EFFECT OF MINERAL AND BIOLOGICAL FERTILIZERS ON THE QUANTITATIVE AND THE QUALITATIVE PARAMETERS OF RICE CULTIVARS

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Abstract: The efficient use and management of organic matter are important aspects of sustainable agriculture. The quality of organic matter is relatively low in most of soils in Iran and the continuous use of mineral fertilizers may create environmental hazards. Therefore, the aim of this study was to evaluate the impact of combined use of mineral fertilizers along with organic manures on the rice production. The experiments were conducted in a randomized complete blocks design (RCBD) with factorial treatments, in three replicates, in two local rice cultivars in North Iran, in 2016. Two local rice cultivars, Tarom Hashemi and Tarom Mahalli, were chosen as the first factor; mineral fertilizers in four levels 100% recommended NPK, 75% recommended nitrogen with 100% PK, 75% recommended phosphorous with 100% NK, and 75% recommended potassium with 100% NP were selected based on soil analysis and were arranged as the second factor; and three levels of bio-fertilizer 0 and 8 ton vermi-compost per hectare and 10 ton of rotted manure per hectare were the third factor. Results revealed that the highest paddy yield occurs with cultivar and bio-fertilizer interaction involving vermi-compost and manure usage for both cultivars. The highest paddy yield (3962 kg ha^{-1}) occurs with 100% recommended NPK and vermi-compost consumption. The highest amount of gel consistency for *cv.* Tarom Hashemi was observed with 100 of NPK and 75% of recommended nitrogen and manure consumption. The maximum amylose content for *cv.* Tarom Mahalli was produced with 100% NPK recommended and manure consumption. Therefore, it can be concluded that by the integrated consumption of mineral and biological fertilizers, farmers can significantly reduce impacts of chemical fertilizers on the environment, and improve the qualitative and the quantitative parameters of rice cultivars with biological fertilizers.
Keywords: *amylose content, grain length, paddy yield, randomized complete blocks design (RCBD), vermi-compost*

Introduction

Rice (*Oryza sativa* L.) is one of the most important staple foods for nearly half of the world's population, most of them living in developing countries such as for example Iran. In Iran, rice is the second most widely consumed cereal next to wheat (Pishgar-Komleh et al., 2011). According to official statistics released by the food and agriculture organization (FAO), global area under rice cultivation has increased from 145 million hectares to over 160 million hectares during the past few years (FAO, 2016). Iran with 550 thousand hectares of paddy field and two million tons of white rice production has 0.4% of total rice production and cultivation area in the world. About 75% of the cultivation area lies to the northern strip, which includes the provinces of Guilan, Mazandaran and Golestan. The 25% of the cultivation area is situated in 13 additional provinces that possess different climates (Ministry of Jihad-e-Agriculture of Iran, 2016).

Chemical fertilizers consumption is now widespread in Iran for supplementing plant nutrients. Manufacturers fabricate chemical fertilizers from inorganic materials, to increase the potential of natural and organic nutrients. Many heavy metals are present as impurities in varying amounts in such chemical fertilizers. The present planting system in Iran is totally dependent on the use of chemical fertilizers, pesticides, and growth regulators for enhancing crop productivity. However, the production gap in major food crops still remains even after intensive use of chemical fertilizers and pesticides for about 50-60 years in Iranian agriculture. In addition, agricultural lands have been reduced and there is a greater threat to soil resources due to changes in the global environment. Of late these problems have started attracting attention. Utilization of farmyard manure seems to be the most effective measure for this purpose (Ministry of Jihad-e-Agriculture of Iran, 2016).

Nitrogen, phosphorous, and potassium are the major elements essential for plant growth and development. To date use of chemical fertilizers has been confined mainly to the application of nitrogen and phosphorous and due attention has not been paid to potassium. Jogloy et al. (2006) reported that the application of animal manure plus chemical fertilizers gave the highest chlorophyll in *Helianthus tuberosus*, Xu et al. (2008) found that the application of organic manure with chemical fertilizers increases the yield more than using just chemical fertilizers because this combination increases nitrogen use efficiency of rice. Pazouki et al. (2017) demonstrate NPK have a high energy consumption and greenhouse gas emissions which caused the environmental pollution.

Deshpande and Devasenapathy (2010) observed that application of green manure along with farmyard manure (FYM) and poultry manure significantly increased protein and carbohydrate content in rice. Roy and Singh (2006) also reported similar results in barley with vermi-compost applications.

Metwally (2015) reported that the integrate use of organic materials and inorganic fertilizers significantly increase the yield and yield contributing characters of Egyptian rice cultivar Giza 179. The highest values of yield, yield parameters, and grain quality characters were observed when urea was used with compost as compared to mineral fertilizer alone. Mineral nitrogen combined with farmyard manure or compost could increase soil organic matter content. Moreover, integrated use of inorganic, organic, and bio-fertilizers positively affect rice yield and its attributes (Elekhtyar et al., 2016). Ghosh and Sharma (1999) reported that application of 10 tons manure per hectare combined with urea fertilizer has a beneficial effect on rice growth and yield in the farm conditions. In the second year, the yield obtained from the use of animal manure was similar to consumption of 40 kg N.ha^{-1}. Moreover, the highest grain yield was produced with application of manure and 40 kg N.ha^{-1}. Regmi et al. (2002) found that rice yield with consumption of four ton farmyard manure per hectare and application of nitrogen-phosphorous-potassium (NPK) was more than other treatments. Rekhi et al. (2004) reported that average rice grain yield with integrated application of farm yard manure and application of NPK fertilizer (80, 30, and 30 kg ha^{-1} respectively) was higher than other treatments.

Hence, the aims of study were (1) to formulate organic fertilizers with different known organic sources like cow manure, poultry manure, and rice straw as well as husk, and (2) to study the effect of organic fertilizers alone and in combination with chemical fertilizers, and compare these with recommended doses of chemical fertilizers (i.e. NPK) on soil chemical properties under rice cultivation for two consecutive years.

Material and methods

Description of the experimental site

Experiments were conducted in 2015 and 2016 in the paddy fields in the Iran Rice Research Institute between Alborz Mountains range and the Caspian Sea in Mazandaran and Guilan provinces in north of Iran. The experimental region is geographically situated at 36°31' N latitude and 52°27' E longitude, west of the meridian, and is 78 m above sea level. The soil property of the experiment site is shown in *Table 1*. The most important climatic parameters of the three sites during the rice growth period are shown in *Table 1*. Solar radiation (MJ m^{-2} d^{-1}) was estimated by the *Srad_calc* program and sunshine hours were estimated by the *PP_calc* program (https://sites.google.com/site/CropModeling).

***Table 1.** Description of climate parameters and soil properties in Amol region and description of name, origin and other characteristics of rice cultivars in the experiment*

Site	Min. temp. (°C)	Max. temp. (°C)	Mean. temp. (°C)	Evaporation (mm)	Rain (mm)	Mean humidity (%)	Mean sunshine hours	Solar radiation (MJ m^{-2} d^{-1})
Apr.	10.8	18.6	14.7	63.2	99.3	77	123.6	13.5
May	16.4	24.8	20.6	85.9	41.4	78	140.9	15.9
Jun.	19.9	27.8	23.8	121.8	24.6	80	232.8	21.1
Jul.	22.3	30.7	26.5	130.2	39.6	79	203.0	19.7
Aug.	22.5	33.1	27.8	142.3	11.4	76	232.5	20.2
Sep.	21.6	31.0	26.3	113.9	88.5	65	193.0	16.5
Mean 15 years	18.5	26.9	32.2	120.8	93.4	77.5	182.7	17.9
Cultivar	**Growth condition**	**Maturity condition**	**Growth period**	**Paddy yield (kg ha^{-1})**	**Quality condition**	**Tolerance to stress**	**Type**	**Origin**
cv. Tarom Hashemi	Tall plant	Early maturing	118 days	4100	High quality	Little sensitive	Local cultivar	Iran
cv. Tarom Mahalli	Tall plant	Early maturing	123 days	3600	High quality	Sensitive	Local cultivar	Iran
Soil properties	**Depth (cm)**	**Texture**	**EC (dSm^{-1})**	**pH**	**Organic matter (%)**	**Phosphorus (mg kg^{-1})**	**Potassium (mg kg^{-1})**	**CEC (%)**
Amol region	0-30	Clay loam	0.96	7.5	1.8	9.2	165	7.4

Description of the experiment

The experiment was carried out based on a randomized complete blocks design (RCBD) with factorial treatment by three replications. Two local rice cultivars, Tarom Hashemi and Tarom Mahalli, were chosen as the first factor; mineral fertilizer in four levels 100% recommended NPK, 75% recommended nitrogen with 100% PK, 75% recommended phosphorous with 100% NK, and 75% recommended potassium with 100% NP were selected based on soil analysis and arranged as the second factor; and three levels of bio-fertilizer 0, and 8 ton vermi-compost per hectare and 10 ton rotted manure per hectare were the third factor. Nitrogen, phosphorous, and potassium

fertilizers were applied according to the suggestions of the Iran Rice Research Institute and the results of soil analysis. The profile of the genotypes is shown in *Table 1*. Description of the site subsections (a map of the experimental region and a photo of the experimental blocks) are showed in *Figures 1* and *2*.

Figure 1. Description of the site subsections (a map of the experimental region)

Figure 2. Description of the site subsection (a photo of the experimental blocks)

Considering the regional climates, seedlings were transplanted in 3-4 leaf stages. Considering the type of the cultivar, the transplanting operation was done in all the three regions with similar situations. The size of each plot was decided as 3×4 m^2, and planting density was 16 plants per square meter by 25×25 cm^2 arrangement. All of the phosphorus and one third of the nitrogen fertilizer were used as basal in paddy field preparation stage. Two thirds of the nitrogen fertilizer was used as top-dressing in

panicle initiation and full heading stages. Sixty percent of potassium fertilizer was used as basal and the remaining amount was used as top-dressing in tillering and panicle initiation stages (splitting to 20% in each stage). Moreover, depth of irrigation water was set at five centimetres according to agricultural principles. In order to prevent the growth of weeds and the mixing of water and fertilizer in paddy fields, nylon plastic covers were put at the borders up to the depth of 30 cm.

Crop protection practices, such as irrigation, weeding, pests and disease controls, and fertilization, were done in the experiment paddy field based on technical instruction of the Iran Rice Research Institute. Other agricultural operations and field management were done according to the Standard Evaluation System (SES) of the International Rice Research Institute (IRRI).

Evaluation traits

Agronomical traits

During the growth period, after the removal of marginal effect in each site, traits were randomly measured according to the Standard Evaluation System (SES) of the International Rice Research Institute (IRRI). Thus, 10 hills per plant were randomly selected from each experimental plot and their average was analyzed.

In order to quantitatively determine the morphological traits, sampling was done 30 days after full heading stage from 12 stems selected from four hills per plant in each experimental plot. Number of tillers per hill was counted by 12 hills per plant in each experimental plot. The number of spikelet per panicle and number of filled spikelet per panicle were measured by counting from 15 panicles in each experimental plot.

Paddy yield and biological yield were measured by harvesting hills from four square meters in the middle part of each plot based on 12% moisture. From the relationship between paddy yield and biological yield, the harvest index was calculated and expressed in percentage.

Determination of grain quality traits

The qualitative traits of rice grain such as grain amylose content, gelatinization temperature, gel consistency, grain length before and after baking, grain width after cooking, grain elongation, conversion efficiency, aroma, brown rice, and healthy and broken grain percentage were measured by the Standard Evaluation System (SES) of the International Rice Research Institute (IRRI).

Statistical analysis

Aftat first, normalization and Kaiser-Meyer-Olkin (KMO) were test. After that, all the investigated data (agronomical and grain quality traits) were statistically analyzed for analysis of variance (ANOVA) using SAS ver. 9.1 software program. The averages so obtained were compared by Least Significant Differences (LSD) test at 5% probability level.

Results and discussion

In order to evaluate these traits, the obtained data was analyzed using variance homogeneity test by the Bartlett method. The results showed that the traits were not

significant in Bartlett's test. Therefore, data analysis was performed based on combined analysis.

Agronomical traits

Data concerning quantitative parameters is presented in *Table 2*. Combined variance analysis of agronomical traits indicates that filling all of these traits demonstrates significant difference under the effect of year, mineral fertilizer, and bio-fertilizer at 1% and 5% probability level respectively. But, under the effect of cultivar, only number of tiller per hill, and number of filled spikelet per panicle revealed significant differences. Moreover, at double interaction of year and cultivar, number of tiller per hill was significant at 1% probability. But, number of spikelet per panicle and number of filled spikelet per panicle showed significant difference ($P \leq 0.05$) at double interaction of cultivar and mineral fertilizer. Only number of tiller per hill appeared significant under the effect of cultivar and bio-fertilizer interaction. A long with number of tiller per hill, number of spikelet per panicle and number of filled spikelet per panicle showed significant differences ($P \leq 0.05$; $P \leq 0.01$) at double interaction of mineral fertilizer and bio-fertilizer (*Table 2*). At triple interaction of year with cultivar and mineral fertilizer, significant differences occurred at 5% probability level for number of spikelet per panicle and number of filled spikelet per panicle. Moreover, triple interaction of cultivar with mineral fertilizer and bio-fertilizer had a significant effect ($P \leq 0.05$; $P \leq 0.01$) on number of spikelet per panicle, number of filled spikelet per panicle, and number of blank spikelet per panicle (*Table 2*).

Table 2. *Combined analysis of variance (ANOVA) of agronomical traits, quantities yield and harvest index of rice cultivar under chemical fertilizer and bio-fertilizer*
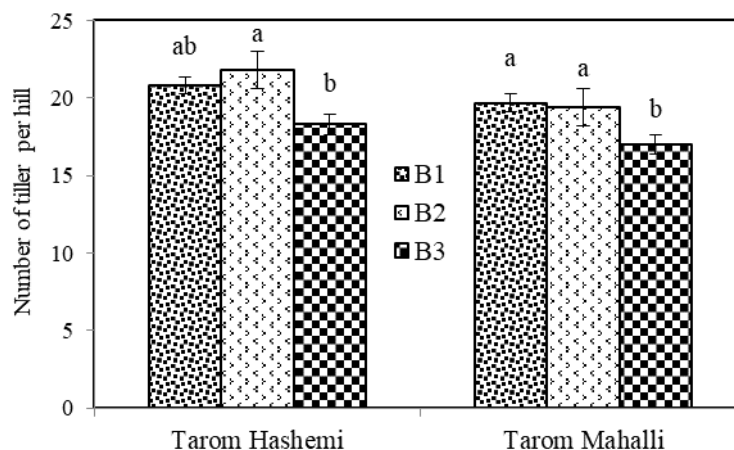
S.O.V.	DF	Number of tiller per hill	Number of spikelet per panicle	Number of filled spikelet per panicle	Number of blank spikelet per panicle	Paddy yield	Harvest index
Year (Y)	1	9.51^*	457.57^{**}	671.80^{**}	20.51^{**}	44519.59^{ns}	0.07^{ns}
Y (R)	4	11.19	24.12	31.44	1.75	37618.30	2.08
Variety (V)	1	91.84^{**}	43.79^{ns}	72.92^*	3.55^{ns}	1694166.90^{**}	2.14^{ns}
Chemical F. (C)	3	22.90^{**}	435.32^{**}	617.54^{**}	17.62^{**}	932104.34^{**}	1.80^{ns}
Bio-fertilizer (B)	2	124.53^{**}	941.60^{**}	1471.26^{**}	61.66^{**}	2761965.98^{**}	1.09^{ns}
Y×V	1	9.51^*	18.84^{ns}	34.45^{ns}	2.34^{ns}	4764.22^{ns}	0.54^{ns}
Y×C	3	3.73^{ns}	15.42^{ns}	25.93^{ns}	1.78^{ns}	40921.87^{ns}	0.02^{ns}
Y×B	2	2.19^{ns}	2.92^{ns}	9.96^{ns}	2.66^{ns}	22856.21^{ns}	3.18^{ns}
V×C	3	0.99^{ns}	70.97^*	73.19^*	1.43^{ns}	62077.76^{ns}	4.87^{ns}
V×B	2	5.53^*	5.62^{ns}	13.12^{ns}	1.65^{ns}	139634.07^*	5.64^{ns}
C×B	6	8.19^{**}	58.71^*	65.93^*	5.86^*	80426.99^*	19.92^{**}
Y×V×C	3	3.73^{ns}	71.65^*	74.01^*	0.16^{ns}	25564.56^{ns}	0.90^{ns}
Y×V×B	2	2.19^{ns}	11.48^{ns}	14.17^{ns}	0.21^{ns}	1597.59^{ns}	0.79^{ns}
Y×C×B	6	2.19^{ns}	32.25^{ns}	31.48^{ns}	0.77^{ns}	8247.64^{ns}	0.67^{ns}
V×C×B	6	3.79^{ns}	81.12^{**}	69.61^*	5.39^*	25175.47^{ns}	5.14^{ns}
Y×V×C×B	6	2.19^{ns}	11.32^{ns}	11.76^{ns}	1.69^{ns}	6249.49^{ns}	0.84^{ns}
Error	92	2.32	24.59	24.88	2.12	29014.78	3.43
C.V. (%)	-	7.81	4.86	5.40	15.10	4.90	3.90

ns, * and **: non significant and significant in 5 % and 1 % probability level, respectively

At double interaction of year and cultivar, most tillers per hill were measured in the first year for *cv.* Tarom Hashemi. The least number of tillers per hill were produced in both years for *cv.* Tarom Hashemi (*Fig. 3*). Furthermore, at double interaction of cultivar and bio-fertilizer the maximum number of tiller per hill was obtained for *cv.* Tarom Hashemi with 8 ton vermi-compost per hectare; the maximum tiller for *cv.* Tarom Mahalli was produced with 8 ton vermi-compost per hectare and 10 ton rotted manure per hectare. The lowest number of tiller per hill for both cultivars was obtained in control treatment (*Fig. 4*).
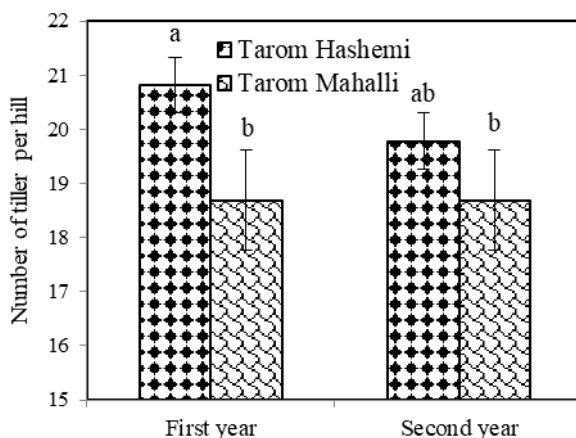
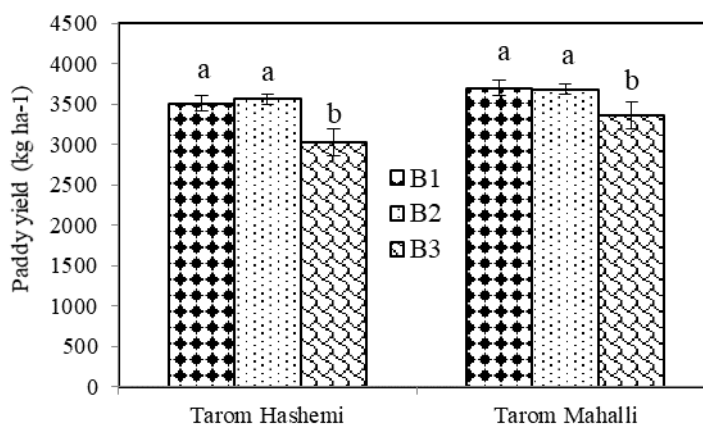*Figure 3. Double interaction of year and cultivar on the number of tiller per hill*

Figure 4. Mean comparison of cultivar and bio-fertilizer on the number of tiller per hill by slice interaction. (B₁, B₂, and B₃: 0 and 8 ton vermi-compost per hectare and 10 ton of rotted manure per hectare, respectively)

Slice interaction of cultivar, mineral fertilizer, and bio-fertilizer demonstrated that the highest spikelets per panicle and number of filled spikelets per panicle were obtained for *cv.* Tarom Hashemi with application of 100% recommended NPK, and 8 ton vermi-compost, and 10 ton manure per hectare, and interaction of 75% recommended phosphorous with 10 ton vermi-compost consumption. The findings of *cv.* Tarom Mahalli cultivar were different from *cv.* Tarom Hashemi: the highest number

of spikelets per panicle and number of filled spikelets per panicle were observed by application of 100% recommended NPK, and 75% recommended N and K. The least number of spikelet per panicle were obtained for both cultivars in the control level of bio-fertilizer with 75% recommended N and K. Moreover, for *cv.* Tarom Hashemi 75% recommended phosphorous with control treatment of bio-fertilizer showed lowest spikelets per panicle. The lowest number of filled spikelets per panicle for *cv.* Tarom Hashemi was obtained at 75% recommended nitrogen and bio-fertilizer control treatment. For *cv.* Tarom Hashemi, the lowest filled spikelet per panicle was produced with application of 75% recommended N and K in bio-fertilizer control treatment (*Table 6*). The result was varied in terms of number of blank spikelets per panicle. The highest number of blank spikelets per panicle for *cv.* Tarom Hashemi were measured with application of 75% recommended N and K in bio-fertilizer control treatment. But the blankest spikelets for *cv.* Tarom Mahalli was obtained at all levels of mineral fertilizer in bio-fertilizer control treatment (*Table 6*)

Quantitative yield and harvest index

Combined statistical analysis of the data revealed that paddy yield was significant under the cultivar, mineral fertilizer, and bio-fertilizer treatment at 1% probability level. Also, paddy yield was statistically significant ($P \leq 0.05$) at interaction of cultivar and bio-fertilizer. Moreover, paddy yield, and harvest index showed significant differences at double interaction of mineral fertilizer and bio-fertilizer (*Table 2*). Mean comparison showed that the highest paddy yield for cultivar and bio-fertilizer interaction belonged to 8 ton vermi-compost and 10 ton manure per hectare for both cultivars. Moreover, the least paddy yield for both cultivars was produced at bio-fertilizer control level (*Fig. 5*). At double interaction of mineral fertilizer and bio-fertilizer, the highest paddy yield was produced for 100% recommended NPK with 8 ton vermi-compost per hectare. The least paddy yield was obtained upon application of 75% recommended P and K and at bio-fertilizer control level (*Table 3*). At double interaction of mineral fertilizer and bio-fertilizer, the highest harvest index was measured with 75% recommended phosphorous usage in bio-fertilizer control treatment. The least harvest index was obtained with 75% recommended phosphorous usage and 10 ton manure per hectare (*Table 3*).

Figure 5. *Mean comparison of cultivar and bio-fertilizer on paddy yield by slice interaction.*
(B$_1$, B$_2$, and B$_3$: 0 and 8 ton vermi-compost per hectare and 10 ton of rotted manure per hectare,
respectively)

Table 3. *Mean comparison of chemical and biological fertilizers on the number of tiller per hill, paddy yield and harvest index by slice interaction*

Interaction	Number of tiller per plant	Paddy yield	Harvest index
C_1B_1	21.50 a	3784 ab	47.27 b
C_1B_2	22.67 a	3962 a	48.06 ab
C_1B_3	17.83 c	3303 bc	48.27 ab
C_2B_1	19.50 abc	3677 ab	48.43 ab
C_2B_2	19.75 abc	3631 ab	46.79 bc
C_2B_3	17.42 c	3264 bcd	46.83 bc
C_3B_1	19.25 abc	3452 bc	45.80 c
C_3B_2	20.33 ab	3451 bc	47.43 b
C_3B_3	18.17 bc	3123 d	49.17 a
C_4B_1	20.67 ab	3508 abc	48.61 ab
C_4B_2	19.67 abc	3452 bc	47.34 b
C_4B_3	17.17 c	3107 d	46.55 bc

Values within a column followed by same letter are not significantly different at LSD ($P \leq 0.05$)
C_1, C_2, C_3, and C_4: 100% recommended NPK, 75% recommended nitrogen with 100% PK, 75% recommended phosphorous with 100% NK, and 75% recommended potassium with 100% NP, respectively
B_1, B_2, and B_3: 0 and 8 ton vermi-compost per hectare and 10 ton of rotted manure per hectare, respectively

Qualitative parameters

Combined variance analysis of qualitative parameters indicates that brown rice, hard husk, white rice, healthy grain, milling efficiency, grain width before cooking, gelatinization temperature, gel consistency, and amylose content showed significant difference under the effect of cultivar at 1% and 5% probability level. Moreover, white rice, soft husk, healthy grain, milling efficiency, grain length before and after cooking, grain elongation, aroma, gelatinization temperature, gel consistency, and amylose content were statistically significant ($P \leq 0.05$; $P \leq 0.01$) under the effect of mineral fertilizer (*Table 4*). Similarly, soft husk, healthy grain, grain length before cooking, gelatinization temperature, gel consistency, and amylose content were significant at 5% and 1% probability level under the effect of bio-fertilizer. Moreover, all qualitative traits except grain width before cooking had significant difference statistically ($P \leq 0.05$; $P \leq 0.01$) at triple interaction of cultivar, mineral fertilizer, and bio-fertilizer (*Table 5*).

Table 4. *Combined analysis of variance (ANOVA) of chlorophyll content and nitrogen, phosphorous and potassium content of grain in rice cultivar under chemical fertilizer and bio-fertilizer*

S.O.V.	DF	Brown rice	Hard husk	White rice	Soft husk	Health grain	Broken grain	Milling efficiency
Year (Y)	1	17.49^{**}	17.49^{**}	6.73^{**}	45.89^{**}	0.71^{ns}	17.49^{**}	6.73^{**}
Y (R)	4	0.07	0.07	1.30	1.66	1.10	0.07	1.30
Variety (V)	1	16.22^{**}	16.22^{**}	14.48^{**}	0.05^{ns}	11.92^{**}	16.22^{**}	14.48^{**}
Chemical F. (C)	3	0.40^{ns}	0.40^{ns}	3.57^{**}	3.59^{**}	6.06^{**}	0.40^{ns}	3.57^{**}
Bio-fertilizer (B)	2	0.24^{ns}	0.24^{ns}	0.50^{ns}	1.42^{*}	1.46^{*}	0.24^{ns}	0.50^{ns}

S.O.V.	DF							
Y×V	1	3.56^{**}	3.56^{**}	2.87^{*}	0.04^{ns}	2.52^{*}	3.56^{**}	2.87^{*}
Y×C	3	0.11^{ns}	0.11^{ns}	0.09^{ns}	0.33^{ns}	1.53^{*}	0.11^{ns}	0.09^{ns}
Y×B	2	0.08^{ns}	0.08^{ns}	0.11^{ns}	0.05^{ns}	0.74^{ns}	0.08^{ns}	0.11^{ns}
V×C	3	1.44^{**}	1.44^{**}	9.11^{**}	11.22^{**}	3.18^{**}	1.44^{**}	9.11^{**}
V×B	2	0.61^{*}	0.61^{*}	4.69^{**}	8.62^{**}	2.75^{**}	0.61^{*}	4.69^{**}
C×B	6	0.28^{ns}	0.28^{ns}	1.83^{**}	1.70^{*}	1.37^{*}	0.28^{ns}	1.83^{**}
Y×V×C	3	0.02^{ns}	0.02^{ns}	0.53^{ns}	0.63^{ns}	2.07^{**}	0.02^{ns}	0.53^{ns}
Y×V×B	2	0.05^{ns}	0.05^{ns}	0.57^{ns}	0.36^{ns}	0.94^{ns}	0.05^{ns}	0.57^{ns}
Y×C×B	6	0.05^{ns}	0.05^{ns}	0.13^{ns}	0.24^{ns}	0.97^{*}	0.05^{ns}	0.13^{ns}
V×C×B	6	0.71^{**}	0.71^{**}	1.97^{**}	2.89^{**}	4.00^{**}	0.71^{**}	1.97^{**}
Y×V×C×B	6	0.18^{ns}	0.18^{ns}	0.45^{ns}	0.72^{ns}	3.16^{**}	0.18^{ns}	0.45^{ns}
Error	92	0.20	0.20	0.44	0.59	0.46	0.20	0.44
C.V. (%)	-	0.56	2.25	0.93	8.84	1.04	0.56	0.93

ns, * and **: non significant and significant in 5 % and 1 % probability level, respectively

Table 5. *Combined analysis of variance (ANOVA) of chlorophyll content and nitrogen, phosphorous and potassium content of grain in rice cultivar under chemical fertilizer and bio-fertilizer*

S.O.V.	DF	Grain length before cooking	Grain width before baking	Grain length after baking	Grain elongation	Aroma and taste	Gelatinization temperature	Gel consistency	Amylose content
Year (Y)	1	0.002^{ns}	0.0001^{ns}	0.014^{ns}	0.006^{ns}	0.01^{ns}	0.02^{ns}	126.79^{**}	0.92^{*}
Y (R)	4	0.31	0.010	0.26	0.019	0.15	0.07	35.25	0.27
Variety (V)	1	0.11^{ns}	0.04^{*}	0.73^{*}	0.27^{ns}	0.004^{ns}	0.37^{**}	1235.41^{**}	1.22^{**}
Chemical F. (C)	3	0.23^{*}	0.02^{ns}	4.03^{**}	3.14^{**}	0.34^{**}	0.05^{ns}	1699.58^{**}	8.76^{**}
Bio-fertilizer (B)	2	0.15^{*}	0.01^{ns}	0.17^{ns}	0.16^{ns}	0.13^{ns}	0.06^{*}	188.84^{**}	4.61^{**}
Y×V	1	0.02^{ns}	0.002^{ns}	0.001^{ns}	0.01^{ns}	0.07^{ns}	0.01^{ns}	98.70^{**}	0.01^{ns}
Y×C	3	0.004^{ns}	0.001^{ns}	0.003^{ns}	0.01^{ns}	0.01^{ns}	0.01^{ns}	179.85^{**}	0.19^{ns}
Y×B	2	0.0004^{ns}	0.001^{ns}	0.001^{ns}	0.0002^{ns}	0.01^{ns}	0.01^{ns}	14.37^{ns}	0.08^{ns}
V×C	3	0.12^{ns}	0.083^{**}	4.51^{**}	4.74^{**}	2.76^{**}	0.65^{**}	1097.41^{**}	11.40^{**}
V×B	2	0.16^{*}	0.001^{ns}	2.76^{**}	1.60^{**}	1.28^{**}	0.10^{*}	540.19^{**}	0.28^{ns}
C×B	6	0.55^{**}	0.008^{ns}	1.53^{**}	1.43^{**}	0.46^{**}	0.04^{ns}	295.99^{**}	2.02^{**}
Y×V×C	3	0.003^{ns}	0.0002^{ns}	0.006^{ns}	0.002^{ns}	0.07^{ns}	0.11^{**}	123.72^{**}	0.18^{ns}
Y×V×B	2	0.003^{ns}	0.0002^{ns}	0.007^{ns}	0.004^{ns}	0.02^{ns}	0.02^{ns}	33.12^{ns}	0.02^{ns}
Y×C×B	6	0.003^{ns}	0.0004^{ns}	0.004^{ns}	0.01^{ns}	0.03^{ns}	0.01^{ns}	39.05^{*}	0.03^{ns}
V×C×B	6	0.19^{**}	0.022^{ns}	2.23^{**}	1.81^{**}	0.97^{**}	0.20^{**}	848.88^{**}	2.10^{**}
Y×V×C×B	6	0.004^{ns}	0.0004^{ns}	0.001^{ns}	0.01^{ns}	0.11^{ns}	0.01^{ns}	77.12^{**}	0.05^{ns}
Error	92	0.06	0.01	0.17	0.18	0.08	0.03	14.14	0.16
C.V. (%)	-	3.34	5.83	3.70	11.50	16.50	4.77	4.46	2.13

ns, * and **: non significant and significant in 5 % and 1 % probability level, respectively

Triple mean comparison by slice interaction showed that the least brown rice for *cv.* Tarom Hashemi was achieved with application of 75% recommended potassium. However, brown rice was highest at another level of mineral and biological fertilizer (*Table 6*). In *cv.* Tarom Mahalli, most brown rice was measured with 75% recommended phosphorous usage and 10 ton manure consumption and with 75% recommended potassium and 8 ton vermi-compost usage. The least brown rice for *cv.*

Tarom Mahalli was observed at all mineral and biological fertilizer levels. The least hard husk for *cv.* Tarom Hashemi was observed with 100% NPK recommended and 10 ton manure consumption and with 75% recommended phosphorous. Moreover, minimum hard husk was observed at 75% recommended potassium and 8 ton vermi-compost per hectare. The softest husk for *cv.* Tarom Hashemi was obtained with 100% mineral fertilizer and 10 ton manure per hectare. Softest husk for *cv.* Tarom Mahalli was obtained with 100% recommended NPK and 10 ton manure per hectare. The least soft husk for *cv.* Tarom Hashemi was obtained with 75% recommended nitrogen rate. For *cv.* Tarom Mahalli, the least soft husk was observed with 75% recommended PK rates along with 8 ton vermi-compost consumption and control treatment (*Table 6*).

Table 6. *Mean comparison of cultivar, and chemical and biological fertilizers on the number of total, filled and blank spikelet and some technological parameters of rice by slice interaction*

Interaction	Number of spikelet per panicle	Number of filled spikelet per panicle	Number of blank spikelet per panicle	Brown rice (%)	Hard husk (%)	White rice (%)	Soft husk (%)	Health grain (%)	Broken grain (%)	Milling efficiency (%)
$V_1C_1B_1$	113.63 a	105.63 a	8.00 bc	80.80 a	19.20 b	70.53 b	10.27 a	63.89 b	6.63 b	70.53 c
$V_1C_1B_2$	112.16 a	104.57 a	7.60 c	80.63 a	19.37 ab	70.85 b	9.78 ab	64.33 ab	6.53 b	70.85 c
$V_1C_1B_3$	100.00 ab	89.95 bc	10.05 ab	80.59 a	19.41 ab	71.48 ab	9.11 ab	65.31 a	6.17 bc	71.48 abc
$V_1C_2B_1$	101.80 ab	93.05 b	8.75 b	80.67 a	19.33 ab	71.72 ab	8.95 b	64.66 ab	7.06 ab	71.72 abc
$V_1C_2B_2$	100.77 ab	91.70 bc	9.07 b	80.16 ab	19.84 a	73.38 a	6.79 c	65.91 a	7.47 a	73.38 a
$V_1C_2B_3$	94.72 b	82.93 c	11.78 a	80.13 ab	19.88 a	72.05 a	8.07 b	65.47 a	6.59 b	72.05 ab
$V_1C_3B_1$	99.54 ab	89.75 bc	9.79 b	80.34 a	19.66 a	71.53 ab	8.82 b	65.37 a	6.16 b	71.53 abc
$V_1C_3B_2$	108.08 a	98.67 ab	9.41 b	80.46 a	19.54 a	72.32 a	8.13 bc	65.11 a	7.22 a	72.32 ab
$V_1C_3B_3$	97.62 b	86.98 bc	10.63 ab	80.81 a	19.19 b	72.23 a	8.58 b	65.84 a	6.38 b	72.23 ab
$V_1C_4B_1$	101.47 ab	92.47 b	9.00 b	80.50 a	19.50 a	71.07 ab	9.43 ab	65.01 a	6.06 bc	71.07 abc
$V_1C_4B_2$	104.10 ab	95.35 b	8.75 b	79.82 b	20.18 a	71.25 ab	8.57 b	65.31 a	5.94 c	71.25 abc
$V_1C_4B_3$	97.94 b	86.90 bc	11.04 a	79.66 b	20.35 a	71.79 ab	7.87 bc	65.58 a	6.21 bc	71.79 abc
$V_2C_1B_1$	106.78 a	99.58 a	7.19 b	79.44 b	20.56 a	71.41 a	8.03 bc	65.12 a	6.29 b	71.41 a
$V_2C_1B_2$	107.38 a	99.99 a	7.39 b	79.46 b	20.54 a	70.64 ab	8.82 b	64.87 ab	5.77 bc	70.64 b
$V_2C_1B_3$	102.75 ab	91.25 ab	11.50 a	79.72 ab	20.28 ab	71.01 a	8.71 b	63.09 b	7.93 a	71.01 b
$V_2C_2B_1$	104.25 a	94.35 a	9.91 ab	79.73 ab	20.27 ab	71.50 a	8.23 b	64.49 ab	7.01 ab	71.50 a
$V_2C_2B_2$	103.86 a	95.57 a	8.30 ab	79.95 ab	20.05 ab	69.74 b	10.21 a	63.77 b	5.98 bc	69.74 b
$V_2C_2B_3$	93.33 b	82.35 b	10.99 a	79.47 b	20.53 a	69.65 b	9.82 ab	63.54 b	6.12 b	69.65 b
$V_2C_3B_1$	96.46 ab	87.50 ab	8.96 ab	80.00 a	20.00 ab	71.21 a	8.79 b	64.63 ab	6.58 b	71.21 a
$V_2C_3B_2$	99.24 ab	87.96 ab	11.28 a	79.56 b	20.45 a	71.70 a	7.86 c	65.40 a	6.30 b	71.70 a
$V_2C_3B_3$	97.38 ab	86.43 ab	10.95 a	79.72 ab	20.29 ab	71.56 a	8.16 b	65.82 a	5.74 c	71.56 a
$V_2C_4B_1$	107.08 a	97.40 a	9.68 ab	79.48 b	20.52 a	71.04 ab	8.45 b	64.16 ab	6.87 b	71.04 b
$V_2C_4B_2$	107.31 a	96.51 a	10.81 a	80.21 a	19.79 b	71.33 a	8.88 b	64.59 ab	6.74 b	71.33 ab
$V_2C_4B_3$	92.73 b	82.06 b	10.66 a	79.77 ab	20.23 ab	71.79 a	7.98 c	65.41 a	6.38 b	71.79 a

Values within a column followed by same letter are not significantly different at LSD (P ≤ 0.05)
V_1 and V_2: Tarom Hashemi and Tarom Mahalli cultivars, respectively
C_1, C_2, C_3, and C_4: 100% recommended NPK, 75% recommended nitrogen with 100% PK, 75% recommended phosphorous with 100% NK, and 75% recommended potassium with 100% NP, respectively
B_1, B_2, and B_3: 0 and 8 ton vermi-compost per hectare and 10 ton of rotted manure per hectare, respectively

According to these findings, the lowest white rice for *cv.* Tarom Hashemi was obtained with 100% recommended NPK along with 10 ton manure and 8 ton vermi-compost consumption per hectare. For *cv.* Tarom Mahalli, the least white rice was obtained with 75% recommended nitrogen and 8 ton vermi-compost consumption and control treatment. However, whitest rice was obtained for both cultivars at all other levels of mineral

fertilizer and bio-fertilizer (*Table 6*). Moreover, for *cv.* Tarom Hashemi the lowest health grain was obtained with 100% recommended NPK and 10 ton manure consumption per hectare. Furthermore, for *cv.* Tarom Mahalli the least healthy grain was produced at 100% recommended NPK applied along with bio-fertilizer control treatment and 75% recommended nitrogen and vermi-compost consumption and control treatment. However, higher rates of health grain were observed at other levels of mineral fertilizer and bio-fertilizer for both cultivars (*Table 6*). Least broken grain for *cv.* Tarom Hashemi was observed at 75% potassium along with vermi-compost consumption. Moreover, lowest broken grain was obtained with 75% phosphorous applied along with bio-fertilizer control level. Maximum broken grain for *cv.* Tarom Hashemi cultivar was observed at 75% recommended nitrogen and phosphorous applied with vermi-compost consumption. Furthermore, for *cv.* Tarom Mahalli maximum broken grain was obtained with manure consumption along with 75% recommended phosphorous (*Table 6*). In terms of milling efficiency, for *cv.* Tarom Hashemi maximum efficiency was obtained with 75% recommended nitrogen and vermi-compost consumption. For *cv.* Tarom Mahalli, maximum milling efficiency was achieved at different levels of mineral and biological fertilizers. The least milling efficiency for *cv.* Tarom Hashemi cultivar was produced with recommended 100% NPK along with cow manure and vermi-compost consumption. For *cv.* Tarom Mahalli, least conversion efficiency was observed for 100% recommended NPK and 75% recommended nitrogen along with vermi-compost consumption and control treatment (*Table 6*).

Based on the finding of mean comparison of cultivar, mineral fertilizer, and bio-fertilizer by slice interaction, least grain length before baking for *cv.* Tarom Hashemi cultivar was observed with 100% recommended NPK applied with vermi-compost consumption and control treatment. The lowest grain length before baking for *cv.* Tarom Mahalli was obtained with 75% recommended potassium usage and manure consumption. The highest grain length before baking for both cultivars was measured in other levels of mineral fertilizer and bio-fertilizer (*Table 6*). Moreover, maximum grain length after baking for *cv.* Tarom Hashemi was measured with 75% recommended nitrogen and bio-fertilizer control level along with 75% recommended phosphorous usage and manure consumption at 12.48 mm. Minimum grain length after baking for *cv.* Tarom Hashemi was calculated AT other levels of mineral and biological fertilizer levels. Furthermore, the least grain length after baking for *cv.* Tarom Mahalli was observed with 100% recommended NPK along with manure and vermi-compost consumption. Maximum grain length after baking for *cv.* Tarom Mahalli was observed at other levels of mineral and biological fertilizers (*Table 7*).

In terms of grain elongation, for *cv.* Tarom Hashemi cultivar maximum grain elongation was measured with 75% recommended nitrogen in bio-fertilizer control level along with 75% recommended phosphorous and mineral consumption at 4.92 mm. The lowest grain elongation for *cv.* Tarom Hashemi was obtained with 75% recommended phosphorous and bio-fertilizer control treatment. For *cv.* Tarom Mahalli cultivar, least grain elongation was measured with 100% recommended NPK along with manure consumption. Maximum grain elongation for *cv.* Tarom Mahalli was obtained with 75% recommended nitrogen and vermi-compost consumption, 75% recommended phosphorous at all three levels of bio-fertilizer, and 75 recommended potassium along with manure and vermi-compost consumption at 4.52 and 4.27 (*Table 7*). Moreover, maximum aroma for *cv.* Tarom Hasemi was obtained with 75% of nitrogen recommended and control treatment along with 75% recommended phosphorous and

vermi-compost consumption. Maximum aroma for *cv.* Tarom Mahalli was observed with 75% recommended potassium in bio-fertilizer control level (*Table 7*).

Table 7. Mean comparison of cultivar, and chemical and biological fertilizers on the number of total, filled and blank spikelet and some technological parameters of rice by slice interaction

Interaction	Grain length before baking	Grain length after baking	Grain elongation	Aroma and taste	Gelatinization temperature	Gel consistency	Amylose content
$V_1C_1B_1$	7.59 a	11.40 ab	3.81 ab	1.96 ab	3.56 a	95.78 a	17.72 bc
$V_1C_1B_2$	7.11 b	10.77 b	3.67 ab	1.91 ab	3.63 a	77.33 c	18.19 b
$V_1C_1B_3$	7.13 b	10.86 b	3.73 ab	1.67 ab	3.35 a	76.99 c	17.44 c
$V_1C_2B_1$	7.43 a	11.25 ab	3.82 ab	1.90 ab	3.27 ab	95.09 a	19.28 a
$V_1C_2B_2$	7.26 a	10.86 b	3.59 ab	1.24 b	3.27 ab	84.58 b	17.92 bc
$V_1C_2B_3$	7.36 a	12.11 a	4.75 a	2.26 a	3.29 ab	93.05 ab	19.48 a
$V_1C_3B_1$	7.56 a	12.48 a	4.92 a	1.98 ab	3.39 ab	86.43 b	18.93 ab
$V_1C_3B_2$	6.96 ab	10.75 b	3.79 ab	2.36 a	3.26 ab	93.10 ab	17.93 bc
$V_1C_3B_3$	7.29 a	10.50 b	3.21 b	1.62 ab	3.07 b	87.32 b	18.48 ab
$V_1C_4B_1$	6.96 ab	9.90 b	2.94 ab	1.67 ab	3.26 ab	87.79 b	19.06 ab
$V_1C_4B_2$	7.46 a	10.33 b	2.88 ab	1.13 b	3.37 ab	77.32 c	18.78 ab
$V_1C_4B_3$	7.71 a	10.74 b	3.03 ab	1.16 b	3.38 ab	92.73 ab	18.54 ab
$V_2C_1B_1$	7.36 a	10.17 b	2.80 b	1.09 b	3.17 b	50.38 e	19.95 a
$V_2C_1B_2$	7.08 b	10.43 b	3.36 ab	1.60 ab	3.21 b	69.60 cd	18.93 b
$V_2C_1B_3$	7.20 ab	10.72 ab	3.52 ab	1.68 ab	3.32 ab	88.46 b	19.04 ab
$V_2C_2B_1$	7.46 a	10.73 ab	3.27 ab	1.16 b	3.67 a	87.79 b	19.69 a
$V_2C_2B_2$	7.50 a	11.58 a	4.08 a	1.93 ab	3.54 ab	89.57 b	19.32 ab
$V_2C_2B_3$	7.63 a	11.18 ab	3.55 ab	1.61 ab	3.63 a	94.38 a	19.82 a
$V_2C_3B_1$	7.38 a	11.49 a	4.11 a	1.87 ab	3.37 ab	81.32 bc	17.20 c
$V_2C_3B_2$	7.57 a	11.79 a	4.22 a	1.68 ab	3.47 ab	74.77 bcd	17.17 c
$V_2C_3B_3$	7.25 ab	11.49 a	4.24 a	1.72 ab	3.56 ab	62.23 d	18.78 b
$V_2C_4B_1$	7.13 b	11.64 a	4.52 a	1.86 ab	3.78 a	91.26 ab	18.81 b
$V_2C_4B_2$	7.35 a	11.61 a	4.27 a	1.93 ab	3.31 ab	92.32 ab	17.57 c
$V_2C_4B_3$	7.58 a	10.83 ab	3.25 ab	2.61 a	3.28 ab	95.13 a	17.70 c

Values within a column followed by same letter are not significantly different at LSD ($P \leq 0.05$)
V_1 and V_2: Tarom Hashemi and Tarom Mahalli cultivars, respectively
C_1, C_2, C_3, and C_4: 100% recommended NPK, 75% recommended nitrogen with 100% PK, 75% recommended phosphorous with 100% NK, and 75% recommended potassium with 100% NP, respectively
B_1, B_2, and B_3: 0 and 8 ton vermi-compost per hectare and 10 ton of rotted manure per hectare, respectively

According to these findings, maximum gelatinization temperature for *cv.* Tarom Hshemi cultivar was measured at 100% recommended NPK applied at all three levels of bio-fertilizer. The least gelatinization temperature was calculated at 75% recommended phosphorous in bio-fertilizer control treatment. Highest gelatinization temperature for *cv.* Tarom Mahalli was obtained with 75% recommended nitrogen in manure consumption and control treatment along with 75% recommended potassium and manure consumption at 3.78. Minimum gelatinization temperature for *cv.* Tarom Mahalli was observed with 100% recommended NPK along with manure and vermi-compost consumption at 3.17 and 3.21 (*Table 7*). In terms of gel consistency for *cv.* Tarom Hashemi cultivar, the highest amount was observed with 100 of NPK and 75% recommended nitrogen and manure consumption at 95.78 and 95.09 mm. Lowest gel

consistency for *cv.* Tarom Hshemi was observed with 75% recommended nitrogen with vermi-compost usage at bio-fertilizer control level along with 75% recommended potassium and vermi-compost consumption at 77.32 mm. Moreover, the most gel consistency for *cv.* Tarom Mahalli cultivar was calculated with 75% recommended nitrogen in bio-fertilizer control treatment and 75% recommended potassium in bio-fertilizer control level at 95.13 mm. Least gel consistency for *cv.* Tarom Mahalli cultivar was measured at 100% recommended NPK and manure consumption. In terms of amylose content in *cv.* Tarom Hashemi cultivar the maximum rates was obtained with 75% recommended nitrogen with manure consumption and control treatment. Least Amylose content was observed with 100% recommended NPK applied in bio-fertilizer control treatment. For *cv.* Tarom Mahalli, maximum amylose content was produced with 100% recommended NPK and manure consumption, and 75% recommended nitrogen along with manure usage and control treatment. Least amylose content was obtained with 75% recommended phosphorous with manure and vermi-compost consumption and 75% recommended potassium with vermi-compost usage and control treatment at 17.57 and 17.70% (*Table 7*). In fact, coherence in the shape and paddy yield is the first factor in quality corroboration. Farmers consider these factors for the cultivation of new cultivars.

In general, biological fertilizers should be used instead of mineral fertilizers. Despite improving performance, chemical fertilizers lead to increased salinity and soil and water contamination. They also reduce the stability of the agricultural systems due to the use of chemical chemicals. If the use of organic fertilizer for more years which caused improves soil structure, prevents water and soil pollution, and leads to increased system stability because they increase soil organic matter. The only problem with the use of organic fertilizers is the low rate of decomposition of these materials: however, by using effective microorganisms and increasing the population of microbial degrading soil this too can be solved. In addition, researches shows that the use of manure instead of chemical fertilizer saves up to 25% in current costs, which adds to the sustainability of the cultivation system (Khaliq et al., 2006). According to the results of application of nitrogen fertilizer on rice growth parameters, the number of panicles per square meter, the total number of spikelet per panicle, and the number of blank spikelet per panicle increased, but the number of filled spikelet per panicle decreased (Jafari et al., 2013a, b). This is important because of the effects of the sink-source in the yield components (Jafari et al., 2013 b). Moreover, in another study on the rice plant, it was found that plant height, panicle length, and third inter-node length increased by increasing the nitrogen fertilizer. Moreover, the fourth inter-node length increased with increase in nitrogen: this also caused more lodging (Dastan et al., 2012).

Chemical fertilizers significant effect world food production and are one of the most important components in today's agriculture. Predictions show that more than 50% of agricultural production relies on the use of chemical fertilizers (Fixon and West, 2002). Conventional agricultural practices in today's world do not have an acceptable success rate of resource management, and rely excessively on artificial inputs and the use of ancillary energy inputs such as fertilizers and chemical pesticides to create unsustainable agro-ecosystems (Roberts, 2008). Biological fertilizers, including cow manure fertilizers, can increase soil water retention capacity, reduce tensions, and stress (Macilwain, 2004), increase soil microbial diversity (Oehl et al., 2004), improve soil physical structure (Pulleman et al., 2003), and prevent soil erosion (Pinamonti, 1998). This increases supply of part of the nutrition needed for the plant (Turgut et al., 2005),

improves plant growth and yield (Kramer et al., 2002), and increases the quality of the product (Gilesm, 2004). Also, the development of soil fertility and soil quality, especially in the case of systems with low inputs, requires organic inputs to the soil (Palm et al., 2001). Moreover, Siavoshi et al. (2014) reported that biological fertilizer compared to chemical fertilizer in rice production improved qualitative traits and increases protein yield and paddy yield.

Field trials of fertilization and cultivar on the grain yield of rice (*Oryza sativa* L.) with two fertilizer levels and 18 modern varieties carried by Li et al. (2016) showed that variation among cultivars had a considerable impact on rice grain yield. Close correlations were observed between grain yield and effective panicles and dry matter production. Harvest index the ratio of grain weight to total plant weight, is an important trait associated with dramatic increases in crop yields. Most progress in improving HI occurred following the introduction of semi-dwarf traits into rice in the 1960s (Sinclair, 1998). However, the scope for continued HI increase in modern rice cultivars was limited by the need for maintaining sufficient leaf area and stem biomass for interception of solar radiation, physical support and storage of assimilate and N used in grain filling (Cassman, 1999; Cassman et al., 1998). Yang et al. (2006) demonstrated that post-anthesis dry matter production of high-yield rice differs between different yield categories. Experimental results in China on the effects of manure and chemical fertilizers on barley showed that the use of manure had similar (or even greater) effect on chemical fertilizers. Grain appearance is important for determining the quality of rice and its market-friendliness. Grain length before cooking is one of the qualitative factors of the rice grain. Rice grains increase in size after cooking: if an increase in length takes place without an increase in thickness is considered a positive factor for cultivars. Rice-cooking traits are mainly determined by the properties of starch, which comprises up to 90% of the endosperm of white rice and consists of two amylose and amylopectin components. High amylose rice is completely separated after drying and is hardened after cooling. Most rice with low amylose content has a spikelet with a minimum amount of blank grain and a number of broken grains (Uphoff, 2011). Measurement of the gel consistency complements the amylose test, which indicates the amount of rice cooked gel movement. Gel consistency also shows the exact hardness and adhesion of cooked rice. The determination of endosperm starch gelatinization temperature is an important test for determining the quality of baking in rice. The temperature of the gelatinized starch is an important quality factor that is related to the cooking time and the nature of cooked rice: in fact, higher the gelatinization temperature, the higher the ranking of rice in terms of qualitative categorization. Studying the effects of genotype and environment on bread making quality in wheat, Dencic et al. (2011) showed that both cultivar and cultivar by environment interaction had significant effect on all quality traits. In addition, the variances of quality traits associated with the genetic factors of cultivars were generally larger than those of cultivars by environmental interaction effects.

Conclusion

According to the finding highest paddy yield occurs with cultivar and bio-fertilizer interaction involving vermi-compost and manure usage for both cultivars. Moreover, the highest paddy yield produced with 100% recommended NPK and vermi-compost consumption. Based on the results, the highest amount of gel consistency for *cv.* Tarom Hashemi cultivar was observed with 100 of NPK and 75% of recommended nitrogen

and manure consumption. The maximum amylose content for *cv.* Tarom Mahalli was produced with 100% NPK recommended and manure consumption. Therefore, it can be concluded that by the integrated consumption of mineral and biological fertilizers, farmers can significantly reduce impacts of chemical fertilizers on the environment, and improve the qualitative and the quantitative parameters of rice cultivars with biological fertilizers. Hence, in the future researchers should be investigating the multiple consumptions of bio-fertilizer and chemical fertilizer for achieving sustainable agriculture.

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