Journal of Crop Nutrition Science
ISSN: 2423-7353 (Print) 2538-2470 (Online)
Vol. 4, No. 4, 2018
http://JCNS.iauahvaz.ac.ir
OPEN ACCESS

# Evaluation Seed Yield, Its Components and Protein Concentration of Wheat in Response to Different level of Nitrogen and Vermicompost

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RESEARCH ARTICLE

**ARTICLE INFO.**
***Received Date:*** *11 Oct. 2018*
***Received in revised form:*** *14 Nov. 2018*
***Accepted Date:*** *15 Dec. 2018*
***Available online:*** *22 Dec. 2018*

**To Cite This Article:**
Mostafa Adebifar. Evaluation Seed Yield, Its Components and Protein Concentration of Wheat in Response to Different level of Nitrogen and Vermicompost. ***J. Crop. Nutr. Sci.,*** 4(4): 47-61, 2018.

## ABSTRACT

**BACKGROUND:** Management of nutrients, especially nitrogen, in order to have economic production, maintain sustainable agriculture and provide food security, is considered to have an important priority.

**OBJECTIVES:** Current study was conducted to evaluate effect of different level of nitrogen fertilizer and vermicompost on quantitative and qualitative traits of wheat.

**METHODS:** This research was carried out via factorial experiment based on randomized complete blocks design with three replications along 2013-2014 agronomic years. The Main plot included nitrogen fertilizer at four levels (nonuse of fertilizer 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 measured traits was significant. Assessment result of mean comparison of different level of nitrogen revealed maximum amount of seed yield (5800 kg.ha$^{-1}$), biologic yield (17210 kg.ha$^{-1}$), harvest index (35.8%), straw yield (11410 kg.ha$^{-1}$), number of spike per m2 (534), number of seed per spike (31), 1000-seed weight (36 gr), number of seed per m2 (15900), number of seed per spikelet (2.4), spike length (17 cm), plant height (91.5 cm), protein (18.4%) was obtained for 150 kg.ha$^{-1}$ nitrogen and minimum amount of mentioned traits were for control treatment. Also mean comparison result of different level of vermicompost indicated the maximum amounts of all measured traits were noted for 10 kg.ha$^{-1}$ and minimum of those belonged to control treatment. Assessment mean comparison result of interaction effect of treatments indicated the maximum amount of all measured traits belonged to 150 kg.ha$^{-1}$ nitrogen and 10 t.ha$^{-1}$ vermicompost and the lowest amounts were for control treatment.

**CONCLUSION:** According result of current research consume 150 kg.ha$^{-1}$ nitrogen fertilizer and 10 t.ha$^{-1}$ vermicompost led to achieve highest amount of seed yield, its components, plant height, spike length and protein concentration and it can be advised to farmers in studied region.

**KEYWORDS:** *Fertilizer, Nutrition, Plant height, Spike length, Straw.*

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## 1. BACKGROUND

Cereals, including wheat and barley, are of primary importance for the food security in the 21st century (Distelfeld *et al.*, 2014). 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). Nitrogen deficiency in the wheat plant may be due to: decrease in fertilizer usage, using organic methods of crop management (David, 1997) and nitrogen consumption in an inappropriate time (Mainard *et al.*, 2001). In these conditions number of seeds per area unit (Modhej and Mojadam, 2006) will be decreased because of decrease in number of spikes per area unit, number of spikelet per spike, number of fertile florets in spikelet, decrease of survival and decrease in fertilization of florets (Peltonen and Peltonen, 1995). Some researches realized nitrogen fertilizer can increase vegetative growth and seed yield. A desirable increase of nitrogen can expand the most important factor of seed yield, number of seeds per spike (Fang *et al.*, 2010; Khalilzadeh *et al.*, 2013). Modhej and Mojadam (2006) reported that, biological yield is one of the traits which deeply decrease when nitrogen decrease. The redistribution of the substances stored in transient sources to the sink organs is called remobilization (Gardner *et al.*, 2003). Some researchers reported the increase of nitrogen causes a significant increase of the number of tillers per plant and fertilized tillers, leaves surface and durability of flag leaf, biological yield, number of spike per square meter and number of seeds per spike and the positive and significant effects of these traits on the seed yield, also a positive correlation between the number of seeds per spikelet and the number of spikelet per spike with the seed yield (Ehdaie and Waines, 2001; Kumar *et al.*, 2001). Use of renewable resources and inputs is one of the principles of sustainable agriculture which causes maximum utilization and minimum environmental risks (Kizilkaya, 2008). Micro organisms as an integral part of the soil are able to improve the growth of their host plant by increasing the solubility of ingredients as well as increasing the absorptive surface of roots especially in soils with low fertility (Azcon and Atrash, 1997). Vermi composting technology involves the bio-conversion of organic waste into vermicasts and vermiwash utilizing earthworms (Jadia and Fulekar, 2008). These earthworms feed on the waste and their gut act as the bioreactor where the vermicasts are produced. These vermicasts are also termed vermicompost and are rich in nitrogen, phosphorous, potassium and micronutrients (Ansari and Sukhraj, 2010). Effect of these vermicompost on plant growth is well reported but mostly it used as a main source of nitrogen. Increasing the vermicompost quantity also promoted plant growth as well as growth of the cob webs by increasing the zinc and phosphorous like nutrients. Zinc enhances plant growth regulation whilst phosphorous promotes plant growth (Abbasi *et al.,* 2009; Manyuchi *et al.*, 2013a; Manyuchi *et al.,* 2013b). 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). 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). 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*., 2009). Edwards and Arancon (2004) reported that the vermicompost applications suppressed the incidence of the disease significantly. Increasing the level of phosphorous content in the soils also promoted plant growth, high resistance and quality of seed. Furthermore, it was well documented that increasing the application time of both the vermicompost and vermiwash also increased the soil copper, iron and phosphorous content (Nath and Singh, 2012; Manyuchi *et al*., 2013c). This increase in soil nutrient content promoted plant growth and chlorophyll production; hence boost the overall corn growth. In addition, microbial activities was also reported higher in the soil treated by vermicompost and this higher microbial activity also affected the production of plant growth regulators such as cytokinins as well as humic acid which promote plant growth (Gopal *et al.,* 2010; Manyuchi *et al.,* 2013d). 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 (Jabeen and Ahmad, 2017). Several studies have investigated the positive effect of vermicompost on increasing the quantitative and qualitative performance of crops and medicinal plants, including the effect of vermicompost on biological yield, basil, chamomile, forage corn, forage, forage sorghum, artemisia and Joe pointed out (Haj Seyed Hadi *et al.,* 2010). The high humic acid content of the vermicompost causes plants to produce more phenolic compounds which make them as a nutrient chelator (Bevacqual *et al*., 1993). According to the results of Stancheva 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). In an experiment on onion, lettuce, antirrhinum and grass by the application of 0.37 and 74 tons of sewage sludge compost per hectare, the growth of the plants increased significantly (Chang *et al*., 2008). Vermicompost increased fresh weight, plant size, number of leaf, 9%, 8% and 9% respectively more than control. Also it caused to an increase in plant height, length and width of leaf for each plant 8% and 12% respectively (Muhammad *et al*., 2007).

## 2. OBJECTIVES

Current study was conducted to evaluate effect of different level of nitrogen fertilizer and vermicompost on quantitative and qualitative traits of bread wheat.

## 3. MATERIALS AND METHODS

### *3.1. Field and Treatments Information*

This research was carried out to assessment effect of nitrogen and vermicompost on agrophysiological characteristics of wheat crop via 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 | 0-30 (cm) |
|---|---|
| **Ec ($ds.m^{-1}$)** | 2.89 |
| **Soil texture** | Clay loam |
| **pH** | 7.73 |
| **O.C (%)** | 0.71 |
| **N ($mg.kg^{-1}$)** | 7 |
| **P ($mg.kg^{-1}$)** | 8.3 |
| **K ($mg.kg^{-1}$)** | 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 and its components, the two side rows and half a meter of the beginning and end of each plot were eliminated as the marginal effects and finally the ultimate samples were taken from an area of 1 $m^2$. In order to determine the number of spikes per area unit, the spikes were taken from an area of 1 $m^2$ of then three middle lines of each plot after considering half a meter of beginning and end of each line as the margin and after counting the spikes their mean was considered as the number of spikes per area unit. As many as 10 spikes were randomly selected from the middle lines of each plot and the number of seeds was counted carefully and their mean was recorded. Two 500-seed samples were randomly selected from the produced seeds by each plot and if the weight difference of the two samples was less than 5%, the total weight of the two samples was considered as weight of 1000-seed. 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. Harvest index (HI) was calculated according to formula of Gardner *et al.* (1985) as follows:

**Equ.1.** HI= (Seed yield/Biologic yield) ×100.

To measure the nitrogen concentration the Kjeldahl method was used. So, to calculate the protein percentage the following formula was used (Bremner *et al*., 1983): **Equation 2.** Protein percentage= Nitrogen percentage×5.8

*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). Mean comparison result of different level of nitrogen indicated that maximum seed yield (5800 $kg.ha^{-1}$) was noted for 150 $kg.ha^{-1}$ nitrogen and minimum of that (2400 $kg.ha^{-1}$) 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. As for Duncan classification made with respect to different level of vermicompost maximum and minimum amount of seed yield belonged to 10 $t.ha^{-1}$ (6424 $kg.ha^{-1}$) and control (2405 $kg.ha^{-1}$) (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated the maximum seed yield (5944 $kg.ha^{-1}$) was noted for 150 $kg.ha^{-1}$ nitrogen and 10 $t.ha^{-1}$ vermicompost and lowest one (2351 $kg.ha^{-1}$) belonged to control treatment (Table 4). 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). 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.

*4.2. Biologic yield*

Result of analysis of variance revealed effect of different level of nitrogen, vermicompost and interaction effect of treatments on biologic yield was significant at 1% probability level (Table 2). According result of mean comparison maximum of biologic yield (17210 $kg.ha^{-1}$) was obtained for 150 $kg.ha^{-1}$ nitrogen and minimum of that (8003 $kg.ha^{-1}$) was for control treatment (Table 3). Evaluation mean comparison result indicated in different level of vermicompost the maximum biologic yield (18300 $kg.ha^{-1}$) was noted for 10 $kg.ha^{-1}$ and minimum of that (8221 $kg.ha^{-1}$) belonged to control treatment (Table 3). 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).

Assessment mean comparison result of interaction effect of treatments indicated the maximum biologic yield (17950 kg.ha$^{-1}$) belonged to 150 kg.ha$^{-1}$ nitrogen and 10 t.ha$^{-1}$ vermicompost and the lowest one (8128 kg.ha$^{-1}$) was for control treatment (Table 4). Application of vermicompost on wheat increased the content of nutrients in the leaf and resulted in improved photosynthesis and biological yield (Anwar *et al*., 2005).

**Table 2.** Result analysis of variance of measured traits

| S.O.V | df | Seed yield | Biologic yield | Harvest index | Straw yield | No. spike per m$^2$ | No. seed per spike |
|---|---|---|---|---|---|---|---|
| Replication | 2 | 412.4$^{ns}$ | 1131.3$^{ns}$ | 36.4$^{ns}$ | 466.7$^{ns}$ | 9.5.5$^{ns}$ | 88.54$^{ns}$ |
| Nitrogen (N) | 3 | 56321.5$^{**}$ | 112374.2$^{**}$ | 95.5$^{*}$ | 63425.2$^{**}$ | 5643.6$^{**}$ | 378.7$^{**}$ |
| Vermicompost (V) | 3 | 63212.7$^{**}$ | 108976.7$^{**}$ | 99.2$^{*}$ | 61289.5$^{**}$ | 4532.5$^{**}$ | 181.5$^{**}$ |
| N×V | 9 | 48976$^{**}$ | 115493.5$^{**}$ | 257.3$^{**}$ | 66983.6$^{**}$ | 5117.8$^{**}$ | 488.7$^{**}$ |
| Error | 30 | 217.7 | 576.6 | 28.15 | 246.4 | 112.2 | 11.2 |
| CV (%) | - | 11.5 | 13.4 | 3.3 | 8.4 | 7.2 | 4.1 |

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

**Continue Table 2.**

| S.O.V | df | 1000-seed weight | No. seed per m$^2$ | No. seed per spikelet | Spike length | Plant height | Protein |
|---|---|---|---|---|---|---|---|
| Replication | 2 | 311.1$^{ns}$ | 4561.2$^{ns}$ | 3.2$^{ns}$ | 76.3$^{ns}$ | 223.8$^{ns}$ | 10.7$^{ns}$ |
| Nitrogen (N) | 3 | 1231.4$^{**}$ | 132351.4$^{**}$ | 10.6$^{*}$ | 334.8$^{**}$ | 454.7$^{**}$ | 177.2$^{**}$ |
| Vermicompost (V) | 3 | 1345.6$^{**}$ | 136398.5$^{**}$ | 11.5$^{*}$ | 387.5$^{**}$ | 5311$^{**}$ | 173.4$^{**}$ |
| N×V | 9 | 2037.7$^{**}$ | 13757.4$^{**}$ | 20.4$^{**}$ | 411.6$^{**}$ | 7232.2$^{**}$ | 185.5$^{**}$ |
| Error | 30 | 232.6 | 3984.5 | 3.5 | 56.2 | 17.5 | 14.4 |
| CV (%) | - | 5.4 | 6.23 | 6.6 | 3.11 | 7.76 | 3.8 |

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

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).

*4.3. Harvest index*

Harvest index is also an important factor in increasing yield, in grains, the increase in biomass has reached its final limit, hence the increase in seed yield through the allocation of more photosynthetic materials to the sink (seeds) is possible, in which case the harvest index will significantly increase (Krishnan *et al*., 2003). According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on harvest index was significant at 5% and 1% probability level, respectively (Table 2). Assessment mean comparison result indicated in different level of nitrogen the maximum harvest index (35.8 %) was noted for 150 kg.ha$^{-1}$ and minimum of that (30%) belonged to control treatment (Table 3). Compare of different level of vermicompost showed that the maximum and the minimum amount of harvest index belonged to 10 $t.ha^{-1}$ (35%) and control (29.1%) treatments (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum harvest index (34.1%) was noted for 150 $kg.ha^{-1}$ nitrogen and 10 $t.ha^{-1}$ vermicompost and the lowest one (28.8%) belonged to control treatment (Table 4). Veisi Nasab *et al*. (2015) by evaluate the effect of different level of vermicompost on maize production reported maximum harvest index (31.04%) was obtain from consume 12 $t.ha^{-1}$ vermicompost.

*4.4. Straw yield*

Result of analysis of variance revealed effect of different level of nitrogen, vermicompost and interaction effect of treatments on straw yield was significant at 1% probability level (Table 2). Evaluation mean comparison result showed in different level of nitrogen the maximum straw yield (11410 $kg.ha^{-1}$) was noted for 150 $kg.ha^{-1}$ and minimum of that (5603 $kg.ha^{-1}$) belonged to control treatment (Table 3). Between different levels of vermicompost the maximum straw yield (11876 $kg.ha^{-1}$) was observed in 10 $t.ha^{-1}$ and the lowest one (5816 $kg.ha^{-1}$) was found in control treatment (Table 3). Assessment mean comparison result of interaction effect of treatments indicated the maximum straw yield (12010 $kg.ha^{-1}$) belonged to 150 $kg.ha^{-1}$ nitrogen and 10 $t.ha^{-1}$ vermicompost and the lowest one (5800 $kg.ha^{-1}$) was for control treatment (Table 4). Rahman *et al*. (2009) reported that the application of organic manure and chemical fertilizers increased the straw yields of rice.

*4.5. Number of spike per $m^2$*

According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on number of spike per $m^2$ was significant at 1% probability level (Table 2). Mean comparison result of different level of nitrogen indicated the maximum and the minimum amount of number of spike per $m^2$ belonged to 150 $kg.ha^{-1}$ (534) and control treatment (414) (Table 3). Among different level of vermicompost maximum number of number of spike per $m^2$ (543) was obtained for 10 $t.ha^{-1}$ and minimum of that (418) was for control treatment (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum number of spike per $m^2$ (544) was noted for 150 $kg.ha^{-1}$ nitrogen and 10 $t.ha^{-1}$ vermicompost and the lowest one (412) belonged to control treatment (Table 4). The correct and proportional nitrogen application rate of fertilizers increases wheat grain yield by increasing the number of spikes per unit area, and increasing the number of seeds per spike has a lower role in raising the yield (Fowler and Brydon, 2001). Researchers reported that the increase in nitrogen consumption increases the number of spikes per unit area, which can increase vegetative growth and, consequently, increase the amount of tillering due to nitrogen consumption. In such a situation, the number of fertilized tillers per unit area increases and the number of spikes per unit area also increases (Mosanaei *et al*., 2017).

*4.6. Number of seed per spike*

Result of analysis of variance revealed effect of different level of nitrogen, vermicompost and interaction effect of treatments on number of seed per spike was significant at 1% probability level (Table 2). Mean comparison result of different level of nitrogen indicated the maximum number of seed per spike (31) was obtained for 150 $kg.ha^{-1}$ and minimum of that (22) was for control treatment (Table 3).

**Table 3.** Mean comparison effect of different level of nitrogen and vermicompost on measured traits

| Treatment | Seed yield ($kg.ha^{-1}$) | Biologic yield ($kg.ha^{-1}$) | Harvest index (%) | Straw yield ($kg.ha^{-1}$) | No. spike per $m^2$ | No. seed per spike |
|---|---|---|---|---|---|---|
| **Nitrogen** | | | | | | |
| $N_1$ | $2400^d$ | $8003^d$ | $30^c$ | $5603^d$ | $414^d$ | $22^c$ |
| $N_2$ | $3150^c$ | $9500^c$ | $33.3^{ab}$ | $6350^c$ | $455^c$ | $23^{bc}$ |
| $N_3$ | $4500^b$ | $12500^b$ | $33.2^{ab}$ | $8012^b$ | $515^b$ | $27^b$ |
| $N_4$ | $5800^a$ | $17210^a$ | $35.8^a$ | $11410^a$ | $534^a$ | $31^a$ |
| **Vermicompost** | | | | | | |
| $V_1$ | $2405^d$ | $8221^d$ | $29.1^c$ | $5816^d$ | $418^d$ | $23^c$ |
| $V_2$ | $3200^c$ | $11100^c$ | $29.3^c$ | $7900^c$ | $478^c$ | $25^b$ |
| $V_3$ | $4507^b$ | $14012^b$ | $32.2^b$ | $9505^b$ | $519^b$ | $29^{ab}$ |
| $V_4$ | $6424^a$ | $18300^a$ | $35^a$ | $11876^a$ | $543^a$ | $32^a$ |

*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 $t.ha^{-1}$.

**Continue Table 3.**

| Treatment | 1000-seed weight (gr) | No. seed per $m^2$ | No. seed per spikelet | Spike length (cm) | Plant height (cm) | Protein (%) |
|---|---|---|---|---|---|---|
| **Nitrogen** | | | | | | |
| $N_1$ | $27^d$ | $8820^d$ | $1.4^b$ | $13^c$ | $74.5^d$ | $13.1^d$ |
| $N_2$ | $30^c$ | $10465^c$ | $1.5^b$ | $14^{bc}$ | $78.6^c$ | $15.3^c$ |
| $N_3$ | $32^b$ | $13905^b$ | $1.9^{ab}$ | $15.5^b$ | $83.3^b$ | $17.5^b$ |
| $N_4$ | $36^a$ | $15900^a$ | $2.4^a$ | $17^a$ | $91.5^a$ | $18.4^a$ |
| **Vermicompost** | | | | | | |
| $V_1$ | $25^d$ | $9522^d$ | $1.5^b$ | $12.6^c$ | $73^c$ | $10.9^c$ |
| $V_2$ | $27^c$ | $11925^c$ | $1.6^b$ | $13.4^{bc}$ | $75.4^{bc}$ | $11.4^{bc}$ |
| $V_3$ | $31^b$ | $14532^b$ | $2.1^{ab}$ | $16.1^b$ | $85.2^b$ | $13.1^b$ |
| $V_4$ | $37^a$ | $16678^a$ | $2.3^a$ | $18.3^a$ | $92.3^a$ | $14.3^a$ |

*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 $t.ha^{-1}$.

Compare different level of vermicompost showed that the maximum and the minimum amount of number of seed per spike belonged to 10 $t.ha^{-1}$ (32) and control (23) treatments (Table 3). Assessment mean comparison result of interaction effect of treatments indicated the maximum number of seed per spike (33) belonged to 150 $kg.ha^{-1}$ nitrogen and 10 $t.ha^{-1}$ vermicompost and the lowest one (20) was for control treatment (Table 4). According to the research of Mosanaei *et al*. (2017), the effect of nitrogen fertilizer on the number of wheat spikes was significant, which was consistent with the results of the present study. Nitrogen increases the biomass production 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).

### *4.7. 1000-seed weight*

According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on 1000-seed weight was significant at 1% probability level (Table 2). Mean comparison result of different level of nitrogen showed the maximum 1000-seed weight (36 gr) was observed in 150 kg.ha$^{-1}$ and the lowest one (27 gr) was found in control treatments (Table 3). Between different levels of vermicompost highest value of 1000-seed weight was belonged to the 10 t.ha$^{-1}$ treatment (37 gr) and the lowest one was found in the control treatment as 25 gr (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum 1000-seed weight (39 gr) was noted for 150 kg.ha$^{-1}$ nitrogen and 10 t.ha$^{-1}$ vermicompost and the lowest one (24 gr) belonged to control treatment (Table 4). Sadeghi and Kazemeini (2011) reported increasing the amount of nitrogen application increased the weight of 1000-seed in barley varieties. Since nitrogen fertilizer increases dry matter production and leaf area, barley seed also became heavier with increasing nitrogen application.

### *4.8. Number of seed per m$^2$*

Result of analysis of variance revealed effect of different level of nitrogen, vermicompost and interaction effect of treatments on number of seed per m$^2$ was significant at 1% probability level (Table 2). Mean comparison result of different level of nitrogen indicated the maximum number of seed per m$^2$ (15900) was obtained for 150 kg.ha$^{-1}$ and minimum of that (8820) was for control treatment (Table 3). Compare different level of vermicompost showed that the maximum and the minimum amount of number of seed per m$^2$ belonged to 10 t.ha$^{-1}$ (16678) and control (9522) treatments (Table 3). Assessment mean comparison result of interaction effect of treatments indicated the maximum number of seed per m$^2$ (16289) belonged to 150 kg.ha$^{-1}$ nitrogen and 10 t.ha$^{-1}$ vermicompost and the lowest one (9171) was for control treatment (Table 4).

### *4.9. Number of seed per spikelet*

According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on number of seed per spikelet was significant at 5% and 1% probability level, respectively (Table 2). Mean comparison result of different level of nitrogen revealed the maximum number of seed per spikelet (2.4) was observed in 150 kg.ha$^{-1}$ and the lowest one (1.4) was found in control treatments (Table 3). Between different levels of vermicompost highest value of number of seed per spikelet was belonged to the 10 t.ha$^{-1}$ treatment (2.3) and the lowest one was found in the control treatment as 1.5 (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum number of seed per spikelet (2.7) was noted for 150 kg.ha$^{-1}$ nitrogen and 10 t.ha$^{-1}$ vermicompost and the lowest one (1.35) belonged to control treatment (Table 4).

### *4.10. Spike length*

Result of ANOVA indicated effect of different level of nitrogen, vermicompost and interaction effect of treatments on spike length was significant at 1% probability level (Table 2). Compare different level of nitrogen indicated the maximum spike length (17 cm) was obtained for 150 kg.ha$^{-1}$ and minimum of that (13 cm) was for control treatment (Table 3). Compare different level of vermicompost showed that the maximum and the minimum amount of spike length belonged to 10 t.ha$^{-1}$ (18.3 cm) and control (12.6 cm) treatments (Table 3). Assessment mean comparison result of interaction effect of treatments indicated the maximum spike length (18.9 cm) belonged to 150 kg.ha$^{-1}$ nitrogen and 10 t.ha$^{-1}$ vermicompost and the lowest one (12.8 cm) was for control treatment (Table 4).

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

| Treatment | | Seed yield (kg.ha$^{-1}$) | Biologic yield (kg.ha$^{-1}$) | Harvest index (%) | Straw yield (kg.ha$^{-1}$) | No. spike per m$^2$ | No. seed per spike |
|---|---|---|---|---|---|---|---|
| $N_1$ | $V_1$ | 2351$^{e}$ | 8128$^{f}$ | 28.8$^{e}$ | 5800$^{f}$ | 412$^{e}$ | 20$^{e}$ |
| | $V_2$ | 2840$^{de}$ | 9303$^{e}$ | 29.85$^{d}$ | 6675$^{de}$ | 448$^{d}$ | 23$^{d}$ |
| | $V_3$ | 3510$^{cd}$ | 11028$^{d}$ | 31.38$^{c}$ | 7525$^{d}$ | 469$^{c}$ | 24.5$^{cd}$ |
| | $V_4$ | 4436$^{bc}$ | 13250$^{bc}$ | 32.60$^{bc}$ | 8825$^{c}$ | 480$^{bc}$ | 26$^{bc}$ |
| $N_2$ | $V_1$ | 2876$^{de}$ | 8900$^{e}$ | 32.50$^{bc}$ | 6025$^{e}$ | 430$^{d}$ | 22$^{e}$ |
| | $V_2$ | 3345$^{d}$ | 10240$^{de}$ | 32.40$^{bc}$ | 6950$^{de}$ | 466$^{c}$ | 24$^{cd}$ |
| | $V_3$ | 3950$^{c}$ | 11750$^{d}$ | 32.55$^{bc}$ | 7800$^{d}$ | 487$^{b}$ | 25.5$^{c}$ |
| | $V_4$ | 4900$^{b}$ | 14110$^{b}$ | 34.90$^{b}$ | 9100$^{bc}$ | 497$^{b}$ | 27$^{b}$ |
| $N_3$ | $V_1$ | 3520$^{cd}$ | 10400$^{de}$ | 33.10$^{b}$ | 6910$^{de}$ | 465$^{c}$ | 25$^{c}$ |
| | $V_2$ | 3951$^{c}$ | 11750$^{c}$ | 33.45$^{b}$ | 7803$^{d}$ | 496$^{b}$ | 26$^{bc}$ |
| | $V_3$ | 4553$^{b}$ | 13250$^{bc}$ | 34.42$^{ab}$ | 8720$^{c}$ | 517$^{ab}$ | 27.5$^{b}$ |
| | $V_4$ | 5227$^{ab}$ | 15400$^{ab}$ | 35.80$^{a}$ | 9950$^{bc}$ | 527$^{ab}$ | 29$^{ab}$ |
| $N_4$ | $V_1$ | 4000$^{bc}$ | 12855$^{c}$ | 32.30$^{bc}$ | 8653$^{c}$ | 470$^{c}$ | 26.5$^{bc}$ |
| | $V_2$ | 4550$^{b}$ | 14200$^{b}$ | 32.11$^{bc}$ | 9621$^{bc}$ | 503$^{b}$ | 28$^{b}$ |
| | $V_3$ | 5204$^{ab}$ | 15700$^{ab}$ | 33.40$^{b}$ | 1045$^{b}$ | 525$^{ab}$ | 29$^{ab}$ |
| | $V_4$ | 5944$^{a}$ | 17950$^{a}$ | 34.1$^{ab}$ | 12010$^{a}$ | 544$^{a}$ | 33$^{a}$ |

*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$^{-1}$.

**Continue Table 4.**

| Treatment | | 1000-seed weight (gr) | No. seed per m$^2$ | No. seed per spikelet | Spike length (cm) | Plant height (cm) | Protein (%) |
|---|---|---|---|---|---|---|---|
| $N_1$ | $V_1$ | 24$^{g}$ | 9171$^{f}$ | 1.35$^{e}$ | 12.8$^{d}$ | 70$^{d}$ | 10$^{d}$ |
| | $V_2$ | 26$^{fg}$ | 10372$^{d}$ | 1.5$^{d}$ | 13.5$^{c}$ | 73.5$^{cd}$ | 12.3$^{c}$ |
| | $V_3$ | 29$^{d}$ | 11675$^{cd}$ | 1.7$^{c}$ | 14.6$^{bc}$ | 79$^{bc}$ | 13.1$^{bc}$ |
| | $V_4$ | 30$^{cd}$ | 12749$^{c}$ | 1.9$^{b}$ | 15.2$^{b}$ | 82$^{bc}$ | 13.5$^{bc}$ |
| $N_2$ | $V_1$ | 27$^{f}$ | 9993$^{e}$ | 1.55$^{d}$ | 13$^{c}$ | 73$^{cd}$ | 13.1$^{bc}$ |
| | $V_2$ | 28$^{e}$ | 11195$^{cd}$ | 1.6$^{cd}$ | 14$^{bc}$ | 76$^{cd}$ | 13.2$^{bc}$ |
| | $V_3$ | 30.5$^{cd}$ | 12498$^{c}$ | 1.8$^{bc}$ | 15.2$^{b}$ | 83$^{bc}$ | 14$^{b}$ |
| | $V_4$ | 32$^{c}$ | 13571$^{bc}$ | 2$^{b}$ | 16$^{ab}$ | 86$^{b}$ | 14.5$^{b}$ |
| $N_3$ | $V_1$ | 27.5$^{f}$ | 11713$^{cd}$ | 1.7$^{c}$ | 14.1$^{bc}$ | 74$^{cd}$ | 14$^{b}$ |
| | $V_2$ | 29.5$^{d}$ | 12915$^{c}$ | 1.8$^{bc}$ | 14.5$^{bc}$ | 80$^{bc}$ | 14.5$^{b}$ |
| | $V_3$ | 31.4$^{c}$ | 14219$^{b}$ | 1.9$^{b}$ | 16$^{ab}$ | 85.5$^{b}$ | 15.3$^{ab}$ |
| | $V_4$ | 34$^{b}$ | 15292$^{ab}$ | 2.2$^{ab}$ | 18.5$^{a}$ | 92$^{ab}$ | 16$^{ab}$ |
| $N_4$ | $V_1$ | 29.5$^{de}$ | 12111$^{c}$ | 1.8$^{bc}$ | 15$^{b}$ | 78$^{c}$ | 14.5$^{b}$ |
| | $V_2$ | 32$^{c}$ | 13912$^{bc}$ | 1.95$^{b}$ | 16$^{ab}$ | 84$^{b}$ | 15$^{ab}$ |
| | $V_3$ | 35$^{b}$ | 15206$^{ab}$ | 2.2$^{ab}$ | 18.5$^{a}$ | 92$^{ab}$ | 15.5$^{ab}$ |
| | $V_4$ | 39$^{a}$ | 16289$^{a}$ | 2.7$^{a}$ | 18.9$^{a}$ | 94$^{a}$ | 18.9$^{a}$ |

*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$^{-1}$.

Sirjastava and Mehrotra (1981) reported nitrogen fertilizer increased the spike length. The results of some researchers such as Sirvastava and Mehrotra (1981) and Mosanaei *et al.* (2017) are in agreement with results of the present study.

*4.11. Plant height*

According result of ANOVA effect of different level of nitrogen, vermicompost and interaction effect of treatments on plant height was significant at 1% probability level (Table 2).

Mean comparison result of different level of nitrogen revealed the maximum plant height (91.5 cm) was observed in 150 $kg.ha^{-1}$ and the lowest one (74.5 cm) was found in control treatments (Table 3). Song and Yao (2001) found that application of NPK fertilizer increased the height of wheat plant compared with control treatment. Increase in plant height in response to recommended dose of fertilizer might be primarily due to the improved vegetative growth and supplementary contribution of nitrogen (Awan *et al*., 2011). The nitrogen fertilizer showed a significant effect on wheat plant height in the present study that is in agreement with the results reported be Moghadam *et al*. (1997). Increasing nitrogen application increases the protein content of the cells, as a result cell size increases; consequently, the leaf area is enlarged, followed by photosynthetic activity and ultimately leads to an increase in plant height (Wysocki *et al*., 2007). Between different levels of vermicompost highest value of plant height was belonged to the 10 $t.ha^{-1}$ treatment (92.3 cm) and the lowest one was found in the control treatment as 73 cm (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum plant height (94 cm) was noted for 150 $kg.ha^{-1}$ nitrogen and 10 $t.ha^{-1}$ vermicompost and the lowest one (70 cm) belonged to control treatment (Table 4). Agrawal *et al*. (2003) found that the increase in soil organic matter content through the application of farm yard manure in wheat increased plant height.

### *4.12. Protein*

According result of analysis of variance effect of different level of nitrogen, vermicompost and interaction effect of treatments on protein was significant at 1% probability level (Table 2). Mean comparison result of different level of nitrogen indicated that maximum protein (18.4%) was noted for 150 $kg.ha^{-1}$ nitrogen and minimum of that (13.1%) 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). As for Duncan classification made with respect to different level of vermicompost maximum and minimum amount of protein belonged to 10 $t.ha^{-1}$ (14.3%) and control (10.9%) (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated the maximum protein (18.9%) was noted for 150 $kg.ha^{-1}$ nitrogen and 10 $t.ha^{-1}$ vermicompost and lowest one (10%) belonged to control treatment (Table 4).

## 5. CONCLUSION

According result of current research consume 150 $kg.ha^{-1}$ nitrogen fertilizer and 10 $t.ha^{-1}$ vermicompost led to achieve highest amount of seed yield, its components, plant height, spike length and protein concentration and it can be advised to farmers in studied region.

## ACKNOWLEDGMENT

The author thanks all colleagues and other participants, who took part in the study.

## FOOTNOTES

**AUTHORS' CONTRIBUTION**: Author design and conducted alone.

**CONFLICT OF INTEREST**: There is no conflict of interest.

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