, number of leaves per plant, leaf chlorophyll index, and water use efficiency as compared to the control group. However, the use of such fertilizers had no significant effect on the number of grains per spike, thousand grain weight, number of spikelets per spike, and harvest index.

2. OBJECTIVES

This research was carried out to assessment effect of different level of nitrogen fertilizer and vermicompost on crop production, concentration of protein and nitrogen in seed and straw and nitrogen harvest index of wheat.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

Current study was conducted to evaluate effect of nitrogen and vermicompost on agro physiological traits of wheat according factorial experiment based on randomized complete blocks design with three replications along 2013-2014 agronomic years. The Main plot included nitrogen fertilizer at four level (0 or control, 50, 100 and 150 $kg.ha^{-1}$) and vermicompost at four level (nonuse of vermicompost or control, 2.5, 5 and 10 $t.ha^{-1}$) belonged to sub plot. The place of current study was located in Ahvaz city at longitude 48°40'E and latitude 31°20'N in Khuzestan province (South west of Iran). The average annual rainfall, temperature, and evaporation in the region are 243 mm, 25°C and 3000 mm, respectively. Chamran cultivar studied in current research. The physical and chemical properties of studied soil mentioned in table 1.

Table 1. Physical and chemical properties of studied field

Depth of soil sampling (cm)	0-30
Electrical conductivity ($ds.m^{-1}$)	2.89
Soil texture	Clay loam
pH	7.73
Organic carbon (%)	0.71
Nitrogen ($mg.kg^{-1}$)	7
Phosphorus ($mg.kg^{-1}$)	8.3
potassium ($mg.kg^{-1}$)	35

3.2. Farm Management

Agronomic practices including tillage operations, leveling, nitrogen and phosphorus fertilizers, organic manure, and weed and pest managements were done. The wheat cultivar used in this experiment is Chamran was obtained from Seed and Plant Improvement Institute in Ahvaz. Land preparation began in the second half of December. The necessary fertilizer according to farm soil test and recommendations of soil and water de Institute is used to the land. Each sub plot was consisted of four stacks with a width of 60 cm and on each stacks 20 lines planting and the length of 4.2 m.

3.3. Measured Traits

In order to determine the seed yield after full maturity of the seeds, the spikes were taken from the 3 middle lines of each plot in an area of 1 m^2 and the seed yield of each plot with moisture of 14% was calculated per area unit and then was recorded. To measure the seed nitrogen content and straw nitrogen content the Kjeldahl method was used. So, to calculate the seed protein content the following formula was used (Bremner *et al*., 1983):

Equ.1. Seed protein content (%) = Nitrogen percentage × 5.8.

Seed nitrogen yield was calculated according to formula of May *et al*. (1991) as follows:

Equ.2. Seed Nitrogen Yield ($gr.m^{-2}$) = Seed Nitrogen Content × Seed Yield.

Straw nitrogen yield was calculated according to formula of May *et al*. (1991) as follows:

Equ.3. Straw Nitrogen Yield ($gr.m^{-2}$) = Straw Nitrogen Content × Straw Yield.

Equ.4. Straw Yield = Biological yield – Seed yield.

Nitrogen Harvest index (NHI) was calculated according to formula of Austin and Jones (1975) as follows:

Equ.4. NHI= (Seed nitrogen yield/ Straw nitrogen yield) ×100.

3.4. Statistical Analysis

Analysis of variance and mean comparisons were done via SAS (Ver.8) software and Duncan multiple range test at 5% probability level.

4. RESULT AND DISCUSSION

4.1. Seed Yield

According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on seed yield was significant at 1% probability level (Table 2). Assessment mean comparison result indicated in different level of nitrogen the maximum seed yield (6484 $kg.ha^{-1}$) was noted for 150 $kg.ha^{-1}$ and minimum of that (2405 $kg.ha^{-1}$) belonged to control treatment (Table 3). Nitrogen increases the production of biomass and increases the possibility of retransmission of photosynthetic materials, producing more seeds per spike and better filling them after flowering, which will increase seed yield (Shanggan *et al*., 2000). Naseri *et al*. (2010) reported that the highest seed yield and biologic yield were obtained in 160 and 240 kg $N.ha^{-1}$ with 5100 and 14360 $kg.ha^{-1}$, respectively. Joorabi *et al*. (2015) reported that nitrogen fertilizer (150 $kg.ha^{-1}$) could increase qualitative and quantitative traits such as seed yield (9.82 $t.ha^{-1}$) of sorghum forage in Speed feed variety. Compare different level of vermicompost showed that the maximum and the minimum amount of seed yield belonged to 10 $t.ha^{-1}$ (4223 $kg.ha^{-1}$) and control (3067 $kg.ha^{-1}$) treatments (Table 3). The effect of vermicompost from 0 to 10 $t.ha^{-1}$ on seed yield of corn showed that seed yield increased significantly showed the positive effect vermicompost on crop production because of stored assimilates (Amyanpoori *et al*., 2015).

Table 2. Result analysis of variance of measured traits

S.O.V	df	Seed yield	Seed nitrogen content	Seed nitrogen yield	Seed protein content	Straw nitrogen content	Straw nitrogen yield	Nitrogen harvest index
Replication	2	412.4^{ns}	5.3^{ns}	11.1^{ns}	10.7^{ns}	4.26^{ns}	13.7^{ns}	37.43^{ns}
Nitrogen (N)	3	56321.5^{**}	17.8^{*}	145.7^{**}	177.2^{**}	17.71^{*}	154.2^{**}	566.2^{**}
Vermicompost (V)	3	63212.7^{**}	17.5^{*}	152.6^{**}	173.4^{**}	17.68^{*}	148.7^{**}	479.78^{**}
N×V	9	48976^{**}	16.6^{*}	177.9^{**}	185.5^{**}	16.2^{*}	157.6^{**}	590.1^{**}
Error	30	217.7	7.9	17.5	14.4	8.01	18.81	26.5
CV (%)	-	11.5	1.11	2.53	3.8	2.76	3.9	5.5

$^{ns,\ *\ and\ **}$: no significant, significant at 5% and 1% of probability level, respectively.

Andhikari and Mishra (2002) showed in that the combined application of vermicompost organic manure with urea chemical fertilizer can reduce by 50 percent the amount of urea in the field conditions. Also the yield was 12% higher than treatments that only received fertilizer. Behera *et al*. (2007) showed that the use of 2.5 $t.ha^{-1}$ vermicompost manure fertilizer with 50 percent fertilizer recommendations for wheat, grain yield in 4.08 $t.ha^{-1}$. While the in treatments of only the fertilizer was added to yield 4.87 $t.ha^{-1}$, respectively. Evaluation mean comparison result of interaction effect of treatments indicated maximum seed yield (6544 $kg.ha^{-1}$) was noted for 150 $kg.ha^{-1}$ nitrogen with 10 $t.ha^{-1}$ vermicompost and lowest one (2350 $kg.ha^{-1}$) belonged to control treatment (Table 4). 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. 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).

4.2. Seed Nitrogen Content

Result of analysis of variance revealed effect of different level of nitrogen, vermicompost and interaction effect of treatments on seed nitrogen content was significant at 5% probability level (Table 2). According result of mean comparison maximum of seed nitrogen content (3.95%) was obtained for 150 $kg.ha^{-1}$ nitrogen and minimum of that (1.88%) was for control treatment (Table 3). The percentage of nitrogen in the seeds filled under drought stress was higher than normal conditions. Therefore, field operations and environmental conditions are effective on nitrogen use efficiency (Davidson and Shevalier, 1992). In wheat production, one kg of nitrogen is added to the soil for achieve 20 to 30 $kg.ha^{-1}$ of seed produced (Palta *et al*., 1994). Evaluation mean comparison result indicated in different level of vermicompost the maximum seed nitrogen content (3.42%) was noted for 10 $t.ha^{-1}$ and minimum of that (2.52%) belonged to control treatment (Table 3). Assessment mean comparison result of interaction effect of treatments indicated maximum seed nitrogen content (4.9%) was noted for 150 $kg.ha^{-1}$ nitrogen with 10 $t.ha^{-1}$ vermicompost and lowest one (1.5%) belonged to control treatment (Table 4). Ghasrodashti *et al*. (2014) reported the maximum nitrogen concentration was achieved from consume 300 $kg.ha^{-1}$ nitrogen fertilizer with 40 $t.ha^{-1}$ compost and the lowest one belonged to 250 $kg.ha^{-1}$ nitrogen fertilizer with 10 $t.ha^{-1}$ compost.

Table 3. Mean comparison effect of nitrogen (N) and vermicompost (V) on measured traits

Treatment	Seed yield ($kg.ha^{-1}$)	Seed nitrogen content (%)	Seed nitrogen yield ($gr.m^{-2}$)	Seed protein content (%)	Straw nitrogen content (%)	Straw nitrogen yield ($gr.m^{-2}$)	Nitrogen harvest index (%)
N_1	2405^{d}	1.88^{b}	8.92^{d}	13.45^{d}	1.10^{b}	6.97^{d}	62.37^{b}
N_2	3152^{c}	2.5^{ab}	11.97^{c}	15.37^{c}	1.24^{ab}	9.82^{c}	64.4^{ab}
N_3	4491^{b}	3.35^{ab}	15.05^{b}	17.27^{b}	1.33^{ab}	11.51^{b}	65.56^{ab}
N_4	6484^{a}	3.95^{a}	18.42^{a}	18.4^{a}	1.51^{a}	16.1^{a}	66.95^{a}
V_1	3067^{b}	2.52^{b}	12.7^{c}	15.7^{c}	1.23^{b}	9.76^{d}	64.12^{b}
V_2	4088^{ab}	2.75^{ab}	13.22^{bc}	15.9^{bc}	1.26^{ab}	10.2^{c}	64.52^{ab}
V_3	4154^{ab}	3.05^{ab}	13.92^{b}	16.25^{b}	1.31^{ab}	11.4^{b}	65.16^{ab}
V_4	4223^{a}	3.42^{a}	14.52^{a}	16.65^{a}	1.38^{a}	13.05^{a}	65.72^{a}

*Similar letters in each column show non-significant difference at 5% probability level, via Duncan test.

N_1= Control or 0 $kg.ha^{-1}$, N_2= 50 $kg.ha^{-1}$, N_3= 100 $kg.ha^{-1}$, N_4= 150 $kg.ha^{-1}$.

V_1= Control or 0 $kg.ha^{-1}$, V_2= 2.5 $t.ha^{-1}$, V_3= 5 $t.ha^{-1}$, V_4= 10 $t.ha^{-1}$.

4.3. Seed Nitrogen Yield

According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on seed nitrogen yield was significant at 1% probability level (Table 2). Assessment mean comparison result indicated in different level of nitrogen the maximum seed nitrogen yield (18.42 $gr.m^{-2}$) was noted for 150 $kg.ha^{-1}$ and minimum of that (8.92 $gr.m^{-2}$) belonged to control treatment (Table 3). Compare different level of vermicompost showed that the maximum and the minimum amount of seed nitrogen yield belonged to 10 $t.ha^{-1}$ (14.52 $gr.m^{-2}$) and control (12.7 $gr.m^{-2}$) treatments (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum seed nitrogen yield (18.8 $gr.m^{-2}$) was noted for 150 $kg.ha^{-1}$ nitrogen with 10 $t.ha^{-1}$ vermicompost and lowest one (7.9 $gr.m^{-2}$) belonged to control treatment (Table 4). Hosseini *et al*. (2013) and Ghasrodashti *et al*. (2014) reported similar result.

4.4. Seed Protein Content

Result of analysis of variance showed effect of different level of nitrogen, vermicompost and interaction effect of treatments on seed protein content was significant at 1% probability level (Table 2). Evaluation mean comparison result revealed in different level of nitrogen the maximum seed protein content (18.4%) was noted for 150 $kg.ha^{-1}$ and minimum of that (13.45%) belonged to control treatment (Table 3). Application of nitrogen fertilizer affects protein accumulation and biomass production in wheat (Zorb *et al*., 2010). Wheat protein content is affected by agronomic management such as time and how nitrogen is applied, type of genotype, and the environmental conditions in the pre- and post-pollination stages as well as by the interaction between the environmental factors and type of genotype (Lemon, 2007). In most studies, increased nitrogen fertilization has increased the protein content of grain (Fowler, 2003). Since nitrogen remobilization from vegetative organs to seed plays a significant role in seed protein content, distribution of stored nitrogen in vegetative organs and transferring it to seeds under stress conditions is very important (Modhej *et al*., 2009). Brown (2010) reported that, triticale seed protein content increased up to 54% by using 120 $kg.ha^{-1}$ nitrogen fertilizer in compare to no nitrogen application treatment. Nasseri *et al*. (2009) reported the protein yield increased with increasing in nitrogen application rates so the highest protein yield (701 $kg.ha^{-1}$) produced by nitrogen rate of 90 $kg.ha^{-1}$. The results of various experiments have proved the greater amount of protein in Durum genotypes than that of bread (Ayadi *et al*., 2014). Between different levels of vermicompost maximum seed protein content (16.65%) was observed in 10 $t.ha^{-1}$ and the lowest one (15.7%) was found in control treatment (Table 3). Compare interaction effect of treatments indicated maximum seed protein content (18.9%) was noted for 150 $kg.ha^{-1}$ nitrogen with 10 $t.ha^{-1}$ vermicompost and lowest one (13%) belonged to control (Table 4).

Table 4. Mean comparison interaction effect of nitrogen and vermicompost on measured traits

Treatment		Seed yield (kg.ha^{-1})	Seed nitrogen content (%)	Seed nitrogen yield (gr.m^{-2})	Seed protein content (%)	Straw nitrogen content (%)	Straw nitrogen yield (gr.m^{-2})	Nitrogen harvest index (%)
N_1	V_1	2350^{e}	1.5^{c}	7.9^{hi}	13^{d}	1.02^{c}	6.1^{g}	61^{f}
	V_2	2380de	1.9^{bc}	8.5^{gh}	13.3^{c}	1.06^{c}	6.8^{fg}	62^{e}
	V_3	2400^{cd}	2.05^{bc}	9.2^{fg}	13.6^{c}	1.14^{b}	7.2^{fg}	63^{d}
	V_4	2490^{c}	2.1^{bc}	10.1^{de}	13.9^{c}	1.19^{b}	7.8^{f}	63.5^{d}
N_2	V_1	3099de	2.2^{b}	10.9^{gh}	15^{bc}	1.21^{b}	8.9^{e}	64.1^{c}
	V_2	3111^{d}	2.4^{b}	11.7^{fg}	15.1^{b}	1.24^{ab}	9.2^{e}	64.5^{c}
	V_3	3150^{c}	2.6^{b}	12.2^{ef}	15.5^{b}	1.25^{ab}	10.1^{d}	64.9^{c}
	V_4	3250^{b}	2.8^{b}	13.1^{cd}	15.9^{b}	1.29^{ab}	11.1^{d}	65.09^{b}
N_3	V_1	4390^{cd}	2.9^{b}	13.9^{ef}	16.8^{b}	1.3^{ab}	9.87^{c}	65.2^{ab}
	V_2	4411^{c}	3.1^{b}	14.4^{cd}	17.1^{ab}	1.31^{ab}	10.2^{c}	65.3^{ab}
	V_3	4553^{b}	3.5^{ab}	15.8^{cd}	17.3^{ab}	1.32^{a}	12.1^{bc}	65.36^{ab}
	V_4	4610^{ab}	3.9^{ab}	16.11^{b}	17.9^{ab}	1.39^{a}	13.9^{bc}	66.4^{ab}
N_4	V_1	6430^{bc}	3.5^{ab}	18.1^{cd}	18^{a}	1.4^{a}	14.2^{b}	66.2^{a}
	V_2	6450^{b}	3.6^{ab}	18.3^{c}	18.1^{a}	1.45^{a}	14.6^{ab}	66.3^{a}
	V_3	6514^{ab}	3.8^{ab}	18.5^{b}	18.6^{a}	1.55^{a}	16.2^{ab}	67.4^{a}
	V_4	6544^{a}	4.9^{a}	18.8^{a}	18.9^{a}	1.65^{a}	19.4^{a}	67.9^{a}

*Similar letters in each column show non-significant difference at 5% probability level, via Duncan test.
N_1= Control or 0 kg.ha^{-1}, N_2= 50 kg.ha^{-1}, N_3= 100 kg.ha^{-1}, N_4= 150 kg.ha^{-1}.
V_1= Control or 0 kg.ha^{-1}, V_2= 2.5 t.ha^{-1}, V_3= 5 t.ha^{-1}, V_4= 10 t.ha^{-1}.

Sofizadeh *et al*. (2006) in their study on six wheat cultivars introduced in Iran during the last 50 years, by compared the old and new wheat cultivars revealed with the increase in seed yield, the protein content of new cultivars was reduced than to the old cultivars. They stated that matter this was due to negative correlation between seed yield and seed protein concentration. Hosseini *et al*. (2013) reported compare different level of nitrogen showed that the maximum and the minimum amount of seed protein content belonged to 270 kg.ha^{-1} (14.82%) and control (8.3%) treatments. So considering that nitrogen is one of the most important elements in increasing the nitrogen content of seed, it seems that increasing nitrogen fertilizer application increased the accumulation of this element in seed as well as in shoots of studied wheat cultivars. This condition eventually led to an improvement in the protein content of the seeds.

4.5. Straw Nitrogen Content

According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on straw nitrogen content was significant at 5% probability level (Table 2). Mean comparison result of different level of nitrogen indicated the maximum and the minimum amount of straw nitrogen content belonged to 150 kg.ha^{-1} (1.51%) and control treatment (1.10%) (Table 3). Among different level of vermicompost the maximum straw nitrogen content (1.38%) was obtained for 10 t.ha^{-1} and minimum of that (1.23%) was for control treatment (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum straw nitrogen content (1.65%) was noted for 150 $kg.ha^{-1}$ nitrogen with 10 $t.ha^{-1}$ vermicompost and lowest one (1.02%) belonged to control treatment (Table 4).

4.6. Straw Nitrogen Yield

According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on straw nitrogen yield was significant at 1% probability level (Table 2). Mean comparison result of different level of nitrogen indicated the maximum straw nitrogen yield (16.1 $gr.m^{-2}$) was obtained for 150 $kg.ha^{-1}$ and minimum of that (6.97 $gr.m^{-2}$) was for control treatment (Table 3). Compare different level of vermicompost showed that the maximum and the minimum amount of straw nitrogen yield belonged to 10 $t.ha^{-1}$ (13.05 $gr.m^{-2}$) and control (9.76 $gr.m^{-2}$) treatments (Table 3). Assessment mean comparison result of interaction effect of treatments indicated maximum straw nitrogen yield (19.4 $gr.m^{-2}$) was noted for 150 $kg.ha^{-1}$ nitrogen with 10 $t.ha^{-1}$ vermicompost and lowest one (6.1 $gr.m^{-2}$) belonged to control treatment (Table 4).

4.7. Nitrogen Harvest Index

Result of analysis of variance showed effect of different level of nitrogen, vermicompost and interaction effect of treatments on nitrogen harvest index was significant at 1% probability level (Table 2). According mean comparison result of different level of nitrogen the maximum nitrogen harvest index (66.95%) was observed in 150 $kg.ha^{-1}$ and the lowest one (62.37%) was found in control treatments (Table 3). Between different levels of vermicompost highest value of nitrogen harvest index was belonged to 10 $t.ha^{-1}$ treatment (65.72%) and the lowest one was found in the control treatment as 64.12% (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum nitrogen harvest index (67.9%) was noted for 150 $kg.ha^{-1}$ nitrogen with 10 $t.ha^{-1}$ vermicompost and lowest one (61%) belonged to control treatment (Table 4). Hosseini *et al*. (2013) reported the maximum and the minimum amount of nitrogen harvest index belonged to control (66.41%) and 270 $kg.ha^{-1}$ (58.52%) treatments, respectively. Application of high levels of nitrogen fertilizer than to lower levels resulted in a significant decrease in this index. The reason for this trend can be stated that with increasing nitrogen application, a certain range of nitrogen transfer to the seed will be stopped, similar to the absorption of more nitrogen from the soil, although application of 270 $kg.ha^{-1}$ nitrogen did not lead to further increase in seed yield. Delogo *et al*. (1998) in their study of wheat and barley cultivars founded that increasing nitrogen application led to significant decrease in nitrogen harvest index, and there was a significant difference for all studied levels in their experiments.

5. CONCLUSION

Finally according result of current study application 150 $kg.ha^{-1}$ nitrogen fertilizer and 10 $t.ha^{-1}$ vermicompost led to achieve highest amount of crop production, seed nitrogen and protein content, straw nitrogen content and nitrogen yield and nitrogen harvest index, so it can be advised to producers.

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FOOTNOTES

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