Pure Appl. Biol., 9(1): 229-239, March, 2020
http://dx.doi.org/10.19045/bspab.2020.90027

Research Article

Analysis of wheat genotypes and N application on the yield in response to protein and nitrogen content in grains and straw

Aamir Khan[1], Wajid Ali Shah[1], Zahid Hussain[1], Manzoor Ahmad[1], Roohul Amin[1], Subhan Uddin[2], Muhammad Ishaq[1*], Safwan Akbar[1], Muhammad Wisal[1], Shah Nawaz Khan[1], Haseeb Ahmad Kakar[1], Murad Ali[1] and Sefat Ullah[1]

1. Department of Agronomy, Bacha Khan University, Charsadda-Pakistan
2. Department of Agricultural Mechanization, The University of Agriculture, Peshawar-Pakistan
**Corresponding author's email:* ishaqagronomist@gmail.com

Citation
Aamir Khan, Wajid Ali Shah, Zahid Hussain, Manzoor Ahmad, Roohul Amin, Subhan Uddin, Muhammad Ishaq, Safwan Akbar, Muhammad Wisal, Shah Nawaz Khan, Haseeb Ahmad Kakar, Murad Ali and Sefat Ullah. Analysis of wheat genotypes and N application on the yield in response to protein and nitrogen content in grains and straw. Pure and Applied Biology. Vol. 9, Issue 1, pp229-239. http://dx.doi.org/10.19045/bspab.2020.90027

Received: 08/07/2019 Revised: 19/09/2019 Accepted: 26/09/2019 Online First: 23/10/2019

Abstract

Nitrogen plays an important role in protein formation, cell improvement and other physiological and agronomical activities, while genotypes also play an important role in increasing yield because different genotypes have different performance. This research mainly focuses on nitrogen application and genotypes performance in wheat production. Nitrogen application showed significant variation for all parameters and produced maximum tiller m^{-2} (366), grains $spike^{-1}$ (52.5), biological yield (11775 kg ha^{-1}), grain yield (4009 kg ha^{-1}), nitrogen concentration in straw (0.50 %), protein concentration in straw (2.84 %), nitrogen concentration in grains (2.01 %) and protein concentration in grains (11.5 %) with nitrogen applied at the rate of 150 kg ha^{-1} while 120 kg nitrogen ha^{-1} gave maximum leaf area index (4.4 cm^{-2}) and thousand grains weight (40.1 g). Genotypes showed differentiation for all parameters recorded during the experiment except nitrogen and protein content in grains and straw while between different genotypes, wheat genotype Pirsabak-2013 performed better and produced good performance and produce maximum tillers m^{-2} (372), grains $spike^{-1}$ (52), leaf area index (4.4 cm^{-2}), thousand grains weight (40.4 g), biological yield (10767 kg ha^{-1}) and grain yield (3658 kg ha^{-1}). Interaction between nitrogen application and wheat genotypes significantly differed tiller m^{-2}, leaf area index, thousand grains weight and biological yield. Wheat genotype Pirsabak-2013 with nitrogen applications 120 up to 150 kg ha^{-1} enhanced grain yield, protein content, nitrogen content and could be recommended for qualitative and quantitative production in wheat.

Keywords: Cultivars; Genotypes; Nitrogen; Protein; Varieties; Wheat

Introduction

Wheat (*Triticum aestivum* L.) belongs to poaceae family and it's one of the most important crop amongst the cereals in terms of production and consumption. In the world, Pakistan ranks 10th number among the wheat producing countries with an average per annum yield production of 22 million (t) **[1]**.

Wheat was cultivated on about 9.25 million ha area with total production of 25.5 million tons, having an average yield of 2873 kg ha^{-1} while in the Khyber Pakhtunkhwa province area under cultivation was 0.75 million hectare having production of about 1.4 million tons with the average yield of 2359 kg ha^{-1} [2]. In Asia, Pakistan represents as a third largest producer of wheat where annual consumption of wheat is around 23 million tons that will leave the country with a surplus of a few tons that can be exported [3, 4].

There are different reasons for low production of wheat in Pakistan and this yield production gap of wheat in the country need to be occupied by increasing yield per unit area. Collective use of fertilizers is very important, as the proper combination of chemical fertilizers can increase the yield of wheat by 50% [5]. Most of these are associated with the nutrient management flaws. Among nutrient management aspects, unoptimistic application of nitrogen has a significant role to influence the crop productivity [6]. Nitrogen is vital in crop productivity, which plays an important role in accelerating yield and gave optimum economic return and its deficiency will constitute in low yield and productivity in cereal crops [7]. Nitrogen is the most important component of chlorophyll and its absence in soil effect the availability of phosphorus, potash and other nutrients [8]. Nitrogen is vital in crop productivity which plays an important role in accelerating yield and gave optimum economic return and its deficiency will result in low yield and productivity [9]. Application of nitrogen has a great importance and considered the best and appropriate for production in wheat and maize [10].

Throughout the world, nitrogen is believed to be the second most limiting factor in wheat crop production and it limits production in non-fertilized agriculture [11]. In the early growth stages of wheat crop, an adequate supply of nitrogen fertilizer in the form of urea is very important for the initiation of leaves and florets [12]. Among the compounds which play role in the process of photosynthesis, nitrogen is an important part of their composition. Stimulation of root development as well as absorption of important nutrients is stimulated by nitrogen. Nitrogen acts as a limiting variable for crop production. Therefore, its application results higher biomass yields. Protein concentration in plant tissues and kernel integrity can be improved by increasing nitrogen supply. The quality of yield in terms of milling and vegetative growth is notably enhanced by applying nitrogen. [13]. Nitrogen being an essential macronutrient, influences the yield of wheat in a significant way by effecting forage as well as production of grains. [14]. Nitrogen application improves different wheat crop parameters like thousand grains weight [15, 16], tillers m^{-2}, grain yield, more productive tillers, spikes m^{-2}, grains $spike^{-1}$ and biological yield [17]. Grain weight is controlled genetically which is greatly impacted by environmental factors during the process of grain filling. Nitrogen is generally the most confining nutrient for irrigated and rainfall wheat production area and as such nitrogen fertilizer is always needed to attain desired yield and protein content [18].

Nitrogen is effective in all components of plant yield including number and weight of grain. Lack of this element reduces economic output of the crop and higher amount of it increases vulnerability of plant to load and diseases [19]. Production of high yielding wheat genotypes mostly increase by increasing level of nitrogen [20]. Application of adequate amount of nitrogen increase seed development, grain filling rate and maturity duration, which finally produce highest grain weight [21]. In addition to the formation of proteins in wheat grains and straw, N is an important and core part of plant chlorophyll which is the primary light energy absorber for photosynthesis. An adequate provision of N is linked with vigorous vegetative growth and high photosynthetic activity and its optimum supply influences the utilization of carbohydrates. Nitrogen is proven beneficial at certain growth stages for many genotypes, its application during grain filling stage is required to get more grain yield **[22]**.

All active processes in plant are connected with protein of which nitrogen is an important constituent. Consequently, to get more crop production, nitrogen application is essential in the form of chemical fertilizer. Nitrogen fertilizer is known to affect the number of tillers m^{-2}, spikelet's per spike^{-1}, Grains spike^{-1}, spike length and thousand grain weight **[23]**. Nitrogen plays a key role in maximizing the crop production **[24]** and enhances the yield as well as quality of all crops **[25, 26]**. Additionally, when N applied at higher rate it increases photosynthetic processes in plant, leaf area production, leaf area duration (LAD) as well as net assimilation rate (NAR) **[27]**. Due to unavailability of broad genetic diverse genotypes, the average yield of wheat in Khyber Pakhtunkhwa province (1807 kg ha^{-1}) is a lot lower than the national average production (2787 kg ha^{-1}). As population increase in Pakistan, the demands of wheat is continuously increasing day by day. In order to fulfil this demand of population and overcome future food shortage, high yielding genotypes and disease resistant genotypes of wheat are required to introduce. For this purpose, wheat genotypes with broad genetic background should be developed **[28]**. Genotypic characteristic of the genotypes is very important to increase different yield traits because different genotypes had different characteristics at different climatic region **[29]**. The plant breeding scientists are actively involved in developing of drought resistance and disease resistance wheat genotypes that produce higher grain yield per hectare. A number of different wheat genotypes are released till now by various researchers and institutions but their comparative study is still absent in the literature. The released and approved high yielding wheat genotypes are conceivably examined in the local climate of the area but their performance with climate change impact of the local weather and sowing time is still a big issue to be tackled properly **[30]**. Keeping in view the significant role of nitrogen and genotype selection, the present study was planned to find effect of wheat genotypes and nitrogen application on the yield in response to protein and nitrogen content in grains and straw.

Materials and methods

A field study entitled "Analysis of wheat genotypes and N application on the yield in response to protein and nitrogen content in grains and straw" was conducted at Bacha Khan Agricultural Research Farm (BARF), Bacha Khan University Charsadda-Pakistan during 2015-16. The experiment was done according to Randomized Complete Block (RCB) Design having three replications with plot size of 3m x 1.8m. Two factors were studied, i.e. nitrogen levels (80, 120 and 150 kg ha^{-1}) and genotypes (Pirsabak-2013, Faisalabad and Shahkar). Recommended dose of phosphorus 90 kg ha^{-1} was applied to all plots uniformly and other agronomic and cultural practices were uniformly maintained. Field data was recorded on tillers m^{-2}, grain spike^{-1}, leaf area index, thousand grains weight (g), biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}), while Lab data was recorded on nitrogen concentration in straw, protein concentration in straw, nitrogen concentration in grains and protein concentration in grains.

Results and discussion

Tillers m^{-2}

Nitrogen, genotypes and interaction N x G considerably affected tillers m^{-2} as showed in (Table 1). Tillers m^{-2} was affected positively by increasing the application rate of nitrogen.

Maximum (366) tillers m^{-2} were produced when N was applied at the rate of 150 kg ha^{-1} as compared to 80 and 120 kg ha^{-1}. Increasing in rate of N can enhance tillers m^{-2} reported by [31, 32]. Among various genotypes, Pirsabak-2013 produced maximum (372) tillers m^{-2} as compared to other genotypes. This might be due to the genetic difference and its interaction with environmental factors. These factors are responsible for significant variation in wheat tillers m^{-2} among different wheat genotypes [33]. In case of interaction N x G, wheat genotype Pirsabak-2013 with nitrogen 150 kg ha^{-1} gave maximum (403) tillers m^{-2} as compared to all other possible interaction as shown in (Fig. 1).

Grains spike^{-1}

Nitrogen and genotypes had significant impact on grain spike^{-1}, however interaction N x G had no significant impact as presented in (Table 1). Nitrogen application up to 150 kg ha^{-1} enhanced grains spike^{-1} and produced maximum (52.5) grains spike^{-1}, while minimum grains spike^{-1} (43.2) were recorded when N applied at the rate of 80 kg ha^{-1}. The results are in accordance with those of [32, 34] who described that grains in spike were increased by N application up to 120 and 150 kg ha^{-1}. Among different wheat genotypes, Pirsabak-2013 produced maximum (52.0) grains spike^{-1} as compared to others wheat genotypes. The variation in number of grains spike^{-1} between genotypes might be genetic. Similar finding was reported by [35] who showed variations among different wheat genotypes for grains spike^{-1}.

Leaf Area index (cm^{-2})

Various nitrogen levels, wheat genotypes and their combination N x G had significant effect on leaf area index (LAI) as presented in (Table 1). Nitrogen varied LAI significantly and maximum mean value (4.4 cm^{-2}) was noted with 120 kg N ha^{-1}, while minimum LAI (3.9 cm^{-2}) was recorded with 80 kg ha^{-1}. Among different wheat genotypes, maximum LAI (4.4 cm^{-2}) was recorded by Pirsabak-2013, while minimum (3.8 cm^{-2}) was recorded by Shahkar. The variation for LAI is the reason of inheritance differentiation among genotypes. The same results were found by [36, 37]. In case of interaction, N x G maximum LAI (4.6 cm^{-2}) was recorded by Pirsabak-2103 with 120 kg N ha^{-1} as shown in (Fig. 2). Nitrogen enhances growth and consequently leaf area expansion. Same results of positive effect of N application on the LAI were reported by [38].

Table 1. Tillers m^{-2}, grains spike^{-1} and thousand grains weight as affected by different wheat genotypes and nitrogen levels

Treatments	Tillers m^{-2}	Grains spike^{-1}	Leaf Area Index) (cm^{-2})
Nitrogen (kg ha^{-1})			
80	344c	43.2b	3.9c
120	358b	51.4a	4.4a
150	366a	52.5a	4.0b
LSD Value	**8.087**	**1.192**	**0.458**
Different Genotypes			
Pirsabak-2013	372a	52.0a	4.4a
Faisalabad	352b	48.7b	4.1b
Shahkar	345b	46.4c	3.8c
LSD Value	**8.087**	**1.192**	**0.045**
LSD Value for interaction	**14.00**		**0.079**
N x G	**	**Ns**	**

Means with letters differ significantly according to Least Significant Difference (LSD) test (P<0.05), ns stands for non-significant difference and* at P < 0.05 level, respectively

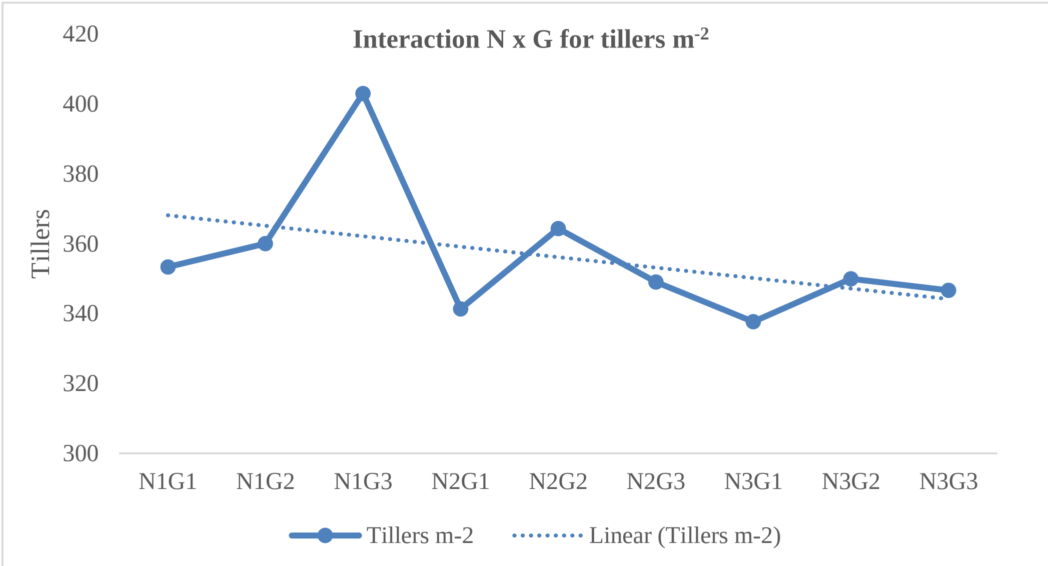

Figure 1. Tillers m^{-2} as affected by interaction of different wheat genotypes and nitrogen levels

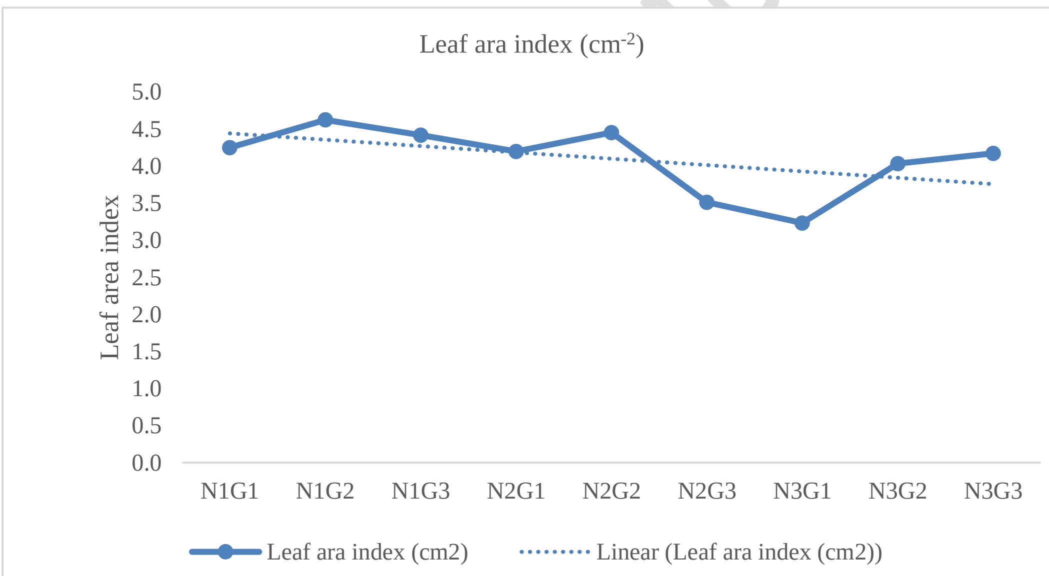

Figure 2. Leaf area index as affected by interaction of different wheat genotypes and nitrogen levels

Thousand grains weight (g)

Weight of grains is a key part of final yield. It was revealed that wheat genotypes, nitrogen and their combination N x G had significant effect on thousand grains weight as presented in (Table 2). Nitrogen enhanced grains weight and maximum thousand grains weight (40.1 g) was recorded with nitrogen 120 kg ha^{-1}, while 80 kg ha^{-1} gave minimum (36.8 g) grains weight. Our result is in accordance with those of **[34]** who showed that when N applied 120 kg ha^{-1} it produced heaviest grains in wheat. Increase in thousand grains weight was also reported by **[31]**. Among different genotypes, Pirsabak-2013 attained highest grains weight (40.4 g) as compared to Faisalabad and Shahkar. In case of interaction, maximum thousand grains weight (42.1 g) was recorded by Pirsabak-2013 with nitrogen 120 kg ha^{-1} as presented in (Fig. 3). The clear difference in thousand grains weight between wheat genotypes may be due to natural genetic variability and other environmental factors. Same outcome was found by **[36, 37]** who showed variations among thousand grains weight for different wheat genotypes.

Biological yield (kg ha^{-1})

Table—2 represent data accordance with biological yield. The results showed variation for biological yield by various genotypes, nitrogen levels and their combination N x G. Among nitrogen application, highest biological yield (11775 kg ha^{-1}) was observed when plots received nitrogen 150 kg ha^{-1}, while lowest (8517 kg ha^{-1}) was attained with 80 kg ha^{-1}. **[32]** Elaborated that N application increased biological yield in wheat. Regarding different genotypes, Pirsabak-2013 produced higher biological yield (10767 kg ha^{-1}) as compared to other genotypes. In case of interaction, Pirsabak-2013 with N application 150 kg ha^{-1} gave maximum (12713 kg ha^{-1}) biological yield as compared with all other possible interaction as shown in (Fig. 3). The difference we got in biological yield between wheat genotypes may be the genetic variability and other ecological factors. **[36, 39]** elaborated considerable differences in biological yield of wheat among different wheat cultivars.

Grain yield (kg ha^{-1})

Grain yield is the main goal of any study, a significant fluctuation in grain yield of wheat genotypes was indicated by various N levels as shown in (Table 2). Different nitrogen levels varied grain yield and maximum grain yield (4009 kg ha^{-1}) was produced with 150 kg N ha^{-1}, while minimum amount of grain yield (2934 kg ha^{-1}) was produced with nitrogen 80 kg ha^{-1}. The findings from this experiment are alike with **[32, 40]** reported that yield of wheat improved by the application of nitrogen 150 kg ha^{-1}. Maximum grain yield (3658 kg ha^{-1}) was produced by Pirsabak-2013 as compare to Faisalabad and Shahkar. The difference in grain yield within wheat genotypes may be due to the genetic variation in wheat cultivars and may be other ecological and environmental factors **[37]**. Our results are also in accordance with the investigations of **[36]** who found clear variation in the grain yield of different wheat genotypes.

Table 2. Thousand grains weight, biological yield and grains yield as affected by different wheat genotypes and nitrogen levels.

Treatments	Thousand grains weight (g)	Biological yield (kg ha^{-1})	Grain yield (kg ha^{-1})
Nitrogen (kg ha^{-1})			
80	36.8c	8617c	2934c
120	40.1a	10028b	3650b
150	38.6b	11775a	4009a
LSD Value	**0.646**	**127.604**	**58.836**
Different Genotypes			
Pirsabak-2013	40.4a	10767a	3658a
Faisalabad	38.8b	10119b	3524b
Shahkar	36.4c	9533c	3412c
LSD Value	**0.646**	**127.604**	**58.836**
LSD Value for interaction	**1.119**	**221.017**	
N x G	**	**	**ns**

Pure Appl. Biol., 9(1): 229-239, March, 2020
http://dx.doi.org/10.19045/bspab.2020.90027

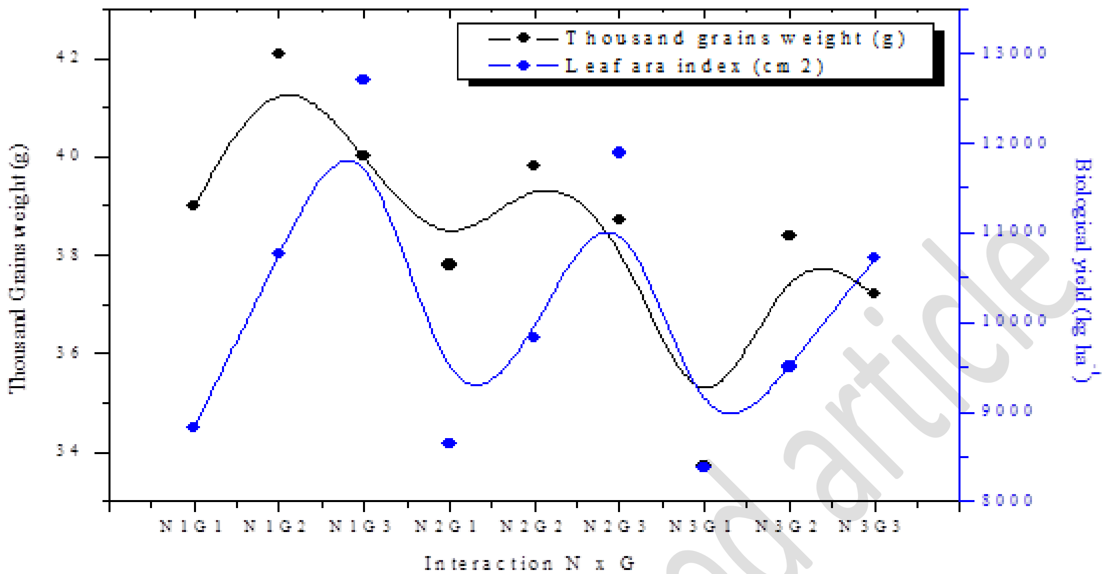

Figure 3. Thousand grains weight (g) and biological yield as affected by interaction of different wheat genotypes and nitrogen levels

Nitrogen Content in Straw (%)

It's confirmed from the findings that the application of nitrogen showed clear variation for N content in straw while genotypes and interaction N x G showed no effect on N content in straw as presented in (Fig. 4). Nitrogen content was increased by increasing nitrogen level and maximum N content in straw (0.50 %) was noted with 150 kg ha^{-1} while minimum (0.42 %) N in straw was noted with 80 kg ha^{-1}. These findings agree with those reported by **[41, 42]**.

Protein Content in Straw (%)

Analysis showed variation for protein content in straw by the application of nitrogen while wheat genotypes and interaction N x G showed no effect as shown in (Fig. 4). Increasing the rate of nitrogen increased the mean value for protein content in straw and produced maximum (2.84 %) protein percent in straw, while decreasing the level of nitrogen to 80 kg ha^{-1} gave minimum (2.41 %) protein content in straw. The result is supported by **[43]** giving the same result in term of P content in straw and grain.

Nitrogen Content in Grains (%)

The application of various nitrogen levels showed variation for N content in grains while wheat genotypes and interaction N x G showed no variation as figure out in (Fig. 5). By increasing level of nitrogen up to 150 kg ha^{-1} gave maximum (2.01 %) nitrogen content in grains, while minimum dose of 80 kg N ha^{-1} gave minimum mean value of (1.79 %) N content in grain. The result is supported by the finding of **[43]** giving the same statement about N and P content in grains of wheat crop.

Protein Content in Grains (%)

Protein content in wheat grains as influence by different wheat genotypes and nitrogen treatments data is presented in (Fig. 5). The application of nitrogen is directly proportional to the protein content in grains and increasing the rate of nitrogen increased the means value of protein content in grains, while different wheat genotypes and interaction N x G showed no effect. Maximum mean value (11.5 %) protein content in grains was noted by the application of N at 150 kg ha^{-1} while minimum protein (10.2 %) was marked with 80 kg N ha^{-1}. The same finding was observed by **[41-43]** giving the same situation for N and P content in grains and straw.

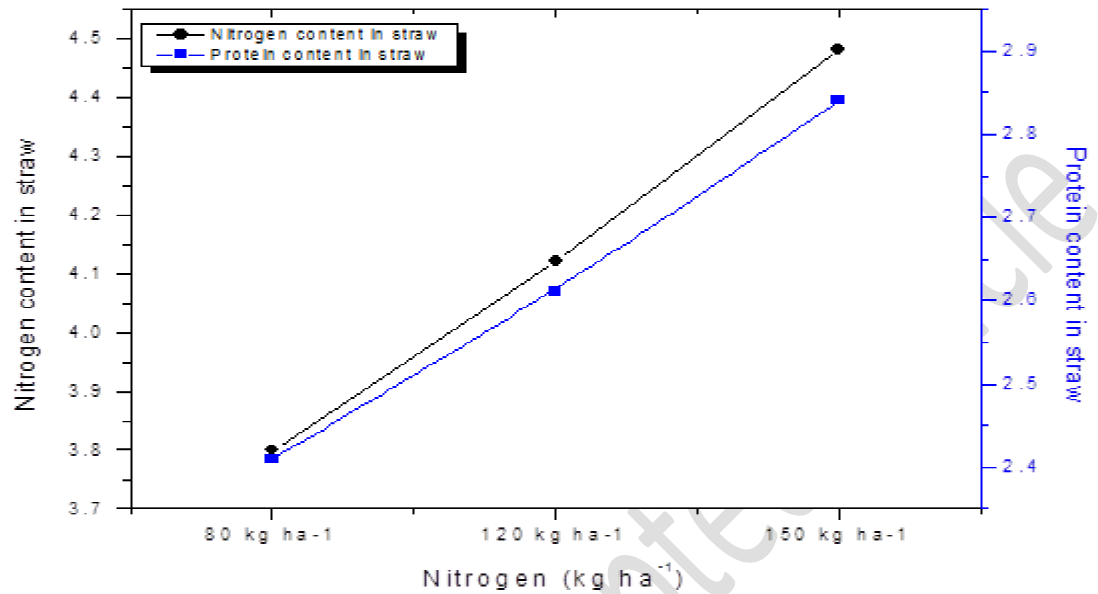

Figure 4. Nitrogen concentration in straw and protein concentration in straw of wheat as affected by different wheat genotypes and nitrogen levels.

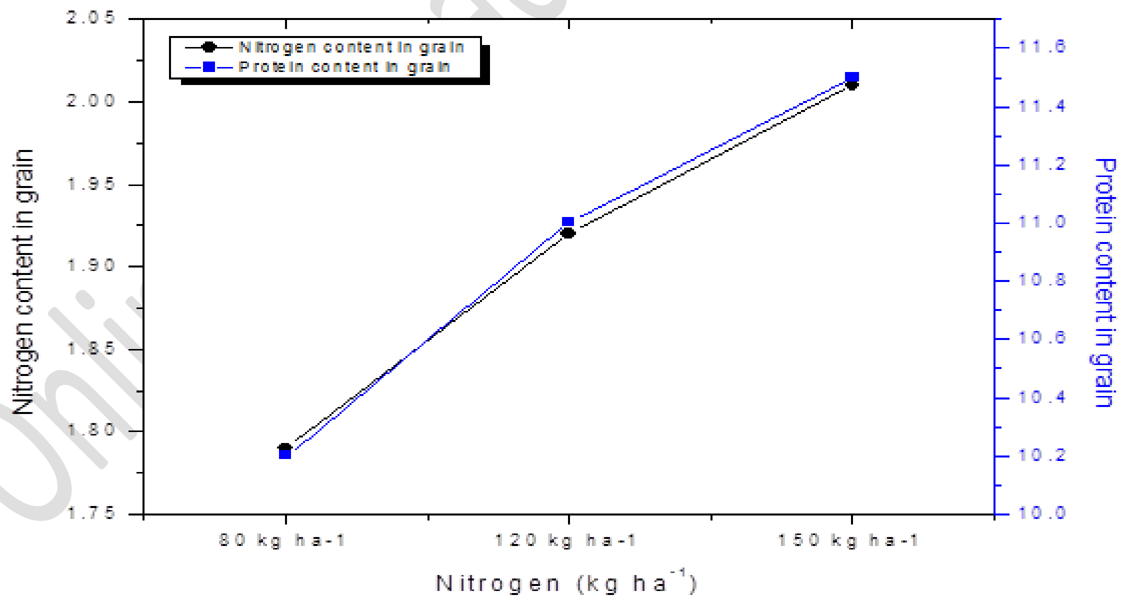

Figure 5. Nitrogen concentration in grains and protein concentration in grains as affected by different wheat genotypes and nitrogen levels

Conclusion

It was concluded from the results of the experiment that Pirsabak-2013 performed well as compared to Faisalabad and Shahkar genotypes in terms of yield and yield components while Nitrogen application 120 up to 150 kg ha^{-1} enhanced and could be recommended for qualitative and quantitative production in wheat.

Authors' contributions

Conceived and designed the experiments: A Khan & WA Shah, Performed the experiments: A Khan, Z Hussain, WA Shah & R Amin, Analyzed the data: M. Ishaq, SN Khan, M Ahmad HA Kakar & S Uddin, Contributed materials/ analysis/ tools: M Wisal, S Akber, S Allah & M Ali, Wrote the paper: M Ishaq & A Khan.

Reference

1. Allah A, Rahujo ZA, Hassan M, Yaqub M, Jakhro MI, Ahmed S, Ahmed N, Ahmed M, Ahmed S, Naseer NS & Sadiq N (2019). Effect of organic and inorganic fertilizers on yield and yield attributes of wheat genotype Ujala-2015 under irrigated conditions of Balochistan. *Pure and Appl Bio* 8(1): 543-552.
2. Liaqat A, Khan N, Nawaz F, Allah S, Hussain & Khan AB (2019). Growth of wheat as affected by fresh and composted poultry manure, urea and beneficial microbes. *Pure and Appl Bio* 8(2): 1408-1419.
3. MNFSR (2015). Agriculture statistics of Pakistan. Ministry of National Food Security and Research (Economic wing) Islamabad.
4. PABA (2016). Pakistan American Business Association. Pakistan's Wheat Production in 2015-16.
5. Zia MS, Gill MA, Aslam M & Hussain MF (1991). Fertilizer use efficiency in Pakistan. *Progre Farm* 11:35-48.
6. Gadehi MA, Kaleri AA, Kalro MW, Mirjat MH, Bhatti IB, Tunio SP, Khan M & Kaleri SH (2017). Nitrogen management efficiency against sunflower (*Helianthus annus* L.) under different irrigation frequencies. *Pure and App Bio* 6(2): 576-586.
7. Anwar S, Allah W, Islam M, Shafi M, Iqbal A & Alamzeb M (2017). Effect of nitrogen rates and application times on growth and yield of maize (*Zea mays* L.). *Pure and Appl Biol* 6(3): 908-916.
8. Bakhtiar M, Afridi MZ, Munsif F, Arshad IUR, Sohail R, Khan S, Adil M, Khan MR, Khan MN, Farooq M (2017). Dry matter partitioning and grain yield of wheat as affected by sources, methods and timing of nitrogen application *Pure and Appl Bio* (6)4: 1198-1215.
9. Mehmood A, Naveed K, Azeem K, Khan A, Ali N & Khan SM (2018). Sowing time and nitrogen application methods impact on production traits of Kalonji (*Nigella sativa* L.). *Pure and Appl Bio* 7(2): 476-485.
10. Anjum MM, Shafi M, Ahmad H, Ali N, Jehanzeb, Iqbal MO, Allah S & Allah S (2018). Phenology and yield response of different maize genotypes to split nitrogen application under climatic conditions of Peshawar. *Pure and Appl Biol* 7(2) 671-677.
11. Alam MS, Nesa MN, Khan SK, Hossain MB & Hoque A (2007). Varietal differences on yield and yield contributing characters of wheat under different levels of nitrogen and planting methods. *Jour Appl Sci Rese* 3(11): 1388-1392.
12. Tisdale SL & Nelson WL (1984). Soil fertility and fertilizers. *Mc Mill Pub Co* 3: 68-73.
13. Blumenthal JM, Baltensperger DD, Cassman KG, Mason SC & Pavlivsta AD (2008). Importance and effect of nitrogen on crop quality and health. *Agro Fac Pub Pap 200 Uni of Nebraska.*

14. Dean G & Munford S (2004). Evaluation of dual-purpose cereal genotypes. *Tos Int of Agri Res Ann Report.*
15. Maqsood M, Akbar M, Mehmood MT & Wajid A (2000). Yield and quality response of wheat to different nitrogen doses in rice wheat cropping system. *Int J Agri Bio* 2: 107-108.
16. Warraich EA, Ahmad N, Basra SMA & Afzal I (2002). Effect of nitrogen on source–sink relationship in wheat. *Int J Agri Biol* 4: 300–302.
17. Al–Abdul Salam MA (1997) Influence of nitrogen fertilization rates and residual effect of organic manure rates on the growth and yield of wheat. *Arab Gulf J Sci Res* 15: 647–660.
18. Kausar K, Akbar M, Rasul E & Ahmad AN (1993). Physiological responses of nitrogen, phosphorus and potassium on growth and yield of wheat. *Pakistan J Agric Res* 14: 2–3.
19. Majidian M, Ghalavand A, Karimian N & Kamgar HAL (2008). The effect of moisture, Nitrogen chemical fertilizer, animal fertilizer and combination of Nitrogen and animal fertilizers on yield, performance and random of using corn water Ksc704. *J of Agric Sci Tech & Natural Res* 12(45): 417-430.
20. Ibrahim M, Hassan A, Arshad M & Tanveer A (2010). Variation in root growth and nutrient element of wheat and rice: effect of rate and type of organic materials. *Soil and Environment* 29: 47-52.
21. Waraich AE, Ahmad R, Ali A & Allah S (2007). Irrigation and nitrogen effects on grain development and yield in wheat (*Triticum aestivum* L.). *Pak J of Botany* 39:1663-1672.
22. Havlin JL, Beaton JD, Tisdale SL & Nelson WL (1999). Function and forms of N in plants. In Soil Fertility and Fertilizers, 6th Ed. Prentice Hall, Upper Saddle River, New Jersey.
23. Ali A, Choudhry MA, Malik MA, Ahmad R & Allah S (2000). Effect of various doses of nitrogen on the growth and yield of two wheat cultivar. *Pak J Biol Sci* 3(6): 1004-1005.
24. Massignam, Chapman SC, Hammer GL & Fukai S (2009). Physiological determinants of maize and sunflower achene yield as affected by nitrogen supply. *Field Crops Res* 113: 256-267.
25. Dreccer MF, Schapendonk AHCM, Slafer GA & Rabbinge R (2000). Comparative response of wheat and oilseed rape to nitrogen supply: absorption and utilization efficiency of radiation and nitrogen during the reproductive.
26. Allah MA, Anwar M & Rana AS (2010). Effect of nitrogen fertilization and harvesting intervals on the yield and forage quality of elephant grass (*Pennisetum purpureum*) under mesic climate of Pothowar plateau. *Pak J of Agric Sci* 47: 231-234.
27. Rafiq MA, Ali A, Malik MA & Hussain M. (2010). Effect of fertilizer levels and plant densities on yield and protein contents of autumn planted maize. *Pak J of Agric sci* 47: 201-208.
28. Mehnaz G, Khan S & Khan W (2018). Genetic variability analysis of wheat (*Triticum aestivum* L.) genotypes for yield and related parameters. *Pure and Appl Bio* 7(2): 547-555.
29. Anjum MM, Shafi M, Ahmad H, Ali N, Iqbal MO, Allah S, Jan MF & Liaqat W (2017). Influence of split nitrogen application on yield and yield components of various maize genotypes. *Pure and Appl Bio* 7(2): 721-721.
30. Nawaz H, Shah S, Rab A, Fayyaz H, Raza H, Khan H, Khan F, Ali I, Sadiq G, Jan T & Ahmad SJ (2017). Response of wheat cultivars toward successive delayed sowing under rainfed condition

in Lower Dir. *Pure and Appl Bio* 6(2) 470-480.

31. Salwau MJM (1994). Effect of soil and foliar application of nitrogen levels on yield and yield components of wheat (*Triticum aestivum* L.). *Ann Agric Sci Moshtohor* 32(2):705- 715.
32. Afridi MZ, Jan MT, Arif MU & Jan AM (2010). Wheat yielding components response to different levels of fertilizer-N application time and decapitation stress. *Sarhad J Agric* 26(4):499-506.
33. Islam MK, Anwar M, Alam AU, Khatun US & Ara KA (2017). Performance of different Gladiolus genotypes under the climatic condition of Tista Meander Floodplain in Bangladesh. *Progr Agric* 28(3): 198-203.
34. Khalil SK, Khan F, Rehman A, Muhammad F, Amanullah, Khan AZ, Shah MK & Khan H (2011). Dual purpose wheat for forage and grain yield in response to cutting, seed rate and nitrogen. *Pak J Bot* 43(2): 937-947.
35. Haider RS (2004). Growth and yield response of three wheat genotypes to N alone and spring in combination with P and P+K under late sown conditions, University of Agriculture, Faisalabad -2013, Pakistan.
36. Al-Doss AA, Al-Hazmi AS, Dawabah AA, Abdel-Mawgood AA, Al-Rehiayani SM, Al-Otayk S, Moustafa KA & Motawei MI (2010). Impact of Cre and Peroxidase Genes of Selected New Wheat Lines on Cereal Cyst Nematode (*Heterodera Avenae Woll*) Resistance. *Australian J Crop Sc* 4(9):737.
37. Munsif F & Arif M (2011) Effect of planting dates on the potential use of dual-purpose wheat cultivars. *KPK Agric Uni Peshawar.*
38. Maan A, Wright AS & Alcock MB (1989). Effects of sowing date, sowing density and nitrogen supply on leaf extension in spring Barley. *J Agric Sci Cambridge* 113: 305-315.
39. Bisht JK, Kant L & Srivastva AK (2008). Cutting management of dual-purpose wheat cultivars; a new approach for increasing fodder availability. *Cereal Research Comm* 36(1): 177-187.
40. Muhammadi A, Rezvani M, Nezhad SZ & Karamzadeh H (2012). Effect of nitrogen rate on yield and yield components of wheat in wild oat infested condition. *Int J Agric Res and Review* 2(4): 496-503.
41. Bly AG & Woodard HJ (2003). Foliar nitrogen application timing influence on grain yield and protein concentration of hard red winter and spring wheat. *Agron J* 95: 335-338.
42. Subedi KD, Ma BL & Xue AG (2007). Planting date and nitrogen effects on grain yield and protein content of spring wheat. *Crop Sci* 47: 36-44.
43. Bakht J, Shafi M, Zubair M, Khan MA & Shah Z (2010). Effect of foliar vs soil application of nitrogen on yield and yield components of wheat genotypes. *Pak J Bot* 42(4): 2737-2745.