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Response of Morphological Traits and Seed Protein Content of Bread Wheat to Apply Different Level of Biological and Chemical Fertilizers

Reza Dashtbozorgi[1], Shahram Lack[2*]

1- *Msc. Graduated, Department of Agronomy, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.*

2- *Professor, Department of Agronomy, Ahvaz Branch, Islamic Azad University, Ahvaz, Iran.*

RESEARCH ARTICLE

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ABSTRACT

BACKGROUND: Nutrient management may be achieved by the involvement of organic sources, bio-fertilizers, and micro-nutrients. Indiscriminate use of chemical fertilizers to achieve high yield and to compensate for lack of nutrients and consequently the increase of production costs and destruction of soil and water resources have made the specialists interested in healthy and stable crop systems in terms of ecology.

OBJECTIVES: This research was done to assess effect of different levels of biologic and chemical fertilizer on quantitative and qualitative characteristics of Bread wheat.

METHODS: Current study was conducted according split plot experiment based on completely randomized block design with three replications. The main plot included Biofertilizer at two levels (a_1: nonuse of biofertilizer, a_2: use of biofertilizer) also the chemical fertilizer in six levels (b_1: nonuse of fertilizer use, b_2: 100% triple superphosphate, b_3: 100% liquid phosphorus, b_4: 50% triple superphosphate + 50% phosphorus liquid, b_5: 75% triple superphosphate + 25% liquid phosphorus, b_6: 25% triple superphosphate + 75% liquid phosphorus) were belonged to sub-plot.

RESULT: According result of analysis of variance effect of different level of Biofertilizer, phosphorus fertilizer and interaction effect of treatments on all measured traits was significant. Evaluation mean comparison result of interaction effect of treatments on all measured traits revealed the highest amount of seed yield (488.4 $gr.m^{-2}$), plant height (95.2 cm), spike length (11.4 cm), leaf area index (5.4) and seed protein content (14%) were noted for use of biofertilizer and 75% triple superphosphate + 25% liquid phosphorus and lowest amount of mentioned traits belonged to control treatment.

CONCLUSION: Generally apply 75% triple superphosphate + 25% liquid phosphorus treatment resulted in an increase of about 22.5% compared to the control treatments and can be advised to producers in studied region.

KEYWORDS: *Leaf area index, Nutrition, Phosphorus, Spike length, Yield.*

***Corresponding Author:** Shahram Lack ✉ sh.lack@yahoo.com

1. BACKGROUND

Chemical fertilizers are significant to succor nutrients in soil. Heavy doses of chemical fertilizers and pesticides are commonly used in order to enhance corn yields. Excessive nitrogen content in soil causes an inappropriate high uptake of this macronutrient by plants, which may result in inadequate growth and development due to the accumulation of nitrogen compounds in plant tissue (Szulc, 2013). Bio-fertilizers are more environmental friendly and in many cases, they have given the same or even better crop yields compared to mineral fertilizers (Saghir Khan *et al.,* 2007). So far considerable number of bacterial species, mostly associated with the plant rhizosphere, were tested and found to be beneficial for plant growth, yield and crop quality. They have been called 'plant growth promoting rhizobacteria (PGPR)' including the strains in the genera Azospirillium, Azotobacter, (Sudhakar *et al.,* 2000). PGPR participates in many key ecosystem processes, such as those involved in the biological control of plant pathogens, N fixation, solubilisation of nutrients and phytohormone synthesis (Vessey, 2003). Azospirillum and Azotobacter by the biological nitrogen fixation and development the roots, helped to optimize the absorption of water, nutrients, hormones, certain vitamins production and boost plant growth quantitative and qualitative (Ram-Rao *et al*, 2007). Soleimanzadeh and Ghooshchi (2013) reported that high input cropping system was the most productive treatment but organic cropping system with bio-fertilizers was the most economical treatment with respect to increasing net profit. Combination mycorrhiza and bacteria holds promise for the organic cropping system of maize. Therefore in organic and low input cropping systems, a combination of mycorrhiza and free-living bacteria performed satisfactorily. Some researcher has suggested that integrated nutrient management strategies involving chemical fertilizers and bio-fertilizers enhance the sustainability of crop production. Integrated plant nutrient management is the combined use of mineral fertilizers with organic resources such as cattle manures, crop residues, urban/rural wastes, composts, green manures and bio-fertilizers (Kemal and Abera, 2015). Nouraki *et al*. (2016) reported mixing of biological fertilizers with chemical fertilizers could reduce the needs of chemical fertilizers up to 25% and these results are comparable to the application of 100% chemical fertilizers. Therefore, the best hybrid maize is the single cross 704 that has good yield potential when the chemical fertilizer is used at either 25% or 50% of the current application when mixed with the bio-fertilizer. Cheraghi *et al*. (2016) studied the effect of organic manure and phosphorus fertilizer on yield and yield components of bread wheat and reported that the combined application of organic manure or vermicompot with chemical fertilizer has a better effect on yield and yield components of common wheat rather than single application. On the other hand combined application of organic and chemical fertilizers had more efficiency due to some positive interaction between their microorganisms in the soil that led to a synergistic effect and therefore lead to an increase in seed yield. Bahamin *et al*. (2014) showed that when seeds were in inculcation by Nitroxin biologic fertilizer seed yield reached 3840 kg per hectare, showing 28% increase compared to non-inculcation treatment. Azimi *et al*. (2013a) found that application of Super nitroplass bio-fertilizer with Phosphate barvar2 treatment has the highest seed yield (7.6 $t.ha^{-1}$) and non-application of bio-fertilizers treatment has the Pishtaz cultivar has the lowest seed yield (6.3 $t.ha^{-1}$). Azimi *et al*. (2013b) was reported that grain yield and biomass yield increasing with the bio fertilizer application, also which account important benefit, causing decreasing in the inputs of production because of economizing much money to chemical fertilizers and increasing in yield and biological yield.

2. OBJECTIVES

This research was done to assess effect of different levels of biologic and chemical fertilizer on quantitative and qualitative characteristics of Bread wheat.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

Current study was conducted in the crop year of 2021-22 according split plot experiment based on completely randomized block design with three replications. The main plot included Bio-fertilizer at two levels (a_1: nonuse of biofertilizer, a_2: use of biofertilizer) also the chemical fertilizer in six levels (b_1: nonuse of fertilizer use, b_2: 100% triple superphosphate, b_3: 100% liquid phosphorus, b_4: 50% triple superphosphate + 50% phosphorus liquid, b_5: 75% triple superphosphate + 25% liquid phosphorus, b_6: 25% triple superphosphate + 75% liquid phosphorus) were belonged to sub-plot. Place of research was located in Ahvaz city at longitude 48°40'E and latitude 31°20'N in Khuzestan province (Southwest of Iran). This experiment had 36 plots. Each plot consisted of 7 lines with a distance of 20 cm and 4 meters length. Result of soil characteristics was mentioned in table 1.

Table 1. Physical and chemical properties of studied field

Soil depth (cm)	Soil texture	Clay (%)	Silt (%)	Sand (%)	K (ppm)	P (ppm)	OC (%)	pH	EC ($ds.m^{-1}$)	SP (%)
0-30	Clay loam	36	40	24	229	11.1	5.8	7.82	4.42	47

3.2. Farm Management

Before planting, half of the nitrogen from the source of urea in the amount of 135 kg was spread with a disc in the field and the other half of the nitrogen was distributed at the initial stage of stem elongation (30 Zadox). Triple superphosphate fertilizer was also added to the soil according to the type of experimental treatments before planting. 100% superphosphate + 0% liquid phosphorus = 48 grams of superphosphate per plot 12 grams each line + without liquid fertilizer. 0% superphosphate + 100% liquid phosphorus = no superphosphate + 3.36 cc of liquid fertilizer. 50% superphosphate + 50% liquid phosphorus = 42 grams of superphosphate per plot (6 grams per line + 1.68 cc per plot). 75% superphosphate + 25% liquid phosphorus = 63 grams of superphosphate per plot (9 grams per line + 0.84 cc per plot). 25% superphosphate + 75% liquid phosphorus = 21 grams of superphosphate per plot (3 grams per line + 2.52 cc per plot). To apply Biofertilizer (provided by Mehr Biotechnology Company), the desired fertilizer (in the amount of 100 grams per hectare) was dissolved in a 10-liter container filled with water. Then, wheat seeds were placed in these containers for 10 minutes before planting and were coated with fertilizer solution (in the form of seeds) and then they were planted. Also, foliar spraying of plants at the 4-6 leaf stage was done with one-liter liquid phosphorus fertilizer prepared from Sena Paliz Company.

3.3. Measured Traits

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. 10 crops were randomly selected from the middle lines of each plot and the plant height and spike length was counted carefully and their mean 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.

To determine the leaf area of the linear relationship S= K. L.W was used in which S, L and W were the leaf area, L and W respectively, the maximum length and width of each leaf and K= 0.75 correction coefficient.

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 biofertlizer, phosphorus fertilizer and interaction effect of treatments on seed yield was significant at 1% probability level (Table 2). Mean comparison result of different level of biofertlizer indicated that maximum seed yield (482.34 $gr.m^{-2}$) was noted for use of biofertilizer and minimum of that (385.22 $gr.m^{-2}$) belonged to control treatment (Table 3). According result of mean comparison maximum of seed yield (477.5 $gr.m^{-2}$) was obtained for 75% triple superphosphate + 25% liquid phosphorus and minimum of that (371.07 $gr.m^{-2}$) was for control treatment (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum seed yield (488.4 $gr.m^{-2}$) was noted for use of biofertilizer and 75% triple superphosphate + 25% liquid phosphorus and lowest one (378.4 $gr.m^{-2}$) belonged to control treatment (Table 4). Hojattipor *et al*. (2014) reported that the maximum total dry weight was obtained in wheat with increasing nitrogen fertilizer up to

225 $kg.ha^{-1}$, along with biological nitrogen fertilizer of Nitrokara. 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.

Table 2. Result of analysis of variance effect of treatment on studied traits

S.O.V	df	Seed yield	Plant height	Spike length	Leaf area index	Seed protein content
Replication	2	75.09^{ns}	0.11^{ns}	1.09^{ns}	1.66^{ns}	0.23^{ns}
Biofertilizer (a)	1	562841**	1851.4**	15.89**	9.25**	104.76*
Error I	2	2900.5	151.08	1.04	0.5	5.07
Phosphorus Fertilizer (b)	5	604051.1**	2019.32**	26.07**	7.59**	88.02*
a×b	5	99852**	1708.4**	18.52**	4.022**	63.19*
Error II	20	2137.2	129.36	0.93	0.31	2.38
CV (%)	-	10.65	12.64	10.47	12.4	13.19

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

4.2. Plant height

Result of analysis of variance revealed effect of biofertlizer, phosphorus fertilizer and interaction effect of treatments on plant height was significant at 1% probability level (Table 2). As for Duncan classification made with respect to different level of biofertlizer maximum and minimum amount of plant height belonged to use biofertilizer (92.72 cm) and control (87.13 cm) (Table 3). Evaluation mean comparison result indicated in different level of phosphorus fertilizer the maximum plant height (93.72 cm) was noted for 75% triple superphosphate + 25% liquid phosphorus and minimum of that (85.24 cm) belonged to control treatment (Table 3). Assessment mean comparison result of interaction effect of treatments indicated maximum plant height (95.2 cm) was noted for use of biofertilizer and 75% triple superphosphate + 25% liquid phosphorus and lowest one (84.0 cm) belonged to control treatment (Table 4). Seyed Sharifi and Nazarli (2013) reported that the application of bacteria with 160 $kg.ha^{-1}$ of urea fertilizer increased the plant height. It is also stated that under nitrogen conditions, photosynthetic materials are more produced and these materials provide suitable conditions for stem elongation. Eydizadeh *et al*., (2010) also described the effect of the combined application of biological fertilizers with chemical fertilizers in maize, and reported which increased the plant height in terms of their combined application compared to the individual application of each fertilizer, which was consistent with the results of this experiment. Probably the main reason of that matter due to increasing absorption of food by the plant in the combined application.

Table 3. Mean comparison effect of different level of Biofertilizer and Phosphorus fertilizer on studied traits

Treatment	Seed yield (gr.m^{-2})	Plant height (cm)	Spike length (cm)	Leaf area index	Seed protein content (%)
Biofertilizer					
a_1	385.22b	87.13b	8.09b	4.0b	10.48b
a_2	482.34a	92.72a	10.34a	5.01a	12.90a
Phosphorus Fertilizer					
b_1	371.07c	85.24c	7.19c	3.95b	10.14b
b_2	450.6ab	91.68ab	9.94ab	4.71ab	12.08ab
b_3	418.02b	88.33b	8.0b	4.13ab	11.1ab
b_4	455.1ab	91.11ab	10.83ab	4.9ab	12.58ab
b_5	477.5a	93.72a	11.01a	5.15a	13.07a
b_6	430.4ab	89.45ab	8.3b	4.2ab	11.2ab

*Mean which have at least once common letter are not significant different at the 5% level using (DMRT).
a_1: nonuse of biofertilizer, a_2: use of biofertilizer, b_1: nonuse of fertilizer, b_2: 100% triple superphosphate, b_3: 100% liquid phosphorus, b_4: 50% triple superphosphate + 50% phosphorus liquid, b_5: 75% triple superphosphate + 25% liquid phosphorus, b_6: 25% triple superphosphate + 75% liquid phosphorus.

4.3. Spike length

According result of analysis of variance effect of biofertlizer, phosphorus fertilizer and interaction effect of treatments on spike length was significant at 1% probability level (Table 2). Mean comparison result of different level of biofertlizer indicated that maximum spike length (10.34 cm) was noted for use of biofertilizer and minimum of that (8.09 cm) belonged to control treatment (Table 3). Assessment mean comparison result indicated in different level of phosphorus fertilizer the maximum spike length (11.01 cm) was noted for 75% triple superphosphate + 25% liquid phosphorus and minimum of that (7.19 cm) belonged to control treatment (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum spike length (11.40 cm) was noted for use of biofertilizer and 75% triple superphosphate + 25% liquid phosphorus and lowest one (7.10 cm) belonged to control treatment (Table 4). Tarang *et al.* (2013) reported applications of Nitroxin bio-fertilizer and chemical fertilizer (400 kg.ha^{-1} urea with 300 kg.ha^{-1} ammonium phosphate) had a significant effect on traits of root dry weight, number of seed per row (36.5), number of seeds per ear (458.56), 1000-grain weight, seed (13.23 t.ha^{-1}) and biological yield (26.4 t.ha^{-1}) , and harvest index (53.88%).

4.4. Leaf area index

Result of analysis of variance revealed effect of biofertlizer, phosphorus fertilizer and interaction effect of treatments on leaf area index was significant at 1% probability level (Table 2). As for Duncan classification made with respect to different level of biofertlizer maximum and minimum amount of leaf area index belonged to use biofertilizer (5.01) and control (4) (Table 3).

Table 4. Mean comparison interaction effects of treatments on measured traits

Biofertilizer	Phosphorus Fertilizer	Seed yield (gr.m^{-2})	Plant height (cm)	Spike length (cm)	Leaf area index	Seed protein content (%)
a_1	b_1	378.4c	84.0c	7.1cd	3.88c	10.0d
	b_2	425.2b	89.1b	9.0bc	4.2b	11.0c
	b_3	403.1bc	87.0bc	8.0c	4.03bc	10.3cd
	b_4	430.1b	88.42b	8.8bc	4.18b	11.38bc
	b_5	434.7b	90.3b	9.2bc	4.25b	11.51bc
	b_6	410.1bc	87.05bc	8.1c	4.09b	10.5cd
a_2	b_1	393.06bc	86.5bc	8.0c	4.05b	10.2cd
	b_2	473.19a	94.8ab	11.0ab	5.32ab	13.0ab
	b_3	441.08b	91.0b	10.0b	4.5ab	12.0b
	b_4	480.02ab	94.1ab	10.8ab	5.25ab	13.2ab
	b_5	488.4a	95.2a	11.4a	5.4a	14.0a
	b_6	447.11b	92.1ab	10.1b	4.9ab	12.2b

*Mean which have at least once common letter are not significant different at the 5% level using (DMRT).
a_1: nonuse of biofertilizer, **a_2**: use of biofertilizer, **b_1**: nonuse of fertilizer, **b_2**: 100% triple superphosphate, **b_3**: 100% liquid phosphorus, **b_4**: 50% triple superphosphate + 50% phosphorus liquid, **b_5**: 75% triple superphosphate + 25% liquid phosphorus, **b_6**: 25% triple superphosphate + 75% liquid phosphorus.

Compare different level of phosphorus fertilizer showed that the maximum and the minimum amount of leaf area index belonged to 75% triple superphosphate + 25% liquid phosphorus (5.15) and control (3.95) treatments (Table 3). Assessment mean comparison result of interaction effect of treatments indicated maximum leaf area index (5.40) was noted for use of biofertilizer and 75% triple superphosphate + 25% liquid phosphorus and lowest one (3.88) belonged to control treatment (Table 4). Nitrogen as an essential constituent of cell components having direct effect on growth, yield and quality of crop. Plant growth is affected more due to deficiency of nitrogen than that of any other nutrient. Nitrogen fertilization influences dry matter yield by influencing leaf area index, leaf area duration and photosynthetic efficiency (Mohan *et al*., 2015). Shamoradi and Marashi (2018) reported among different level of biofertilizer maximum leaf area index in tassel emergence, silk emergence and grain filling stage were 4.28, 3.40 and 2.33, respectively, due to application of Nitrokara and *Azotobacter* biological fertilizer and lowest one (4.13, 3.21 and 2.18) belonged to non-bio fertilized treatment. Sprent and Sprent (1990) reported that *Azospirillum*, Pseudomonas and *Azotobacter* bacteria, through the roots of plants, increase the moisture absorption and this extensive network through the absorption of water and nutrients and their transfer to the plant increases plant height, leaf area and dry weight.

4.5. Seed protein content

According result of analysis of variance effect of biofertlizer, phosphorus fertilizer and interaction effect of treatments on seed protein content was significant at 5% probability level (Table 2). Mean comparison result of different level of biofertlizer indicated that maximum seed protein content (12.90%) was noted for use of biofertilizer and minimum of that (10.48%) belonged to control treatment (Table 3). Evaluation mean comparison result indicated in different level of phosphorus fertilizer the maximum seed protein content (13.07%) was noted for 75% triple superphosphate + 25% liquid phosphorus and minimum of that (10.14%) belonged to control treatment (Table 3). Evaluation mean comparison result of interaction effect of treatments indicated maximum seed protein content (14.0%) was noted for use of biofertilizer and 75% triple superphosphate + 25% liquid phosphorus and lowest one (10.0%) belonged to control treatment (Table 4). Shadab Niazi *et al*. (2017) by evaluate the effect of different level of vermicompost (0, 2.5 and 5 $t.ha^{-1}$) on mung bean, reported the highest protein yield and seed yield were obtained from 5 $t.ha^{-1}$ vermicompost and the least of these traits were due to non-use of vermicompost. 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).

5. CONCLUSION

Generally apply 75% triple superphosphate + 25% liquid phosphorus treatment resulted in an increase of about 22.5% compared to the control treatments and can be advised to producers in studied region.

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FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

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REFRENCES

Azimi, S. M., A. Farnia, M. Shaban. and M. Lak. 2013a. Effect of different bio-fertilizers on seed yield of barley, Bahman cultivar. Intl. J. Adv. Biol. Biomedical Res. 1(5): 538-546.

Azimi, S. M., E. Nabati, M. Shaban. and M. Lak. 2013b. Effect of N and P bio fertilizers on yield components of barley. Intl. J. Adv. Biol. Biomedical Res. 2(2): 365-370.

Bahamin, S., M. Sohrab, A. B. Mohammad, K. T. Behroz. and A. Qorbanali. 2014. Effect of bio-fertilizer, manure and chemical fertilizer on yield and reproductive characteristics of sunflower (*H. annuus* L.). Intl. J. Res. Agric. Environ. Sci. 3(1): 36-43.

Bremner, J. M. and G. A. Breitenbeck. 1983. A simple method for determination of ammonium in semi micro Kjeldahl analysis of soils and plant materials using a block digester. Soil Sci. Plant Anal. 14: 905-913.

Cheraghi, Y., F. A. Mohyedi. and M. Kalhor. 2016. Effects of organic and chemical fertilizers on yield components of common wheat (*Triticum aestivum* L.). Inst Integrative Omics App. Bio-Tech. J. 7(8): 82-86.

Eidy-Zadeh, Kh., A. Damghani Mahdavi, E. Ebrahimpur. and H. Sabahi. 2012. Effects of amount and method organic fertilizers combined with the chemical fertilizer application on yield and yield components of maize. Electronic J. Crop Prod. 4(3): 35-21. (Abstract in English)

Eidy-Zadeh, Kh., A. Damghani Mahdavi, F. Ebrahimpur. and H. Sabahi. 2012. Effects of amount and method organic fertilizers combined with the chemical fertilizer application on yield and yield components of corn. Electronic J. Crop Prod. 5(3): 35-21.

Hojattipor, E., B. Jafari. and M. Dorostkar. 2014. The effect of integration of biological and chemical fertilizers on yield, yield components and growth indexes of wheat. J. Plant Echophysiol. 5(15): 36-48. (Abstract in English)

Kemal, Y. O. and M. Abera. 2015. Contribution of integrated nutrient management practice for sustainable crop productivity, nutrient uptake and soil nutrient status in Maize based cropping systems. J. Nutr. 2(1): 1-10.

Mohan, S., M. Singh. and R. Kumar. 2015. Effect of nitrogen, phosphorus and zinc fertilization on yield and quality of kharif fodder: A review. Agri. Rev. 36(3): 218-226. **Moosavi, S. Gh., M. J. Seghatoleslami. and R. Arefi. 2013.** Effect of N fertilization and plant density on yield and yield components of grain sorghum under climatic conditions of Sistan, Iran. J. Sci. Agri. 3 (1): 1-8. PSCI Publ.

Nouraki, F., M. AlaviFazel, A. Naderi, E. Panahpoor. and Sh. Lack. 2016. Effects of Integrated Management of Bio and Chemical Fertilizers on Yield of Maize Hybrids (*Zea mays* L.). J. Exp. Biol. Agric. Sci. 4(4): 421.426.

Ram-Rao, D. M., J. Kodan-Daramaiah, M. P. Reddy, R. S. Katiyar. and V. K. Rahmathulla. 2007. Effect of VAM fungi and bacterial biofertilizers on mulberry leaf quality and silk worm cocoon characters under semiarid conditions. Caspian J. Environ. Sci. 5(2): 111-117.

Saghir Khan, M., A. Zaidi. and A. Parvaze Wani. 2007. Role of phosphate-solubilizing microorganisms in sustainable agriculture, A review. Agron. Sustainable Development. Springer Verlag. Sci. 27(1): 29-43.

Seyed Sharifi, R. and H. Nazarli. 2013. Effects of Nitrogen and seed biopriming with plant growth promoting rhizobacteria (PGPR) on yield, rate and effective grain filling period of sunflower (*Helianthus annus* L.). 23(2): 19-36. (Abstract in English)

Shadab Niazi, P., R. Monaem. and A. Azadi. 2017. Effect of vermicompost on yield and forage quality in intercropping of maize and mung. J. Agri. Sci. 9(5): 233-240.

Shamoradi, F. and S. K. Marashi. 2018. Influence of Chemical and Biological Fertilizers on Agro Physiological Characteristics of Corn (*Zea mays* L., S.C. 703). J. Crop. Nutr. Sci. 4(1): 1-16.

Soleimanzadeh, H. and F. Ghooshchi. 2013. Response of growth and yield of maize to bio-fertilizers in organic and conventional cropping systems. Intl. J. Agri. Crop Sci. 5 (7): 797-801.

Sprent, J. and P. Sprent. 1990. Nitrogen Fixation Organisms. Chapman and Hall. New York. USA. 323p.

Sudhakar, P., G. N. Chattopadhyay, S. K. Gangwar. and J. K. Ghosh. 2000. Effect of foliar application of *Azotobacter*, *Azospirillum* and *Beijerinckia* on leaf yield and quality of mulberry (*Morus alba*). J. Agric. Sci. 134: 227–234.

Szulc, P. 2013. Effects of soil supplementation with urea and magnesium on nitrogen uptake, and utilization by two different forms of maize (*Zea mays* L.) differing in senescence rates. Polish J. Environ. Studies. 22: 239-248.

Tarang, E., M. Ramroudi, M. Galavi, M. Dahmardeh. and F. Mohajeri. 2013. Effects of Nitroxin bio-fertilizer with chemical fertilizer on yield and yield components of grain corn. Intl. J. Agri. Sci. 3(5): 400-405.

Vessey, J. K. 2003. Plant growth promoting rhizobacteria as bio-fertilizers. J. Plant Soil. 255: 571-586.