Research Article

Nitrogen and phosphorus fertilization of improved varieties for enhancing yield and yield components of wheat

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Abstract

A field experiment was conducted at New Developmental Farm, The University of Agriculture Peshawar during rabi 2012-2013 to study the effect of N and P fertilization of improved varieties for enhancing yield and yield components of wheat varieties. Randomized Complete Block (RCB) Design with split plot arrangement having three replications was used. A sub plot size of 12 m² having ten rows of 4 m length was used. N levels (100, 125 and 150 kg ha⁻¹) and P levels (60, 90 and 120 kg ha⁻¹) were applied to the main plots and wheat varieties (Siran-2010 and Atta-Habib) were assigned to the sub plots and one control having no N and P was maintained in main plot treatment. All of the phosphorus and half of the nitrogen were applied at sowing time. The remaining N was applied at tillering stage. The results of the experiment showed that maximum tillers m⁻² (377), spikes m⁻² (362), grains spikes⁻¹ (50.67), thousands grains weight (41.16 g), biological yield (10060 kg ha⁻¹), grain yield (3855 kg ha⁻¹) and harvest index (38.7 %) were produced by Siran-2010 while maximum nonproductive tillers m⁻² (18) was maintained by Atta-Habib. The plots that received nitrogen at the rate of 62.5 kg ha⁻¹ produced maximum tillers m⁻² (383). Maximum spikes m⁻² (368), grains spikes⁻¹ (51.44), thousand grains weight (42.16 g), grain yield (4061 kg ha⁻¹) and harvest index (40.9 %) were produced by 125 kg N ha⁻¹ while nitrogen application at the rate of 150 kg ha⁻¹ produced maximum biological yield (10386 kg ha⁻¹). Phosphorus application at the rate of 90 kg ha⁻¹ produced highest number of tillers m⁻² (379), spikes m⁻² (364), grains spikes⁻¹ (52.44), thousand grains weight (41.21 g), biological yield (10298 kg ha⁻¹), grain yield (3944 kg ha⁻¹) and harvest index (38.8 %). It is concluded that wheat variety Siran-2010 produced higher grain yield when treated with 125 kg N ha⁻¹ and 90 kg P ha⁻¹.

Keywords: Wheat (*Triticum aestivum* L.); Varieties; Nitrogen; Phosphorus; Yield and yield components

Introduction

Wheat (*Triticum aestivum* L.) is the major crop among the cereal in the world and it has been playing a vital role in cultural and economic development since immemorial time. Wheat is known as the king of

cereal. It has greater significance in Pakistan in preventing food demand of the people [1, 2]. Wheat is the basic staple food of Pakistan. Wheat grain contains 12 % protein and provides about 73 % calories [3]. Wheat grains can be directly

or indirectly used as human food and its straw is used as animal feed. In Pakistan the total area under cultivation of wheat crop was 8.9 million ha, that produce 25.21 million tons of food grain with mean production of 2833 kg ha⁻¹, while in KPK wheat is cultivated over an area of about 0.72 million ha, which produce 1.11 million tones with average production of 1595 kg ha⁻¹ [4]. The leading producer of wheat in Pakistan is Punjab. In KPK, more wheat is grown in barani (61 %) than irrigated area (39 %). As compared to others developing countries wheat production in Pakistan is very low. Quality production and improvement in yield can be achieved by use of balanced nutrient application especially NPK to improved varieties of wheat crop [5]. Besides grain, wheat straw (bhossa) can also be used as roughage for livestock. In order to get highest grain yield selection of the best suited variety is very important. Cultivars are selected on the basis of various characteristics such as straw strength, grain quality and climatic adaptability etc. Fertilizer application at proper time in balance proportion with proper method of application gave better impact on crop productivity [6]. N is essential for growth, protein synthesis, vigorous vegetative growth, chlorophyll and deep green color. Nitrogenous fertilizers are used by the farmers in much larger amount than any other fertilizer. This is because plants needed nitrogen in much larger amount than any other nutrient. Moreover our soil is deficient in this most demanding nutrient. On world basis nitrogen application is about 80 million tons [7]. To meet the increasing demand of food for increasing population of the world developing countries apply more and more fertilizers. In 2012 the world population will be more than eight billion [8]. However, the fertilizer N efficiency tends to be low in this system [9]. The chemical fertilizers are the most important source of the readily available nitrogen for the crop growth. Due to the

greater availability [10] and crucial input for enhancing crop productivity [11], N is a vital part of modern technology for enhancing crop productivity. Nitrogen is one of the major limiting elements for crop growth and development [12]. However effective N management presents greater challenge to the farmers than other fertilizer nutrients [13]. The availability of N can be enhanced by its proper time of application, and better strategies to increase crop production. Application of N improves various growth parameters like fertile tillers m⁻² [14], grain yield [15], thousand grain weight [16], more productive tillers [17]. Different nitrogen and phosphorus levels significantly effect the agronomic parameters like, plant height, grain spike, thousand grain weight and root biomass [18].

Phosphorus is essential for many physiological processes, such as storage of energy and its transfer, respiration, photosynthesis, cell division and cell enlargement etc. Phosphorous is involved in the synthesis of energy rich phosphate compound such as adenosine triphosphat (ATP) and adenosine diphosphat (ADP) which derive various biochemical reactions within the plant. Phosphorus role in plant is not limited to metabolic reactions. Phosphorus is a structural component of nucleic acid (DNA, RNA) nucleotide, phospholipids and phosphoproteins. The movement of applied phosphatic fertilizer in soil is just only 3-4 cm. Consequently, it is hardly available to the extent of 15-20% to the plant. The rest goes to waste from immediate crop being fixed in soil [19]. Phosphorus application at proper time, in optimum quantity through proper method of application is essential to increase crop production and its sustainability [20]. Phosphorous deficiency in the soil reduced crop response to nitrogen [21]. Crop required proper amount of phosphorus for the initiation of leaves and florets primordial [22]. Whenever a plant breeder develops a new variety it is very

important to find out the production technology of that variety especially with reference to the requirement of N and P as the nutritional requirement of different variety of the same species may vary due to agro-climatic conditions of the region and their yield potential [23]. Phosphorous is an important element that impacts on zinc uptake, as by increasing phosphorous level in soil zinc uptake by plant is reduced [24]. The rate and form of N and P fertilizers can effect plant growth response to mycorrhizal inoculation. The basic role of commercial fertilizer is to enhance crop productivity but the greatest problem is the minimum use of phosphatic fertilizer in obtaining maximum crop production than nitrogenous fertilizer [25]. With reference to the important role of N and P in crop productivity, this research study was planned to evaluate the effect of various phosphorous and nitrogen levels on wheat varieties.

Materials and methods

An experiment on nitrogen and phosphorus fertilization of improved varieties for enhancing yield and yield components of wheat was carried out at New Developmental Farm, The University of Agriculture, Peshawar during winter season 2012-2013. The experiment was arranged in a randomized complete block design with three replications in split plot arrangement. Size of the sub plots was 4 x 3 m². Seed rate of 120 kg ha⁻¹ was used. Urea and SSP fertilizers were used as N and P sources respectively. All of the P and half of the N fertilizers were applied at sowing. The rest of the N was applied at tillering stage. One control having no N and P was maintained in main plot treatment. The experiment was consisted of treatments which are nitrogen levels and phosphorus levels which are assigned to Main plots and levels are N₁ (100 kg ha⁻¹), N₂ (125 kg ha⁻¹), N₃ (150 kg ha⁻¹) where P levels are P₁ (60 kg ha⁻¹), P₂ (90 kg ha⁻¹), P₃ (120 kg ha⁻¹). Subplot included wheat varieties which are V₁ (Siran-2010) and V₂ (Atta-Habib). Data was recorded on

parameters which are number of tillers m⁻², spike m⁻², grain spike⁻¹, thousand grains weight (g), biological yield (kg ha⁻¹), grain yield (kg ha⁻¹) and harvest index (%). In each sub plot three rows of one meter length were selected randomly to count tillers m⁻² and change accordingly to tillers m⁻². Spikes m⁻² was recorded by counting spikes in three randomly selected central rows in each sub plots and changed to productive tillers m⁻² accordingly. In each sub plot ten spikes were selected randomly and grains were counted and averaged to calculate grains spike⁻¹. Thousand grains weight was recorded by weighing thousand grains taken randomly from the grain lot of each sub plot. Data concerning biological yield was taken by reaping four central rows of every sub plot, dried in sun, weighed and then changed to kg ha⁻¹. The harvested four central rows in each sub plot were threshed, cleaned, weighed and converted to grain yield kg ha⁻¹. Harvest index was calculated by the following formula.

$$\text{Harvest index (\%)} = \frac{\text{Grain yield}}{\text{Biological yield}} \times 100$$

Method applicable to the randomized complete block design (split-plot arrangement) was used for statistical analysis of the recorded data. For mean comparison in case of significant difference least significant difference (LSD) test at 5% level of significance was used [26].

Results

Total tillers m⁻²

Table 1 showed significant ($P \leq 0.05$) effect of nitrogen, phosphorus and varieties (V) on number of total tillers m⁻². In interactions only N x P showed a considerable impact on number of total tillers m⁻². All interactions except N x P were non-significant. Siran-2010 exhibited greater number of tillers m⁻² (377) than Atta-Habib (370). Plots that received 62.5 kg N ha⁻¹ produced greater number of tillers m⁻² (383) than control plots (279). Different phosphorus levels also showed a significant effect on number of tillers m⁻².

Phosphorus level of 90 kg ha⁻¹ resulted in maximum number of tillers m⁻² (379) and less number of tillers m⁻² (279) were counted in control plots. In case of interactions between nitrogen and phosphorus, tillers m⁻² significantly increased with increasing P rates up to 90 kg ha⁻¹ at all N levels. Varieties, nitrogen, phosphorus and NP interaction considerably ($P \leq 0.05$) influenced number of tillers m⁻². Highest number of tillers m⁻² was maintained by Siran-2010 while lowest by Atta-Habib. The variation in tillers m⁻² may be due to genetic variations

of these two cultivars. These results are similar with that of [27]. Highest number of tillers m⁻² was maintained by N level of 62.5 kg ha⁻¹ and minimum was recorded in control plots. This is supported by [28]. Similarly [29] stated that tillering capacity enhanced with increasing N application. Highest number of tillers m⁻² was produced at P level of 90 kg ha⁻¹ while lowest was found in control plots. Higher P rates enhanced tillers survival, emergence and yield, especially for secondary tillers [30].

Table 1. Number of total tillers m⁻² of wheat varieties as affected by nitrogen and phosphorus fertilization

Nitrogen (kg ha ⁻¹)	Phosphorus (kg ha ⁻¹)	Siran-2010	Atta-Habib	N x P
50	60	363	358	361
50	90	366	357	362
50	120	366	357	361
62.5	60	368	360	364
62.5	90	402	398	400
62.5	120	390	379	385
75	60	380	374	377
75	90	380	372	376
75	120	381	375	378
50		365	357	361c
62.5		387	379	383a
75		380	374	377b
	60	370	364	367c
	90	383	376	379a
	120	379	370	375b
Mean		377a	370b	374
Control		280	278	279
Rest		377	370	374

LSD value at $P \leq 0.05$ for varieties = 2.367

LSD value at $P \leq 0.05$ for nitrogen = 1.800

LSD value at $P \leq 0.05$ for phosphorus = 1.800

LSD value at $P \leq 0.05$ for nitrogen x phosphorus = 5.020

Mean values of each category followed by different letter (s) are statistically different at $P \leq 0.05$ using LSD test.

Spike m⁻²

Data recorded on spikes m⁻² is shown in table 2. Mean data revealed that nitrogen, phosphorus, varieties and NP interaction significantly ($P \leq 0.05$) affected spikes m⁻². While the interactions between control vs. rest x varieties, N x V, P x V and N x P x V showed a non-significant response.

More spikes m⁻² (362) was produced by variety Siran-2010 while lowest spikes m⁻² (352) was produced by Atta-Habib. Nitrogen level of 125 kg ha⁻¹ resulted in highest number of spikes m⁻² (368). Less number of spikes m⁻² (261) was reported in control plots. In case of phosphorus application maximum spikes m⁻² (364)

were produced by 90 kg P ha⁻¹ while minimum spikes m⁻² (261) were counted in control plots. In case of N and P interactions increased in number of spikes m⁻² occurred with increasing P levels upto 90 kg P ha⁻¹ at all levels of N and then decreased at 120 kg P ha⁻¹. The result showed that N, P and the interaction of N and P significantly ($P \leq 0.05$) affected spikes m⁻² of wheat varieties. Maximum spikes m⁻² was produced by Siran-2010 while minimum was produced by Atta-Habib. The probable reason for this might be the variation in genetic makeup of these varieties. Greater number of spikes m⁻² was counted at nitrogen application rate of 125 kg ha⁻¹ lowest was counted in control plots. These results are in line with [31] who reported maximum spikes m⁻² at N rate of 120 kg ha⁻¹. Highest number of spikes m⁻² was counted at 90 kg P ha⁻¹ and minimum were counted in control plots. Fertilizer application provides essential plant nutrients well in time and thus might have enhanced the crop efficiency to produce more spikes m⁻². [32] stated that NPK application had significant impacts on spikes m⁻². These result are supported by [33] who stated that phosphorus application positively influenced productive tillers.

Grains spike⁻¹

Table 2 shows the data with concerning the effects of different levels of nitrogen and phosphorus on number grains spike⁻¹ of wheat varieties. From mean data it was concluded that various rates of P and N considerably ($P \leq 0.05$) influenced number of grains spike⁻¹. Among the entire interactions i.e. N x P, N x V, P x V, N x P x V and control vs. rest x V only the interaction between N and P showed significant result on number of grains spike⁻¹. Varieties (V) also significantly affected number of grains spike⁻¹. Nitrogen rate of 125 kg ha⁻¹ produced highest number of grains spike⁻¹ (51.44) and lowest (40) were counted in control plots. Phosphorus application at the rate of 90 kg ha⁻¹ developed highest number of grain

spike⁻¹ (52.44) while lowest (40) were developed by control plots. Highest number of grain spike⁻¹ (50.67) was developed by Siran-2010 and less number of grain spike⁻¹ (48.04) was produced by Atta-Habib. The interactive response of N and P showed that enhancement of grains spike⁻¹ increased with increasing P levels upto 90 kg ha⁻¹ at all levels of N and then decreased at 120 kg P ha⁻¹. The influence of N, P and varieties on grain spike⁻¹ were found significant. All the interactions except N x P were found non-significant. Grains spike⁻¹ is a vital factor that adds to the grain yield of any crop. Siran-2010 produce more grains spike⁻¹ than Atta-Habib. The difference in grains spike⁻¹ might be due to the genetic variations of these varieties. Our results are agreed with that of [27] who reported variations among wheat cultivars for number of grains spike⁻¹. Nitrogen application positively influenced number of grains spike⁻¹. Highest number of grains spike⁻¹ was counted in plots treated with of 125 kg N ha⁻¹ and lowest numbers of grains spike⁻¹ were counted in control plots. Our results are in line with that of [31] who recorded maximum grains spike⁻¹ at 120 kg N ha⁻¹. Our result also supported by [34] who found more grains spike at 120 kg N ha⁻¹. P application considerably influenced number of grain spike⁻¹. More grains spike⁻¹ was counted at P rate of 90 kg P ha⁻¹ and less number of grains spike⁻¹ was recorded in control plots. Our results are at par with that of [34] who also found maximum grains spike⁻¹ at 90 kg P ha⁻¹.

Thousand grains weight (g)

Statistical analysis of the data showed that N, P and V had significant ($P \leq 0.05$) impact on the weight of thousand grains. Interactive response of N and P on thousand grains weight also showed significant result while N x V, P x V, N x P x V and control vs. rest x V were found to be non-significant (Table 2). Variety Siran-2010 developed heavier grains (42.16 g) as compared to Atta-Habib (38.73 g). Heavier thousand grains (42.16

g) were found in plots received 125 kg N ha⁻¹ as compared to control which had thousand grains weight of 30.13 (g). With respect to P levels highest thousands grains weight (41.21 g) were produced by the plots received P at the level of 90 kg ha⁻¹ while minimum thousand grains weight (30.13 g) were found in control plots. Regarding interactive response of N and P grain weight linearly increased with increasing both N and P levels. Varieties, nitrogen, phosphorus and NP interaction significantly affected thousand grains weight. Grain weight is a major contributing factor that adds to the final yield of a crop. Siran-2010 produced maximum thousand grain weight than Atta-Habib. The difference in thousand grains weight of these two varieties may be attributed to the inherent differences and suitability of the variety to ecological condition. Similar results were obtained by [35]. Nitrogen application considerably influenced thousand grains weight. Nitrogen level of 125 kg ha⁻¹ produced heavier grains while lighter grains were recorded in control plots. Our results are supported by [31] who achieved maximum thousand grains weight at 120 kg N ha⁻¹. [29] also find increase in thousand grain weight up to 75 kg N feddan⁻¹. P application showed a positive response on the weight of thousand grains. P level of 90 kg P ha⁻¹ produced heaviest grains which was statically similar to that produced by 120 kg P ha⁻¹ while lowest were recorded in control plots. Our results are at par with that of [36] who stated significant enhancement in all the growth and yield parameters at P level of 80 kg P ha⁻¹. Highest level of P in combination with a fix N rate contributed maximum to transfer physiological attributes and assimilates towards the yield attributes. Our results are similar to the finding of [37] who reported heaviest grains at 120-90-60 kg NPK ha⁻¹ respectively.

Biological yield (kg ha⁻¹)

Biological yield of wheat varieties was significantly affected ($P \leq 0.05$) by

different levels of N and P. The interaction between N and P was also significantly affected biological yield kg ha⁻¹ (table 2). Higher biological yield (10386 kg ha⁻¹) was produced when nitrogen was applied at the rate of 150 kg ha⁻¹. Control plots resulted in lowest biological yield (7738 kg ha⁻¹). With reference to the P application highest biological yield (10298 kg ha⁻¹) was produced by 90 kg P ha⁻¹ while least biological yield (7738 kg ha⁻¹) was recorded in control plots. Wheat variety Siran-2010 developed highest biological yield (10060 kg ha⁻¹) than Atta-Habib which produced least biological yield (9977 kg ha⁻¹). In case of N x P biological yield increased with increasing P levels upto 90 kg ha⁻¹ at all levels of N and then decreased at 120 kg P ha⁻¹. Varieties, N, P and interaction between N and P considerably influenced biological yield all others interactions showed non-significant results. Siran-2010 produced more biological yield than Atta-Habib when treated with 150 kg N ha⁻¹ along with 90 kg P ha⁻¹. This might be due to variations in genetic makeup of these varieties and other ecological factors. [35] and [38] also stated significant difference in biological yield of wheat varieties. Increased vegetative phase of the crop resulted in increased biological yield. Maximum biological yield was obtained in plots treated with 150 kg N ha⁻¹. [39] reported that N application increased biological yield. Similar result was also reported by [27] who stated that N application linearly increased biological yield. P application greatly increased biological yield. Highest biological yield was recorded at P rate of 90 kg P ha⁻¹. [40] reported highest biological yield at P application rate of 120 kg P ha⁻¹. Our results are also agreed with that of [36] who got highest biological yield at 80 kg P ha⁻¹.

Grain yield (kg ha⁻¹).

Statistical analysis of the data indicated that N, P and V had significant ($P \leq 0.05$) effect on grain yield (kg ha⁻¹). Interactive

response of N and P on grain yield kg ha^{-1} also showed significant result. N x V, P x V, N x P x V and control vs. rest x V were found non-significant (Table 2). Wheat variety Siran-2010 produced greater grain yield (3855 kg ha^{-1}) than Atta-Habib which produced grain yield of 3729 kg ha^{-1} . Highest grain yield (4061 kg ha^{-1}) was found in plots received 125 kg N ha^{-1} than control. With respect to P levels greater grain yield (3944 kg ha^{-1}) was recorded in plots in which P was applied at the rate of 90 kg ha^{-1} while minimum grain yield (1879 kg ha^{-1}) was found in control plots. The interactive response of N and P revealed that grain yield increased by increasing P levels upto 90 kg ha^{-1} at all levels of N and then decreased at 120 kg P ha^{-1} . Grain yield of wheat varieties was significantly affected by N, P and N x P. Achievement of highest grain yield is the ultimate goal of many research project. The main objective of fertilizer application is to get best yield in terms of quantity as well as quality. Wheat variety Siran-2010 produced highest grain yield when treated with 125 kg N ha^{-1} along with 90 kg P ha^{-1} than Atta-Habib. This is because of more number of spikes m^{-2} , heavier grains and more number of grains spike $^{-1}$. Lowest grain yield was obtained from control plots. Such a result obtained by [41]. The others probable reason might be the variations in genetic potential of both varieties and environmental factors [42]. Nitrogen application significantly increased grain yield. In term of N application grain yield was maximum at 125 kg N ha^{-1} while minimum were produced by control plots. Our results are similar to the finding of [43] who stated considerable increased in grain yield at 120 kg N ha^{-1} . P application also enhanced grain yield. Highest grain yield was recorded at 90 kg P ha^{-1} and minimum was recorded in control plots. Our results are similar to the finding of [36] who reported maximum grain yield at 80 kg P ha^{-1} . Similarly [34] reported that 120 kg N ha^{-1}

along with 90 kg P ha^{-1} is a suitable rate for getting maximum wheat production.

Harvest index (%)

Statistical analysis of the data showed that N, P and V considerably ($P \leq 0.05$) affected harvest index. Among interactions only N x P showed significant effect on harvest index (table 2). Wheat variety Siran-2010 maintained greater harvest index (38.5%) followed by Atta-Habib (37.69 %). Greater harvest index (40.9 %) was recorded at 125 kg N ha^{-1} while lowest harvest index (24.3 %) in control plots. Phosphorus rate of 90 kg ha^{-1} produced highest harvest index (38.8%) and lowest (24.3 %) in control plots. N x P developed highest harvest index (43.4%) at nitrogen rate of 125 kg ha^{-1} and P rate of 90 kg ha^{-1} . Regarding the interactive effect of nitrogen and P the harvest index increased upto 125 kg N ha^{-1} and 90 kg P ha^{-1} and then tends to decreased at 150 kg N ha^{-1} and 120 kg P ha^{-1} . Harvest index was significantly affected by varieties, nitrogen and phosphorus and N x P all others interactions showed non-significant results. Siran-2010 produced maximum harvest index than Atta-Habib when treated with 125 kg N ha^{-1} along with 90 kg P ha^{-1} and minimum were recorded in control plots. This might be due to variations in genetic makeup of these varieties and other ecological factors. Our results also supported by [38] who stated significant difference in harvest index of wheat varieties. N application increased vegetative phase of the crop which resulted in increased biological yield as a result harvest index decreased. Maximum harvest index was obtained in plots received 125 kg N ha^{-1} while lowest were recorded in control plots. Our results are supported by [31] who reported that N application at the level of 120 kg ha^{-1} gave maximum harvest index. P application greatly increased harvest index. Highest harvest index was recorded in the plots received 90 kg P ha^{-1} that was statistically similar to that produce by 120 kg P ha^{-1} while lower were recorded in control plots.

[6] reported that P fertilizer greatly improved harvest index.

Table 2. Number of spikes m⁻², grains spike⁻¹, 1000 grains weight, biological yield, grain yield and harvest index of wheat varieties as affected by nitrogen and phosphorus fertilization

Treatment	Spikes m ⁻²	Grains spike ⁻¹	1000 grains weight	Biological yield	Grain yield	Harvest index
N (kg ha⁻¹)						
100	345c	46.83c	37.22c	9626c	3423c	35.6c
125	368a	51.44a	42.16a	10044b	4061a	40.9a
150	358b	49.78b	40.46b	10386a	3892b	37.5b
LSD (0.05)	2.286	0.965	1.308	34.910	63.969	0.623
P (kg ha⁻¹)						
60	351c	46.72c	38.33b	9751c	3676c	37.7b
90	364a	52.44a	41.21a	10298a	3944a	38.8a
120	356b	48.89b	40.31a	10007b	3756b	38.4a
LSD (0.05)	2.286	0.965	1.308	34.910	63.969	0.623
Varieties						
Siran-2010	362a	50.67a	41.16a	10060a	3855a	38.7a
Atta-Habib	352b	48.04b	38.73b	9977b	3729b	37.8b
LSD (0.05)	2.457	0.816	0.669	29.976	29.318	0.339
Control	261	40.00	30.32	7738	1879	24.3
Interaction						
N x P	*	*	*	*	*	*

Mean values of each category followed by different letter (s) are statistically different at $P \leq 0.05$ using LSD test

Conclusion and recommendation

It is concluded from the experiment that wheat variety Siran-2010 performed better than Atta-Habib in terms of yield and yield components. Nitrogen application at the rate of 125 kg ha⁻¹ produced maximum grain yield. Phosphorus application up to 90 kg ha⁻¹ showed better impact on growth and yield. Wheat variety Siran-2010 is recommended for general cultivation due to its better yield performance. Phosphorus level of 90 kg ha⁻¹ is recommended on the basis of higher grain yield. Nitrogen level of 125 kg ha⁻¹ is recommended for higher grain yield.

Authors' contributions

Conceived and designed the experiments: S Anwar & Israeel, Performed the experiments: Israeel, B Iqbal & S Khan, Analyzed the data: S Anwar & Israeel, Provided reagents: M Faraz, N Ali, S Hussain & MM Anjum, Wrote the paper: S Anwar & B Iqbal.

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