Malaysian Journal of Sustainable Agriculture (MJSA)
DOI : http://doi.org/10.26480/mjsa.01.2019.08.12

ISSN: 2521-2931 (Print)
ISSN: 2521-294X (Online)
CODEN : MJSAEJ

REVIEW ARTICLE

GRAIN YIELD AND QUALITY OF WHEAT AS AFFECTED BY CULTIVARS AND SEEDING RATES

Intsar H.H, Al-Hilfy[1]*, S.A. Wahid[2]*, H.M.K. Al-Abodi[3], S. A. A. Al-Salmani[4], Md. Reaz Mahamud[5], Md. Bellal Hossain[6]

[1]Department of Field Crops Science, College of Agriculture, University of Baghdad.
[2]Mesopotamia State Company for Seed Production, Ministry of Agriculture, Baghdad, Iraq,
[3]Office of Agricultural Researches, Ministry of Agriculture Baghdad, Iraq
[4]Department of Field Crops, College of Agricultural Sciences University of Anbar.
[5]Department of Nutrition and Food Engineering, Daffodil International University
[6]Department of Nutrition and Food Engineering, Daffodil International University
**Corresponding Author Email: dr.intsar_hadi@yahoo.com,safa_20003@yahoo.com,reaz.nfe@daffodilvarsity.edu.bd,headnfe@daffodilvarsity.edu.bd*

ARTICLE DETAILS

Article History:

Received 15 November 2018
Accepted 17 December 2018
Available online 2 January 2019

ABSTRACT

An experiment was conducted at Research Station, State Board for Seeds Testing and Certification, Baghdad, Iraq during 2015-2016 and 2016-2017 seasons to determine the effect of six seeding rates (80, 100, 120, 140, 160, and 180 kg ha^{-1}) on yield and quality of three wheat cultivars (Bohooth 22, Bohooth 158, and Rasheed). The experiment was laid out in Randomized Complete Blocks Design (RCBD) with split plots arrangement placing seeding rates in main plots and cultivars in sub-plots with three replicates. Seeding rate 140 kg ha^{-1} gave highest grain yield (4.95 and 4.99 t ha^{-1}) for both seasons, respectively. Seeding rate 80 kg ha^{-1} gave highest protein content (13.95% and 13.68%) and gluten (34.46% and 32.95%) for both seasons, respectively. Seeding rate of 140 kg ha^{-1} gave the highest protein yield (618.60 kg ha^{-1}) during the first season, while seeding rate of 120 kg ha^{-1} gave the highest yield in this trait (621.02 kg ha^{-1}) during the second season. Rasheed cultivar plants produced highest grain yield (4.77 and 4.89 t ha^{-1}), whereas Bohooth 158 plants recorded highest protein content (13.13% and 13.28%) and gluten (34.85% and 33.21%) for both seasons, respectively. So, it's recommended to cultivate the three studied wheat cultivars at seeding rate 140 kg ha^{-1} to obtain highest grain yield, whereas seeding rate 80 kg ha^{-1} is the best to get the highest protein and gluten content.

KEYWORDS

Wheat, seeding rates, grain yield, protein, gluten.

1. INTRODUCTION

Wheat (*Triticum aestivum* L.) is one of the most important cereal crops used as a food all over the world. It ranks first in the world's cereal production and is a staple food for approximately one third of the world's population [1]. The grain contains about 60-80% carbohydrates, 8-15% protein, 1.5-2% fat, 1.5-2% inorganic ions, and vitamins (B complex and E) in small amounts [2]. Wheat grain quality is a complex trait resulting from the interaction between several protein components. It has been observed that the grains quality is a function of grain composition predominantly in proteins, which in turn depends on many factors [3]. Wheat is the main strategic crop in Iraq, and the date of its cultivation extends to several thousand years since the emergence of the first communities in the world. The harvested area during 2014 winter season was estimated 2109455 ha, whereas the average yield per hectare for the same season was estimated 2396.4 kg ha^{-1} on the basis of the total harvested area [4]. Despite this, Iraq has faced a large and expanding deficit in the production of this crop, especially during the past three decades, and in order to overcome the deficit, several million tons of wheat grains were imported every year, which was a burden on the country budget. The reasons behind this deficit might be due to poor crop management, including seeding rates and the use of old cultivars. For achieving high yield and quality of wheat, it is necessary to use all the cultural practices completely and on time and adapt them to cultivars [5]. So, the aim of this study was to determine the effect of different seeding rates on the grain yield and quality of three bread wheat cultivars.

2. MATERIALS AND METHODS

A field experiment was carried out at Abu-Ghuraib Research Station, State Board for Seeds Testing and Certification, Ministry of Agriculture, Baghdad, Iraq during the winter season of the years 2015/2016 and 2016/2017 to determine the effect of six seeding rates on yield and quality of three bread wheat cultivars. The experiment was laid out according to randomized complete blocks design having split plot arrangements with three replicates. Seeding rates (80, 100, 120, 140, 160, and 180 kg ha^{-1}) were allocated in the main plots and the three cultivars (Bohooth 22, Bohooth, 158 and Rasheed) in the sub-plots. The net of sub plot area was 6 m^2 (ten rows, three meters long, 20 cm apart, and 5 cm depth). Seed bed was prepared by ploughing the field three times with cultivator followed by planking. Wheat grains were sown manually on 25th November in both seasons with single row hand drilling. Before sowing, soil was analyzed for its physico-chemical properties which were clay loam in texture with 70.0 and 88.3 ppm available nitrogen, 5.38 and 4.95 ppm available phosphorus, 372.0 and 428.0 ppm available potassium, 3.6 and 2.4 dSm^{-1} Ec and 7.0 and 7.2 pH for both seasons, respectively. The nitrogen fertilizer (200 kg ha^{-1}) in the form of urea (46%) was applied as per treatment in four splits, one at the time of sowing, second at growth stage ZGS:13, third at ZGS:32, and forth at ZGS:40 according to Zadoks scale, while phosphorus (100 kg ha^{-1}) was added at the time of planting in a form of tri super phosphate (P_2O_5 46%) [6,7]. All plots received uniform cultural practices. The recorded

data were analyzed statistically by using statistical software package Genstat version (12). The least significant differences (L.S.D) at the level of 0.05 probability was employed to compare the differences among the treatment means [8]. The studied traits are:

- Grain yield (t ha^{-1}): At maturity, one square meter was harvested manually from each plot. Spikes were threshed manually and grains were separated and weighed. Then the grain yield was converted into tons per hectare. The moisture equation below was used to measure the moisture of harvested grains. The weight was then converted to one ton [9]:

$$\mathbf{Y(M_2)} = \frac{100 - M_1}{100 - M_2} \times Y(M_1)$$

  Y (M2) = grain weight at the level to be measured (14%).
  Y (M1) = grain weight at actual moisture level (moisture level at harvest).
  M1 = the actual percentage of moisture.
  M2 = required percentage of moisture.

- Protein content in grains (%): Total nitrogen content in grains was estimated using Kernelyzer-M apparatus from Brabender (Germany) which belongs to the Agricultural Researches Office - Ministry of Agriculture.
- Gluten content in grains (%): gluten is estimated using the same device used to estimate the protein content in grains.
- Protein yield (kg ha^{-1}): estimated according to the following equation:
  Protein yield (kg ha $^{-1}$) = grain yield (kg ha $^{-1}$) × percentage of protein in grains

3. RESULTS AND DISCUSSION

3.1 Grain yield (t ha^{-1})

Data in Table 1 show that the effect of seeding rates, cultivars, and their interaction on this trait was significant for both seasons. Grain yield increased with increasing seeding rates from 80 to 140 kg ha^{-1} which recorded highest grain yield (4.95 and 4.99 t ha^{-1}), then followed with a decrease till the seeding rate 180 kg ha^{-1} which gave the lowest yield (3.84 and 3.97 t ha^{-1}) for both seasons, respectively. The highest grain yield recorded with plants sown at seeding rate 140 kg ha^{-1} might be due the superiority of the plants sown at this seeding rate in some growth and yield traits compared to other seeding rates (unpublished data).

It is clear from Table 1 that the cultivar Rasheed gave the highest grain yield (4.77 and 4.89 t ha^{-1}), then followed by Bohooth 22 (4.45 and 4.65 t ha^{-1}), whereas the lowest values were obtained from cultivar Bohooth 158 plants (4.07 and 4.23 t ha^{-1}) for both seasons, respectively. Cultivar Rasheed achieved an increase in this trait 7.19% and 17.33% during the first season, and 5.25% and 15.74% during the second season in comparison with Bohooth 22 and Bohooth 158 cultivars, respectively. The superiority of Rasheed cultivar could be due to its superiority in a number of growth and yield traits compared to two other cultivars (unpublished data).

Table 1: Effect of seeding rates, cultivars, and their interaction on the grain yield (t ha^{-1}) during the seasons 2015-2016 and 2016-2017

Seeding rates (kg ha^{-1})	First season 2015-2016			Means	Second season 2016-2017			Means
	Cultivars				Cultivars			
	Bohooth 22	Bohooth 158	Rasheed		Bohooth22	Bohooth 158	Rasheed	
80	4.47	3.68	4.78	4.31	4.64	3.73	4.82	4.40
100	4.51	3.82	4.86	4.39	4.75	4.13	4.93	4.60
120	4.69	4.33	5.13	4.72	4.86	4.55	5.15	4.86
140	4.84	4.79	5.22	4.95	4.93	4.83	5.22	4.99
160	4.47	4.19	4.47	4.38	4.68	4.64	4.77	4.70
180	3.75	3.59	4.17	3.84	4.02	3.46	4.45	3.97
L.S.D 5%	0.38			0.26	0.39			0.26
Means	4.45	4.07	4.77		4.65	4.23	4.89	
L.S.D 5%	0.15				0.16			

Regarding the effect of interaction between seeding rates and cultivars, its obvious from Table 1 that the response of cultivars to increased seeding rates was different, where the grain yield for all cultivars increased with increasing seeding rates till 140 kg ha^{-1}, then a reduction in this trait occurred with increasing seeding rates till 180 kg ha^{-1} during both seasons. Rasheed cultivar recorded highest grain yield (5.22 and 5.22 t ha^{-1}) when plants sown at seeding rate 140 kg ha^{-1}, while the lowest values in this trait were obtained from Bohooth 158 plants when sown at seeding rate 180 kg ha^{-1} (3.59 and 3.46 t ha^{-1}) for both seasons, respectively.

3.2 Protein content (%)

Data in Table 2 show that the effect of seeding rates, cultivars and their interaction was significant on this trait for both seasons. There was a decrease in the means of this trait with increasing seeding rates. Seeding rate of 80 kg ha^{-1} gave the highest protein content (13.95% and 13.68%), whereas lowest means for the same trait were recorded with seeding rate 180 kg ha^{-1} (11.76% and 11.62%) for both seasons, respectively.

This decrease in protein content with increasing seeding rates might be due to the high competition between plants in the unit area for nutrients (the most important of which is nitrogen), as well as light, causing a decrease in the protein content due to the lack of necessary assimilates to form the protein compared to the low seeding rates, and consequently an increase in the percentage of this trait. The result of this study was in agreement with those obtained and found that the increase in seeding rates caused a decrease in protein content [10,11].

The cultivars significantly differed in this trait. Bohooth 158 recorded the highest percentage of protein (13.13% and 13.28%), while Rasheed cultivar recorded the lowest percentage (12.41% and 12.20%) for both study seasons, respectively.

It is noted that Rasheed cultivar, which achieved the highest percentage of grain yield in this study, is the same that gave the lowest percentage of this trait, whereas the highest percentage of the same trait was recorded with Bohooth 158 cultivar, which gave the lowest grain yield. The reason for the difference between cultivars might be due to the variation in their competition on various growth factors at different seeding rates, (nitrogen is considered the most important factor, because it is the basic component

of protein) [12].

Table 2: Effect of seeding rates, cultivars, and their interaction on the protein content (%) during the seasons 2015-2016 and 2016-2017

Seeding rates (kg ha^{-1})	First season 2015-2016			Means	Second season 2016-2017			Means
	Cultivars				Cultivars			
	Bohooth 22	Bohooth 158	Rasheed		Bohooth22	Bohooth 158	Rasheed	
80	13.91	14.41	13.51	13.95	13.49	14.32	13.22	13.68
100	13.51	13.81	13.11	13.48	13.15	14.25	13.09	13.50
120	13.01	13.31	12.61	12.98	12.65	13.45	12.32	12.81
140	12.61	12.91	12.01	12.51	12.25	12.92	12.06	12.41
160	12.31	12.41	11.71	12.15	11.96	12.60	11.49	12.01
180	11.85	11.91	11.51	11.76	11.69	12.16	11.02	11.62
L.S.D 5%	0.19			0.1032	0.17			0.12
Means	12.87	13.13	12.41		12.53	13.28	12.20	
L.S.D 5%	0.08				0.06			

As for interaction, the cultivar Bohooth 158 achieved highest percentage of protein (14.41% and 14.32%) when sown at seeding rate of 80 kg ha^{-1}, whereas lowest percentage was recorded with Rasheed cultivar plants sown at seeding rate of 180 kg ha^{-1} (11.51% and 11.02%) for both seasons, respectively.

3.3 Wet gluten percentage (%)

The data in Table 3 show a significant effect of seeding rates, cultivars and their interaction on the percentage of wet gluten for both seasons. The percentage of this trait decreased with increasing seeding rates during both seasons. Seeding rate 80 kg ha^{-1}, recorded the highest percentage of wet gluten (34.46% and 32.95%), while seeding rate 180 kg ha^{-1} gave the lowest percentage of the same trait (31.07% and 29.67%) for both seasons, respectively. The reason for the decrease in this trait with increasing seeding rates might be due to the increased competition among plants at high seeding rates for nutrients and light, which caused a decrease in the percentage of nitrogen in the green parts of the plants at different growth stages during both seasons, resulting in a decrease in the percentage of wet protein, and consequently a decrease in gluten percentage which is considered the largest component of protein.

Regarding cultivars, Bohooth 158 was superior in this trait and recorded the highest percentage of wet gluten (34.85% and 33.21%), whereas Rasheed cultivar plants recorded the lowest percentage of the same trait (31.27% and 29.72%) for both seasons, respectively. In regard to the effect of interaction between seeding rates and cultivars on this trait, the cultivar Bohooth 158 gave the highest percentage (36.43% and 35.08%) with seeding rate 80 kg ha^{-1}, while the lowest percentage was with Rasheed plants when sown at seeding rate 180 kg ha^{-1} (29.44% and 28.00%) for both seasons, respectively.

Table 3: Effect of seeding rates, cultivars, and their interaction on the wet gluten percentage (%) during the seasons 2015-2016 and 2016-2017

Seeding rates (kg ha^{-1})	First season 2015-2016			Means	Second season 2016-2017			Means
	Cultivars				Cultivars			
	Bohooth 22	Bohooth 158	Rasheed		Bohooth22	Bohooth 158	Rasheed	
80	34.23	36.43	32.73	34.46	32.89	35.08	30.89	32.95
100	33.93	36.03	32.34	34.10	32.79	34.60	30.60	32.67
120	33.33	35.23	31.84	33.47	31.46	33.46	30.12	31.68
140	32.44	34.63	31.04	32.70	30.51	32.51	30.00	31.00
160	31.84	34.03	30.24	32.04	30.03	32.16	28.69	30.29
180	31.04	32.73	29.44	31.07	29.55	31.46	28.00	29.67
L.S.D 5%	0.21			0.12	0.40			0.24
Means	32.80	34.85	31.27		31.20	33.21	29.72	
L.S.D 5%	0.09				0.17			

3.4 Protein yield (kg ha^{-1})

Table 4 reveals that the effect of seeding rates, cultivars, and their interaction on this trait was significant for both seasons. The means of this trait decreased with increasing seeding rate from 80 to 100 kg ha^{-1} and then increased till the seeding rate 140 kg ha^{-1}, which recorded the highest

protein content in the grains (618.60 kg ha^{-1}), and then a decrease in the means of this trait occurred with increasing seeding rates till 180 kg ha^{-1}, which recorded the lowest value (450.55 kg ha^{-1}) in the first season. In the second season, the means of the same trait increased with increasing seeding rates from 80 to 120 kg ha^{-1}, which recorded the highest mean (621.02 kg ha^{-1}), then a decrease occurred with increasing seeding rate to 180 kg ha^{-1}, which gave the lowest protein yield in the grains (459.98 kg ha^{-1}).

In terms of cultivars, Rasheed recorded the highest protein yield in grains (593.45 and 597.43 kg ha^{-1}), followed by Bohooth 22, which gave a protein yield of 574.10 and 583.19 kg ha^{-1}, while Bohooth 158 recorded the lowest means in this trait (533.48 and 560.86 kg ha^{-1}) for both seasons, respectively.

Regarding the interaction, the response of the cultivars to the different seeding rates varied during both seasons. The highest yield (647.12 kg ha^{-1}) was recorded with planting Rasheed at seeding rate 120 kg ha^{-1} during the first season, while the same cultivar gave the highest mean (644.60 kg ha^{-1}) at seeding rate 100 kg ha^{-1} during the second season. The lowest means of this trait were obtained from Bohooth 158 cultivar plants at seeding rate 180 kg ha^{-1} (427.87 and 420.25 kg ha^{-1}) for both seasons, respectively.

Table 4: Effect of seeding rates, cultivars, and their interaction on the protein yield (kg ha^{-1}) during the seasons 2015-2016 and 2016-2017

Seeding rates (kg ha^{-1})	First season 2015-2016			Means	Second season 2016-2017			Means
	Cultivars				Cultivars			
	Bohooth 22	Bohooth 158	Rasheed		Bohooth22	Bohooth 158	Rasheed	
80	621.46	530.44	645.60	599.17	625.58	534.20	637.26	599.01
100	608.79	527.64	637.08	591.17	625.24	588.68	644.60	619.51
120	610.59	576.45	647.12	611.39	615.46	612.58	635.00	621.02
140	610.35	618.34	627.10	618.60	603.58	624.49	629.63	619.23
160	549.81	520.15	523.63	531.19	559.67	584.94	548.00	564.20
180	443.63	427.87	480.15	450.55	469.62	420.25	490.06	459.98
L.S.D 5%	48.55			32.89	51.19			37.41
Means	574.10	533.48	593.45		583.19	560.86	597.43	
L.S.D 5%	19.34				19.22			

4. RECOMMENDATIONS

It is recommended to plant wheat at a seeding rate 140 kg ha^{-1} to obtain highest yield of grains, while the seeding rate 80 kg ha^{-1} is the best to get highest percentage of protein and gluten in the grains.

REFERENCES

[1] Nizamani, G.S., Tunio, S., Buriro, U.A., Keerio, M.I. 2014. Influence of different seed rates on yield contributing traits in wheat varieties. Journal of Plant Sciences, 2(5), 232-236.

Shahzad, M.A., Din, W.U., Sahi, S.T., Khan, M.M., Ehsanullah, Ahmad, M. 2007. Effect of sowing dates and seed treatment on grain yield and quality of wheat. Pakistan Journal of Agricultural Sciences, 44(4), 581-583.

[3] Farooq, O., Ali, M., Naeem, M., Sattar, A., Ijaz, M., Sher, A., Iqbal, M.M. 2015. Impact of sowing time and planting method on the quality traits of wheat. Journal of Global Innovations in Agricultural and Social Sciences, 3(1), 8-11.

[4] FAO. 2014. Food and Agriculture Organization statistical data. Available at http://www.fao.org/faostat/en/#data/QC

[5] Zecevic, V., Boskovic, J., Knezevic, D., Micanovic, D. 2014. Effect of seeding rate on grain quality of winter wheat. Chilean Journal of Agricultural Research, 74(1), 23-28.

[6] Zadoks, J.C., Change, T.T., Knozak, C.F. 1974. Adecimal code for growth stages of cereals. Weed Res., 14, 415-421.

[7] Jadoaa, Abbas, K. 1995. Wheat Facts and Guidelines. Publications of the Ministry of Agriculture. Extension and Agricultural Cooperation office. P. 487.

[8] Steel, R.G., Torrie, J.H. 1980. Principles and Procedures of Statistics: A biometrical Approach (2nd edn). McGraw Hill Book Co. USA. P. 481.

[9] AOAC. 1980. Official Methods of Analysis 13thed. The Association of Official Analytical Chemists. Washington DC, U.S.A.

[10] Gooding, M.J., Pinyosinwat, A., Ellis, R.H. 2002. Responses of wheat grain yield and quality to seed rate. The Journal of Agricultural Science, 138, 317-331.

[11] Daaboush, T.A., Bader, A.A.Y., Al-Absi, W. 2014. Response of some local Yemeni wheat cultivars to seeding rates and nitrogen fertilization. Yemeni Journal of Agriculture and Veterinary Sciences, 1 (2), 73-87.

[12] Abdulkerim, J., Tana, T., Eticha, F. 2015. Response of bread wheat (*Triticum aestivum* L.) varieties to seeding rates at Kulumsa, South Eastern Ethiopia. Asian Journal of Plant Sciences, 14(2), 50-58

AUTHOR DETAILS

Md. Reaz Mahamud
Asst. Technical Officer
Department of Nutrition and Food Engineering Daffodil International University
reaz.nfe@daffodilvarsity.edu.bd

Prof. Dr. Md. Bellal Hossain
Head
Department of Nutrition and Food Engineering Daffodil International University
headnfe@daffodilvarsity.edu.bd