



Response of Chinese Wheat Germplasms to Different Levels of Nitrogen, Phosphorus and Potassium

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ABSTRACT

Pakistan's average wheat production is significantly lower than that of the rest of the world, including adjoining countries like India and China. NPK are the major primary nutrients needed by the plants in large amount. Optimum amount of these nutrients has to be maintained in soil for achieving the maximum wheat yield. High yielding varieties of wheat have high nutritional requirements and generally give prominent response to the applied levels of NPK. Field research entitled "Response of Chinese wheat lines to different levels of NPK" was conducted at Agronomy Research Farm, The University of Agriculture Peshawar during Rabi season 2021-2022. The research was carried out in randomized complete block design (RCBD) having three replications. Treatments were consisted of Chinese wheat lines (MY-1501, MY-1416, MY-1419, MY-902, 15CA73, JM-1683J, MY-1215, MY-2914 and MY-409) and two NPK levels (F1: 120-90-60 and F2: 240-180-120 kg ha⁻¹). The results of the experiment indicated that wheat line JM-1683 maintained higher number of tillers (385 m⁻²) and number of spikes (360 m⁻²). While higher. MY-15CA73 produced higher thousand grains weight (47.682 kg ha⁻¹). MY-1419 produced higher biological yield (11433 kg ha⁻¹). MY-1419 produced higher grain yield (4779.3 kg ha⁻¹). Wheat germplasms with the application of NPK at the rate of 240-180-120 kg ha⁻¹ produced maximum number of tiller (385 m⁻²), number of spikes (347 m⁻²), thousand grain weight (41.955 kg ha⁻¹), biological yield (10068 kg ha⁻¹) and grain yield (4271.7 kg ha⁻¹) followed by lower level of NPK (120-90-60 kg ha⁻¹). It is concluded that wheat lines MY-1419 produced higher grain yield with the application of NPK at the rate of 240-180-120 kg ha⁻¹ and is therefore recommended

INTRODUCTION

In Pakistan, wheat (*Triticum aestivum* L.) holds a critical role as a staple and economically significant grain crop, contributing approximately 72% of the total dietary calories (Irshad et al., 2018). On a global scale, Pakistan secures the 8th position among leading wheat-producing nations and dedicates a substantial portion of its cultivated land to wheat (Farooq et al., 2015). Wheat is abundant in essential dietary nutrients, with proportions of approximately 70% carbohydrates, 22% crude fiber, 14% proteins, 14% water, 2% lipids, and 1.8% minerals (Farooq et al., 2015). This crop is cultivated extensively across both irrigated and rainfed regions.

According to data from the Ministry of National Food Security and Research (2018), Pakistan's total wheat cultivation area spans 8,972.5 thousand hectares, resulting in a total production of 26,673.6 metric tons, with an average yield of 2,973 kg ha⁻¹. Within the province of Khyber Pakhtunkhwa (KPK), wheat covers a substantial area of 748.7 thousand hectares, yielding 1,365.1 million tons (Ministry of Finance, 2009). Wheat is a noteworthy contributor to the agricultural sector, accounting for 14% of its value and contributing 3% to Pakistan's GDP (Ministry of Finance, 2009). The 2018-2019 Pakistan Economic Survey reported an increase in wheat cultivation, with an area of 8,825 thousand hectares and a production of 25 million tons, marking a 1.8-fold and 2.50-fold rise, respectively, compared to the previous year.

NPK nutrients are indispensable elements for plant growth and vitality (Memon et al., 2019). These three essential nutrients, Nitrogen (N), Phosphorus (P), and Potassium (K), form the cornerstone of agricultural practices. Nitrogen, as described by Chen et al. (2020), stands as a pivotal crop nutrient influencing productivity and Nitrogen Use Efficiency (NUE) in wheat. In recent years, the application of N has been on the rise in wheat production, contributing to enhanced wheat yields, as observed in the study by Duan et al. (2019). Phosphorus (P) plays an equally crucial role by serving as a key component in various plant compounds and catalyzing biochemical reactions, as affirmed by Taiz & Zeiger (2010) and Gupta et al. (2014). P is essential for vital processes like photosynthesis, energy storage, and transfer within plant cells. Moreover, it promotes root growth, stem vigor, flower development, the production of high-quality seeds, and enhances plant resistance to diseases (Popovic, 2015). Ensuring an adequate supply of P in the initial stages of plant growth is imperative for achieving a robust yield, as acknowledged by Bindraban et al. (2020).

Potassium (K), ranking as the third most vital nutrient after N and P, is often referred to as a "quality nutrient." K significantly contributes to increased crop yield, shields crops against diseases and pest attacks, mitigates lodging, and provides protection against terminal heat stress (Sharma and Singh, 2020). Moreover, it plays essential roles in protein formation and various physiological processes within plants (Lakudzala, 2013). Effective nutrient management stands as a cornerstone of optimal agronomic practices. However, the continuous cultivation of exhaustive crops and high-yielding genotypes has led to potassium deficiency in soils. Furthermore, the imbalanced application of nutrients,

particularly K, has resulted in its constant depletion from agricultural soils (Ali et al., 2019).

In light of these critical factors, an experiment was conducted to compare various wheat lines with an elite variety in Khyber Pakhtunkhwa (KPK). The study aimed to assess their performance concerning yield and yield-related traits, as well as to determine the optimal planting time under the agro-ecological conditions of Peshawar

LITERATURE REVIEW

Bhutto et al., (2021) conducted a study evaluating various wheat cultivars for growth and yield traits. Their findings revealed that all the cultivars exhibited superior performance in terms of growth and yield-related characteristics. Notably, Moomal-2002 excelled in vegetative traits, while TD-1 demonstrated superior performance in yield-related attributes. As a result, the study concluded that Moomal-2002 and TD-1 outperformed the other cultivars.

Horvat et al., (2021) explored the impact of different nitrogen (N) application rates on gluten and protein composition. Their results showed that increased N levels (100 kg ha⁻¹) often led to improved grain protein (11.3%), total gliadin (1.1%), and glutenin (0.9%), while reducing albumins (1.1%) and globulins (1.7%). Additionally, they highlighted that elevated N levels (100 kg ha⁻¹) generally increased grain protein content. However, changes in the composition of gliadins and glutenins were more cultivar-specific, emphasizing the need for consideration in wheat baking quality assessment.

Jan et al., (2021) delved into techniques of N and K application and their impact on wheat crop growth, yield, and N uptake in a semi-arid climate. Their findings suggested that applying N and K at levels of 180 and 90 kg ha⁻¹, respectively, with 15 percent through foliar spray and 85 percent through soil application, enhanced wheat crop performance under such conditions.

Li et al., (2021) investigated the role of chemical and organic fertilizers in wheat-rice crop rotation. They found that combining 50 percent chemical nitrogen (N) with organic fertilizer (NPKM) produced the highest crop yields (wheat and rice). However, they also noted an increase in the soil bacterial community in NPKM treatments during the wheat and rice seasons. Overall, substituting some chemical fertilizer with organic fertilizer proved optimal for increasing crop yields and restoring soil bacterial diversity in the wheat-rice rotation.

Li et al., (2021) researched N management techniques for wheat in China, reporting that these techniques enhanced wheat yield, economic performance, and reduced greenhouse gas emissions. The comprehensive use of N management techniques resulted in a 7% increase in wheat production, a 9% improvement in the net ecosystem economic budget, and a 17% reduction in greenhouse gas emissions.

Sedri et al., (2021) explored the interactive effects of N and K on quantitative and qualitative traits of a wheat cultivar. Their study revealed that drought stress and cool, rainfed locations boosted the production and quality of winter wheat cultivars. They recommended the application of N-K (60-30 and 90-

60 kg ha⁻¹) under drought stress and non-stress conditions to optimize grain yield and protein content in rainfed wheat.

Tanwar (2021) examined the impact of farmyard manure (FYM) and N application on wheat productivity. The results showed that both FYM (15 ton ha⁻¹) applied in both rabi and kharif seasons and N (120 kg ha⁻¹) substantially increased crop yield. When these treatments were combined under weed-free conditions, they resulted in the highest gross returns, net returns, wheat growth, yields, and economic returns.

METHODOLOGY

Response of Chinese wheat germplasms to different levels of NPK was conducted at the Agronomy Research farm, The University of Agriculture Peshawar during winter season 2020-2021. The experiment was laid out in Randomized Complete Block design (RCBD) with three replications. Every experimental unit was 10 x 18m having 60 rows with 30 cm apart. NPK were applied in two levels i.e. F1: 120-90-60 and F2: 240-180-120 kg ha⁻¹. The Chinese wheat lines (MY-1501, MY-1416, MY-1419, MY-902, 15CA73, JM-1683, MY-1215, MY-2914, MY-409) were sown in rows on 5th November 2021 with the help of hand hoe at the rate of 120 kg ha⁻¹. Before experiment, the field was properly irrigated and tilled with the help of disc harrow followed by cultivator twice and plunker. Nitrogen (N), Phosphorus (P) and Potassium (K) were applied from Urea, SSP and MOP at time of sowing along with 25% of nitrogen as a source of Urea as per treatment requirements. The remaining 75% nitrogen was applied in three splits i.e. 25% at the time of seedling emergence, 25% at tillering stage and 25% at boot stage. Weeds were manually controlled. The recommended irrigation scheduled was applied, although changes were considered based on weather conditions.

The following factors were used:

Factor A: Wheat Lines

- 1: MY-1501
- 2: MY-1416
- 3: MY1419
- 4: MY-902
- 5: 15CA-73
- 6: JM-1683
- 7: JM-1215
- 8: MY-2914
- 9: MY-409

Factor B: NPK levels (kg ha⁻¹)

- F1: 120-90-60
- F2: 240-180-120

The following parameters were studied and data was collected:

1. Tillers (m⁻²)

In every experimental unit five rows of one meter long was representatively selected for counting tillers. The average calculated tillers were converted to tillers m⁻² by using the following formula:-

$$\text{Tillers (m}^{-2}\text{)} = \frac{\text{Total tillers counted}}{\text{Row-row distance(m)} \times \text{Row length(m)} \times \text{No.of rows}} \times 1$$

2. Number of Spikes (m⁻²)

Data relating to spike m⁻² was recorded by counting number of spikes in one meter row and was changed to spike m⁻² using a formula:-

$$\text{Number of spike m}^{-2} = \frac{\text{Number of spikes counted}}{\text{Row-row distance(m)} \times \text{Row length(m)} \times \text{No.of rows}} \times 1$$

3. Thousand Grain Weight (g)

Data regarding mentioned parameter were documented by collecting 1000 grains from each grain lot of all the experimental units and weighed to record the grain weight in grams with help of digital balance.

4. Biological Yield (kg ha⁻¹)

Data relating to biological yield were noted by reaping three lines in every experimental units, dried by sun, weighed, changed to kg ha⁻¹ by using a formula:-

$$\text{Biological yield (kg ha}^{-1}\text{)} = \frac{\text{Biological yield of three central rows}}{\text{Row-row distance (m)} \times \text{No.of rows} \times \text{Row length (m)}} \times 10000$$

5. Grain Yield (kg ha⁻¹)

The reaped three lines were dried by sun, threshed, grains were collected, weighed, changed to kg ha⁻¹ by using a formula:-

$$\text{Grain yield (kg ha}^{-1}\text{)} = \frac{\text{Grain yield of three central rows}}{\text{Row-row distance (m)} \times \text{No.of rows} \times \text{Row length}} \times 10000$$

Statistical Analysis

The collected data of various parameters were investigated by concerning RCB design. For means comparison, least significance test was used at 5% of significance (Steel et al., 1997).

RESULTS AND DISCUSSION

Tillers (m⁻²)

Data regarding on tillers m⁻² is shown in Table 01. Data analyzed statistically showed that wheat lines (L) and NPK levels significantly affected tillers m⁻². The L × NPK interaction was also found significant for tillers m⁻². Wheat line JM-1683 produced higher tillers (385 m⁻²) which is statistically similar to JM-1215 (385 m⁻²) followed by MY-409 (379 m⁻²) while less tillers were recorded by wheat line MY-1501 (364 m⁻²). In case of NPK levels, higher level of NPK resulted in higher tillers JM-1683 (403 m⁻²) followed by lower level of NPK JM-1215 (375 m⁻²). The L × NPK interaction showed that higher NPK level resulted in higher tillers m⁻² for wheat lines but lower NPK level had lower tillers m⁻² for wheat lines. Higher levels of NPK produced more tillers m⁻² followed by lower levels of NPK. Our results are in line with Badr *et al.*, (2009), El-Sayed and Hammad (2007) who reported that significant differences of tillers in wheat cultivars were because of their genetic difference. Similarly, our results also supported by Dugassa *et al.*, (2019) found that higher NP (96-46 kg ha⁻¹) application had a higher tiller per unit area of wheat compared to non-treated one.

Number of Spikes (m⁻²)

Data regarding on spikes m⁻² is shown in Table 02. Data analyzed statistically showed that wheat lines (L) and NPK levels significantly affected spikes m⁻². The L × NPK interaction was found non-significant for spikes m⁻². Wheat line JM-1683 produced higher spikes (360 m⁻²) followed by MY-1501 (353 m⁻²), MY-1419 (342 m⁻²). Lower spikes (310 m⁻²) were noted for wheat line MY-2914. In case of NPK levels, higher level of NPK resulted in higher spikes m⁻² as compared to lower level of NPK. Higher level of NPK (240-180-120 kg ha⁻¹) resulted in higher spikes m⁻² than lower level of NPK (120-90-60 kg ha⁻¹). Our results are suggested by Youssef *et al.*, (2013) and El-Sayed and Hammad (2007) who revealed that due to increase in the application of fertilizers for the benefits of tillers emergence and subsequently increased spike m⁻². However our results also supported by Hussain *et al.*, (2006) who suggested that grain yield is closely related to spike m⁻² and spike population increased with increased in nitrogen levels.

Table 1. Tillers (M-2) of Different Wheat Lines as Affected by NPK Levels

Wheat Lines	N-P-K levels (kg ha ⁻¹)		Mean
	120-90-60	240-180-120	
MY-1501	352.67	374.67	363.67d
MY-1416	357.67	378.00	367.83d
MY-1419	371.67	384.67	378.17abc
MY-902	373.67	369.67	371.67bcd
15CA73	354.00	384.67	369.33cd
JM-1683	368.67	403.00	385.83a
JM-1215	375.00	396.67	385.83a
MY-2914	359.00	382.67	370.83bcd
MY-409	370.00	388.00	379.00ab
Mean	364.70b	384.67a	

Factors = 5% significance / LSD
Wheat lines (L) = 9.60
NPK levels = 4.52
L x NPK = 13.57

Table 2. Spike (M-2) of Different Wheat Lines as Affected by NPK Levels

Wheat Lines	N-P-K levels (kg ha ⁻¹)		Mean
	120-90-60	240-180-120	
MY-1501	329.67	375.33	352.50ab
MY-1416	327.33	343.00	335.17abcd
MY-1419	326.33	359.33	342.83abc
MY-902	315.00	333.33	324.17cd
15CA73	318.00	338.00	328.00bcd
JM-1683	347.67	372.67	360.17a
JM-1215	319.33	344.00	331.67bcd
MY-2914	294.00	326.33	310.17d
MY-409	323.00	335.33	329.17bcd
Mean	322.26b	347.48a	

Factors = 5% significance / LSD
Wheat lines (L) = 27.84
NPK levels = 13.12
L x NPK = 39.37

Means of the same category followed by different letters are significantly different from each other using LSD test ($P \leq 0.05$).

Thousand Grain Weight (g)

Data regarding on thousand grain weight is shown in Table 03. Data analyzed statistically showed that wheat lines (L) and NPK levels significantly thousand grain weight. The L x NPK interaction was also found significant for thousand grain weight. Higher thousand grain weight in Wheat line 15CA73 (47.682 g) followed by MY-902 (43.593 g) which is statistically similar to MY-409 (43.433 g), and lower thousand grain weight MY-2914 (38.097 g). In case of NPK levels, higher level of NPK resulted in higher thousand grain weight in wheat lines expected MY-1419, JM-1683 and MY-409 and lower NPK levels had less thousand grain weight. The L x NPK interaction showed that higher NPK level resulted in higher thousand grain weight and lower level of NPK were produced lower thousand grain weight in wheat lines. The variation in cultivars for thousand grain weight might be due to better vegetative growth of the wheat plants that leads to more tiller *m-2*, resulting more seeds with higher weight were produced (Bhutto *et al.*, 2021). These finding are with familiar with (Sardana *et al.*, 2002 and Sing *et al.*, 2002). Increasing in the nitrogen levels resulted in the increasing of the thousand grain weight. (Shuaib *et al.*, 2009) investigated from his finding that by applying macro and micro nutrients or when nitrogen level increase up to a certain levels there is a positive effect on thousand grain weight of wheat crop.

Biological yield (kg ha⁻¹)

Data regarding on biological yield (kg ha⁻¹) is shown in Table 04. Data analyzed statistically showed that wheat lines (L) and NPK levels significantly affected biological yield (kg ha⁻¹). The L x NPK interaction was also found significant for biological yield (kg ha⁻¹). Wheat line MY-1419 (11433 kg ha⁻¹) produced higher biological yield followed by MY-1416 (10238 kg ha⁻¹) which is statistically similar to MY-409 (10168 kg ha⁻¹) and lower biological yield in wheat line JM-1683 (7224 kg ha⁻¹). In case of NPK levels, higher level of NPK resulted in higher biological yield (kg ha⁻¹) in wheat lines except JM-1683 (7247 kg ha⁻¹) lower level of NPK noted lower biological yield (kg ha⁻¹). The L x NPK interaction showed that higher NPK level resulted in higher biological yield (kg ha⁻¹) and lower level of NPK had higher biological yield (kg ha⁻¹) wheat lines. Our results are suggested by Rabha (2018) concluded that the application of nitrogen at right amount and right time significantly increased the biological yield of wheat crop. Likewise, Surendra Prashad Bhatt and Rajendra Bam (2021); El-Said and Mahdy (2016) and Amjed *et al.*, (2012) showed that biomass yield of wheat crop was significantly increase with the increasing of fertilizers levels and also decrease with the excess of NPK levels.

Grain Yield (Kg Ha⁻¹)

Data regarding on grain yield (kg ha⁻¹) is shown in Table 05. Data analyzed statistically showed that wheat lines (L) and NPK levels significantly affected grain yield (kg ha⁻¹). The L x NPK interaction was found non-significant for grain yield (kg a⁻¹). Wheat line MY-1419 (4779 kg ha⁻¹) produced higher grain yield followed by MY- 2914 (4544 kg ha⁻¹) and lower grain yield (kg ha⁻¹) was noted for wheat line JM-1215 (2861 kg ha⁻¹). In case of NPK levels, higher level of NPK resulted in higher grain yield (kg ha⁻¹) expected MY-409 and lower NPK level was less grain yield. Differences in grain yield between wheat cultivars could be

attributed to reproductive stages translocation, which is reliant on the genetic capacity of different wheat cultivars (Bhutta *et al.*, 2019). Similarly, Ali (2014) and Malik *et al.*, (2010) found that wheat cultivars grown in favorable environmental and soil conditions increase spike length, grains per spike, spikelet spike⁻¹, all of which contribute to grain yield increasing.

Table 3. Thousand grain weight (g) of different wheat lines as affected by NPK levels

Wheat Lines	N-P-K levels (kg ha ⁻¹)		Mean
	120-90-60	240-180-120	
MY-1501	37.133	42.533	39.833c
MY-1416	36.400	43.083	39.742c
MY-1419	40.297	38.833	39.565c
MY-902	43.150	44.037	43.593b
15CA73	45.990	49.373	47.682a
JM-1683	40.080	39.453	39.767c
JM-1215	37.277	39.260	38.268d
MY-2914	37.923	38.270	38.097d
MY-409	44.117	42.750	43.433b
Mean	40.263b	41.955a	

Factor = 5% significance / LSD
Wheat lines (L) = 1.14
NPK levels = 0.54
L x NPK = 1.62

Table 4. Biological Yield (Kg Ha-1) of Different Wheat Lines as Affected by Npk Levels

Wheat Lines	N-P-K levels (kg ha ⁻¹)		Mean
	120-90-60	240-180-120	
MY-1501	8254	10617	9435bc
MY-1416	8464	12012	10238b
MY-1419	9993	12872	11433a
MY-902	8377	9921	9149cd
15CA73	7640	9474	8557de
JM-1683	7247	7201	7224f
JM-1215	7646	8382	8014ef
MY-2914	8981	9952	9467bc
MY-409	10152	10183	10168b
Mean	8528b	10068a	

Factor = 5% significance / LSD
Wheat lines (L) = 819.97
NPK levels = 386.54
L x NPK = 1159.6

Means of the same category followed by different letters are significantly different from each other using LSD test (P ≤ 0.05).

Table 5. Grain Yield (Kg Ha-1) of Different Wheat Lines as Affected by NPK Levels

Wheat Lines	N-P-K levels (kg ha ⁻¹)		Mean
	120-90-60	240-180-120	
MY-1501	4039.7	4357.7	4198.7d
MY-1416	4223.3	4731.7	4477.5bc
MY-1419	4510.3	5048.3	4779.3a
MY-902	3955.7	4530.7	4243.2cd
15CA73	3557.3	3786.0	3671.7e
JM-1683	3994.7	4435.3	4215.0d
JM-1215	2629.7	3092.3	2861.0f
MY-2914	4304.0	4785.0	4544.5ab
MY-409	3901.0	3678.3	3789.7e
Mean	3901.7b	4271.7a	

Factor = 5% significance / LSD
 Wheat lines (L) = 248.3
 NPK levels = 117.0
 L x NPK = 351.2

This part allows you to elaborate on your results findings academically. You must not put numbers related to your statistical tests here; instead, you have to explain that numbers here. You have to compile your discussion with academic supports to your study and a good explanation according to the specific area you are investigating.

CONCLUSIONS AND RECOMMENDATIONS

Based on the findings, it is concluded that: Wheat lines MY-1419 produced higher grain yield. Plots treated with higher levels of NPK (240-180-120 kg ha⁻¹) produced more grain yield than treated with lower levels of NPK (120-90-60 kg ha⁻¹). Keeping in view the conclusions of the research, wheat lines MY-1419 produced higher grain yield with the application of NPK at the rate of 240-180-120 kg ha⁻¹ is therefore recommended.

FURTHER STUDY

Advanced research could focus on optimizing NPK combinations for various wheat varieties, with an emphasis on sustainable and efficient nutrient utilization. This research can include genetic, microbiome, and climate-resilience studies, as well as economic and policy analyses. Furthermore, advanced research can explore the adoption of these findings among farmers and promote sustainable agricultural practices in Chinese wheat farming.

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