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Assessment Effect of Different Level of Combination Chemical and Biological Fertilizer and Several Type of Application Fertilizer on Morphological and Qualitative Traits of Bread Wheat

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RESEARCH ARTICLE

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ABSTRACT

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

OBJECTIVES: Current study was done to assess effect of different rate of combination fertilizer and biological fertilizer and type of application biofertilizer on morphological and qualitative characteristics of Wheat.

METHODS: This research was carried out via factorial experiment based on randomized complete blocks design with three replications along 2020-2021 year. The treatments included different rate of combination Nitrogen fertilizer and Biofertilizer (Fla Wheat) (a_1: 100% nitrogen with nonuse of Fla Wheat as control or N_{100}/F_0, a_2: 70% Nitrogen with Fla Wheat or N_{70}/F_1, a_3: 40% Nitrogen with Fla Wheat or N_{40}/F_1) and several methods of applying biofertilizer (Fla Wheat) (b_1: 100% Seed treatment, b_2: 100% by irrigation, b_3: 50% seed treatment with 50% by irrigation).

RESULT: Result of analysis of variance indicated effect of different level of fertilizer combination, method of application fertilizer (instead spike length) and interaction effect of treatments (instead spike length, seed nitrogen content and seed protein content) on all measured traits was significant. Mean comparison result of different level of fertilizer combination showed that maximum amount of plant height (84.71 cm), spike length (11.68 cm), seed yield (7032.1 $kg.ha^{-1}$) and seed nitrogen content (2.13%) was noted for N_{100}/F_0 and minimum of those belonged to N_{40}/F_2 treatment. As for Duncan classification made with respect to different level of Method of application fertilizer the highest and lowest amount of measured traits was for M_3 and M_2 treatment (instead spike length and seed protein content). Seed protein content against treatment showed reverse trend.

CONCLUSION: Based on result of current research according economically situation consume 70% Nitrogen with biofertilizer (Fla Wheat) at 50% seed treatment with 50% by irrigation can advised to producers.

KEYWORDS: *Nitrogen, Plant height, Protein, Spike length, Yield.*

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1. BACKGROUND

The world does not have enough potential for increasing the soil level cultivated with wheat; therefore in order to increase the wheat production, we have to increase the productivity of the fields which have been cultivated with wheat (FAO, 2017). There is a need to increase the yield of wheat per unit area in the world to fulfill its demands as a result in the rapid growth of the world's population. The use of modern varieties of wheat and judicious fertilization are the important factors which can help the increase of wheat production. It is well recognized that crop productivity depends on adequate plant nutrient and organic matter content of the soil (Mehraban, 2013). 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. Lotfi Jala-Abadi (2012) evaluated the different fertility systems associated with wheat cultivars production and reported that wheat yield and its component can be raised significantly by modifying agronomic practices. Yields were increased, by application of animal manure and bio-fertilizer, as well as application of inorganic nutrients. The integrated use of animal manure and bio-fertilizer performed better than the use of inorganic fertilizer or animal manure alone. Most southwestern lands of Iran, especially Khuzestan province, are poor in organic matter, hence their organic carbon content is less than 1%; therefore, increasing the amount of organic matter is necessary. Wheat is one of the most important crops playing an important role in providing food security of the country. Lack of adequate amounts of micronutrients such as iron, copper and manganese in environment will cause disorder in growth and yield of this plant. Nowadays, due to the low concentration of micro-nutrients in wheat seed which is the main food of Iranians, the emergence and spread of many diseases, such as kidney stones, anemia, fatigue and gastrointestinal diseases are common in the country. Lack of micronutrients is mainly observed in calcareous soils (Ziaeian and Malakouti, 1999). The purpose of the use of these elements in the process of crop production is to improve the quality and quantity of products and to enrich them in addition to increasing production. So far, much many studies have been done on the effect of each micronutrient on increasing the quality and quantity of wheat (Hung *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). The growth and yield of a crop can be adversely affected by deficient or exces-

sive supply of any one of the essential nutrients. However, in intensive agriculture nitrogen is the major nutrient which determining crop yield. 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). Nitrogen (N) is essential for all biological process that occurs in the plant. A sub-optimal supply of N limits the expression of yield potentials of green bean varieties (Dauda *et al*., 2015). Beyranvand *et al*. (2013) suggested that effect of nitrogen and phosphate bio-fertilizers were evaluated the positively, there were an increase in plant height, ear weight, and number of grain per cob, grain yield and biomass yield. Increasing yield was attributed to the plant growth promoting substances by root colonizing bacteria more than the biological nitrogen fixation, stated that yield increased due to promoting root growth which in turn enhancing nutrients and water uptake from the soil (Lin *et al*., 1983). Combined application of organic fertilizer and urea fertilizer or combination urea fertilizer and polyamines significantly increased yield, vegetative growth and chlorophyll index (Zeid, 2008).

2. OBJECTIVES

Current study was done to assess effect of different rate of combination fertilizer and biological fertilizer and type of application biofertilizer on morphological and qualitative characteristics of Wheat.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

This research was carried out to evaluate Nitrogen fertilizer and Biofertilizer (Fla Wheat) on growth indices of Wheat crop via factorial experiment based on randomized complete blocks design with three replications along 2020-2021 year. Place of research was located in Hamidiyeh city at longitude 48°40'E and latitude 36°31'N in Khuzestan province (Southwest of Iran). The treatments included different rate of combination Nitrogen fertilizer and Biofertilizer (Fla Wheat) (a_1: 100% nitrogen with nonuse of Fla Wheat as control or N_{100}/F_0, a_2: 70% Nitrogen with Fla Wheat or N_{70}/F_1, a_3: 40% Nitrogen with Fla Wheat or N_{40}/F_1) and several methods of applying biofertilizer (Fla Wheat) (b_1: 100% Seed treatment, b_2: 100% by irrigation, b_3: 50% seed treatment with 50% by irrigation). This experiment had 36 plots. Each plot consisted of 9 lines with a distance of 20 cm and 5 meters length. Properties of studied field was mentioned in table 1.

Table 1. Physical and chemical properties of studied field

Soil texture	Clay (%)	Silt (%)	Sand (%)	K (ppm)	P (ppm)	N (%)	OC (%)	pH	EC ($ds.m^{-1}$)	SP (%)
Clay loam	52	27	21	168	9.1	0.039	0.6	7.2	3.5	48

3.2. Farm Management

According to the fertilizer recommendation of the soil and water department of the Agricultural and Natural Resources Research Center of Khuzestan Province, the rate of application urea fertilizer was 300 $kg.ha^{-1}$ (equivalent to 138 $kg.ha^{-1}$ pure nitrogen). Phosphorus fertilizer from triple superphosphate source at the rate of 90 $kg.ha^{-1}$ and potash fertilizer from potassium sulfate source at the rate of 50 $kg.ha^{-1}$ were applied as a base before planting. 1/3 of nitrogen fertilizer was applied as a base and the remaining 2/3 at tillering and steam elongation stage. Distilled water was used instead of Fla Wheat in the control treatment. It should be noted that according to the manufacturer's recommendation, for every 100 kg of seeds, one liter of Fla Wheat biofertilizer was used as seed treatment. Place the seeds in the shade on nylon or a clean surface and sprinkle the bio-inoculum gradually on the seeds after shaking and mix well so that all of them are evenly impregnated with fertilizer. Then, in the shortest time after drying the seeds in the shade, planting was done. In the method of inoculation with irrigation in two shifts (each stage in the amount of one liter per hectare and at intervals of 40 days) Fla Wheat biofertilizer was applied with irrigation water. The first stage was at the beginning of the stem and the second stage was at the time of pollination. Fla Wheat biofertilizer contains *Microbacterium sp*. This biofertilizer increases wheat yield in dry and irrigated conditions due to its growth-promoting bacteria (10^7-10^8 CFU per gram) and production of natural growth hormones.

3.3. Measured Traits

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

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

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. Plant height

According result of analysis of variance effect of fertilizer combination, method of application fertilize and interaction effect of treatments on plant height was significant at 1% and 5% probability level, respectively (Table 2). Result of mean comparison of the fertilizer combination showed the maximum of plant height was obtained for N_{100}/F_0 (84.71 cm) and minimum of that (65.69 cm) was for N_{40}/F_2 treatment (Table 3).

Evaluation mean comparison result indicated in different level of method of application fertilizer the maximum amount of plant height was noted for M_3 (77.44 cm) and minimum of that belonged to M_2 (74.05 cm) treatment (Table 4). Evaluation mean comparison result of interaction effect of treatments indicated maximum plant height was noted for N_{100}/F_0 and M_3 (84.90 cm) and lowest one belonged to N_{40}/F_2 and M_2 treatment (63.43 cm) (Table 5). 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. In addition, biological fertilizers have been reported to affect plant growth through the production of hormones that stimulate growth, especially auxin (Krism, 2018). Potals (2017) reported that the maximum plant height was produced in rice plant with the use of biological fertilizers with consumption of 180 kg.ha^{-1} nitrogen.

Table 2. Result of analysis of variance effect of treatment on plant height, spike length, seed yield, seed nitrogen content and seed protein content

S.O.V	df	Plant height	Spike length	Seed yield	Seed nitrogen content	Seed protein content
Replication	2	41.95**	1.1135**	2421*	0.03714**	1.448**
Fertilizer combination (F)	2	821.61**	45.8136**	404948**	1.83034**	71.453**
Method of application fertilize (M)	2	25.77**	0.5881^{ns}	22273**	0.02849*	1.112*
F×M	4	5.10*	0.0953^{ns}	1644*	0.00329^{ns}	0.131^{ns}
Error	16	1.54	0.1686	435	0.00474	0.185
CV (%)	-	11.06	20.45	7.04	13.14	14.23

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

4.2. Spike length

Result of analysis of variance revealed effect of fertilizer combination on spike length was significant at 5% probability level but effect of method of application fertilize and interaction effect of treatments was not significant (Table 2). Mean comparison result of different level of Fertilizer combination indicated that maximum spike length was noted for N_{100}/F_0 (11.68 cm) and minimum of that belonged to N_{40}/F_2 (7.18 cm) treatment (Table 3). 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).

4.3. Seed yield

According result of analysis of variance effect of fertilizer combination, method of application fertilize and interaction effect of treatments on seed yield was significant at 1% and 5% probability level, respectively (Table 2). Mean comparison result of different level of Fertilizer combination indicated that maximum seed yield was noted for N_{100}/F_0 (7032.1 kg.ha^{-1}) and minimum of that belonged to N_{40}/F_2 treatment (2791.4 kg.ha^{-1}) (Table 3). As for Duncan classification made with respect to different level of Method of application fertilizer maximum and minimum amount of seed yield belonged to M_3 (5462.1 kg.ha^{-1}) and M_2 treatment (4469.3 kg.ha^{-1}) (Table 4). Evaluation mean comparison result of interaction effect of treatments indicated maximum seed yield was noted for N_{100}/F_0 and M_3 (7389.7 kg.ha^{-1}) and lowest one belonged to N_{40}/F_2 and M_2 treatment (2366.4 kg.ha^{-1}) (Table 5). Eydizadeh *et al*. (2010) stated that biological fertilizers increase the root contact with soil and ultimately increase the absorption of nutrients. Mentioned researchers also stated that the production of various acids by bacteria could lead to more organic solubility of the soil. It seems that the effect of bio-fertilizers provides up to 50% of the plant's nutritional requirements, and the rest of the plant's needs must be provided through the use of chemical fertilizers. 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.

Table 3. Effect of different method of Fertilizer combination on plant height, spike length, seed yield, seed nitrogen content and seed protein content

Fertilizer combination	Plant height (cm)	Spike length (cm)	Seed yield (kg.ha^{-1})	Seed nitrogen content (%)	Seed protein content (%)
N_{100}/F_0	84.71a	11.68a	7032.1a	2.13a	7.72c
N_{70}/F_1	76.84b	9.63b	5016.5b	1.63b	10.21b
N_{40}/F_2	65.69c	7.18c	2791.4c	1.23c	13.34a

*Mean which have at least once common letter are nit significant different at the 5% level using (DMRT)

N_{100}/F_0: 100% nitrogen with nonuse of Fla Wheat as control or, N_{70}/F_1: 70% Nitrogen with Fla Wheat or, N_{40}/F_1: 40% Nitrogen with Fla Wheat.

4.4. Seed nitrogen content

Result of analysis of variance showed effect of fertilizer combination and method of application fertilize on seed nitrogen content was significant at 1% and 5% probability level, respectively but interaction effect of treatments was not significant (Table 2). Compare different level of fertilizer combination showed that the maximum and the minimum amount of seed nitrogen content belonged to N_{100}/F_0 (2.13%) and N_{40}/F_2 (1.23%) treatments (Table 3). Evaluation mean comparison result indicated in different level of method of application fertilizer the

maximum amount of seed nitrogen content was noted for M_3 (1.72%) and minimum of that belonged to M_2 (1.62%) treatment (Table 4). Jafari Haghighi and Yarmahmodi (2011) in conclusion for reach to high yield in corn stated biological fertilizer cannot sufficient but integrated application of fertilizers (Biological and chemical fertilizers) became causes significant increase in yield. Use of bio-fertilizers offers agronomic and environmental benefits to intensive farming systems in Egypt, and the data showed that using *Azospirillum brasilense* or commercial bio fertilizers in cereals with a half nitrogen rate (144 kgN.ha^{-1}) caused a significant increase in yield. Further, seed inoculation with Rhizobium, phosphorus solubilizing bacteria, and organic amendment increased the seed production of the crop (Panwar *et al*., 2006).

Table 4. Effect of different method of application Fertilizer on plant height, spike length, seed yield, seed nitrogen content and seed protein content

Method of application fertilizer	Plant height (cm)	Spike length (cm)	Seed yield (kg.ha^{-1})	Seed nitrogen content (%)	Seed protein content (%)
M_1	75.75ab	9.57a	4908.8b	1.67ab	10.46ab
M_2	74.05b	9.21a	4469.3c	1.61b	10.96a
M_3	77.44a	9.71a	5462.01a	1.72a	10.16b

*Mean which have at least once common letter are nit significant different at the 5% level using (DMRT)

4.5. Seed protein content

According result of analysis of variance showed effect of fertilizer combination and method of application fertilize on seed protein content was significant at 1% and 5% probability level, respectively but interaction effect of treatments was not significant (Table 2).

Table 5. Mean comparison interaction effects of treatments on plant height and seed yield

Fertilizer combination	Method of application fertilizer	Plant height (cm)	Seed yield (kg.ha^{-1})
N_{100}/F_0	**M_1**	84.80ab	6947.1b
	M_2	84.43ab	6759.4b
	M_3	84.90a	7389.7a
N_{70}/F_1	**M_1**	77.17bc	4974.9d
	M_2	74.30c	4281.9e
	M_3	79.05b	5792.8c
N_{40}/F_2	**M_1**	65.29de	2804.4fg
	M_2	63.43e	2366.4g
	M_3	68.36d	3203.6f

*Mean which have at least once common letter are nit significant different at the 5% level using (DMRT)
N_{100}/F_0: 100% nitrogen with nonuse of Fla Wheat as control or, N_{70}/F_1: 70% Nitrogen with Fla Wheat or, N_{40}/F_1: 40% Nitrogen with Fla Wheat.

The mean comparison result of different level of fertilizer combination indicated that maximum amount of seed protein content was related for N_{40}/F_2 (13.34%)

and minimum of that belonged to the N_{100}/F_0 treatment (7.72%) (Table 3). Shadab Niazi *et al*. (2017) by evaluate the effect of different level of vermicompost components (0, 2.5 and 5 $t.ha^{-1}$) on Mung bean crop, reported the highest amount of 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 (or control). As for Duncan classification made with respect to different level of Method of application fertilizer maximum and minimum amount of seed protein content belonged to M_2 (10.96%) and M_3 treatment (10.16%) (Table 4). 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 the seeds under stress conditions is very important matter (Modhej *et al*., 2009).

5. CONCLUSION

Based on result of current research according economically situation consume 70% Nitrogen with biofertilizer (Fla Wheat) at 50% seed treatment with 50% by irrigation can advised to producers.

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FOOTNOTES

AUTHORS' CONTRIBUTION: All authors are equally involved.

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