Original Article

RESIDUE MANAGEMENT WITH NITROGEN FERTILIZER FOR IMPROVING THE PRODUCTION OF WHEAT *(Triticum aestivum L.)*

Saeedur Rahman[1,*], Ahmad Khan[1,*], Atique Azam[1], Abdur Rauf[2], Khalida Hamid Abbasi[3], Ali Hamza[4], Nadia[1], Muhammad Basit[5], Muhammad Ashfaq[6], Shafiqa Ali[7], Saeeda Khanum[3], Hafiz Malik Naeem Iqbal[4], Muhammad Aamer[8], Khuram Shahzad[9], Muhammad Uzair Khan[1], Muhammad Babar[5,*]

[1]Department of Agronomy, Faculty of Crop Production Sciences, University of Agriculture Peshawar, Pakistan.
[2]Department of Botany, Abdul Wali Khan University, Garden Campus Mardan, Pakistan.
[3]Barani Agricultural Research Institute, Chakwal 48800, Pakistan.
[4]Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan.
[5]Department of Agriculture, University of Swabi, Khyber Pakhtunkhwa, Pakistan.
[6]Regional Agriculture Research Institute, Bahawalpur 63100, Pakistan.
[7]Department of Earth and Environmental Sciences, National Chung Cheng University, Chiayi 621, Taiwan .
[8]Soil and Water Testing Laboratory, Lodhran 59320, Pakistan.
[9]Soil and Water Testing Laboratory, Gujranwala 52290, Pakistan.
Email: saeed345.uos@gmail.com (S.R.); ahmad0936@yahoo.com (A.K.)

DOI: 10.47750/pnr.2022.13.S07.431

Abstract

Nitrogen and residue management plays a vital role in the productivity of wheat. Therefore a field experiment "Residue management with nitrogen fertilizer for improving the production of wheat" was carried out at Research Farm of Agronomy, Agriculture University Peshawar during 2019-20. The experiment was conducted in RCB design having four replications. Treatments consisted of nitrogen fertilizer (i.e. 0, 60 and 120 kg N ha^{-1}) and mungbean residues (MR) levels (0, 2 and 4 tons MR ha^{-1}). A significant impact on wheat production was demonstrated by nitrogen fertilizer and mungbean residue levels. The higher level of N (120 kg ha^{-1}) had improved the spike m^{-2} (234), grains spike^{-1} (53), biological yield (8708 kg ha^{-1}), thousand grains weight (44.91 g), grain yield (3478 kg ha^{-1}) and soil organic nitrogen (0.059%) as compared to those plots having 0 kg N ha^{-1}. Taller plants (100 cm), more spike m^{-2} (234) grains Spike^{-1} (52), thousand grains weight (44.46 g), grains yield (3267 kg ha^{-1}), biological yield (8319 kg ha^{-1}) and harvest index (39.20%) were observed in plots having 4 tons MR ha^{-1}. However, lower soil pH (7.11), more soil organic carbon (0.50%) and nitrogen (0.065%) were recorded in plots having 4 tons MR ha^{-1}. It is concluded that the use of nitrogen fertilizer (120 kg ha^{-1}) along with mungbean residue (4 tons ha^{-1}) has boosted soil fertility and wheat production.

Keywords: Residue management**,** Nitrogen, Wheat, yield**.**

Introduction

Many people around the world rely on wheat as a primary source of food. In Pakistan, it is the main cereal crop and takes up 66% of the total cereal crops cultivated every year (Anon., 2006). It is a staple food for the Pakistani population and supplies 60% of the normal diet's caloric and protein intake (Khalil & Jan, 2002). The average person consumes more wheat (125 kg per year) than in any other country in the globe (Mustafa et al., 2004). in Pakistan, wheat actual farm yield is around 30-35% of the total potential production, however in comparison to leading nations like China and Mexico, 50% of the potential output is achieved (Anon., 1997).

Farmers commonly use high doses of nitrogenous fertilizers as they want to guarantee a sufficient amount of N for the requirement of crop. The nitrogen requirement for each crop is different across the various fields. Increased supply of nitrogen result in lodging and increased risk of weeds problems, susceptibility to diseases and delayed maturity (Skjødt et al., 2003). Moreover, more use of N leads to denitrification, and loss of nitrogen in large portion to ammonia, leaching and volatilization (Montemurro, 2009). To reduce nitrogen loses, fertilizer nitrogen must be used according to requirement of crop. These problems must be solved, so that farmers have to use nitrogen in proper amount and time to minimize N losses to atmosphere. Nitrogen application in the developed countries is applied in the form of chemical fertilizer in sufficient quantity, however in some part of the world like India or Pakistan, due to high cost of synthetic fertilizers, and lack of credit facilities its usage according to the crop requirements is limited (López-Bellido & López-Bellido, 2001). So, growers use the existing sources of nutrients i.e. organic sources of nutrients (residue and manure). Since, last few years, fertilizer cost increased exceptionally and accessibility to the fertilizer in optimum amount and period has been an issue of serious concern.

Crop residues are plant pieces that are still present in the field after the crop's edible components, such as grain, tubers, and roots, have been taken. Crop residues have occasionally been thought of as trash that need to be disposed of, but it is becoming more and more clear that they are valuable natural resources rather than wastes (CTIC, 2004). Crop residues can be used as an important management strategy to maintain the soil fertility, crop production and nutrients availability through their decomposition. However, farmers do not know the best ways to manage these residues such as legume and rice straw are mostly burnt by them for cleaning the fields after harvesting. So, searching for a good way to recycle the nutrients through crop residues became a vital task. Recently, recycling of the nutrients through organic residues as a soil amendment is considered a beneficial way and popular approach for improving soil properties.

Keeping in view, the significance of residue returning to the soil along with N fertilizer, and lack of proper information on the subjected cited, an experiment was therefore conducted to investigate the impact of crop residue levels i.e. incorporation of mungbean residues along with additional supply of nitrogen fertilizer for improving the soil fertility and wheat production.

Materials and methods

The research entitled "Residue management with nitrogen fertilizer for improving the production of wheat" was conducted at the Agronomy Research Farm, The University of Agriculture Peshawar, in Rabi Season, 2019-20. There are two experimental factors i.e., Factor A are levels of nitrogen, which is consist of N_1: Control, N_2: Half of recommended rate (60 kg ha^{-1}), N_3: Full recommended rate **(**120 kg ha^{-1}), and Factor B: mungbean residue levels were organized in the following shape i.e., MR_1: Removed (0 ton ha^{-1}), MR_2: Half residues retained **(**2 tons ha^{-1}), MR_3: Full residues retained (4 tons ha^{-1}).

The experiment was conducted in Randomized Complete Block Design (RCBD) having 4 replications. Mungbean residue levels were soil incorporated 25 days before sowing using common field cultivator. However, the N levels were applied in split half at the time of sowing and half at first irrigation. The size of each plot was 3 x 3 m, having R-R distance of 30 cm and total of 10 rows. Wheat variety (Pirsabak 2015) was sown on 13th November, 2019 at the seed rate of 120 kg ha^{-1}. All agronomic and cultural practices include hoeing, weeding, and irrigation (4-6 times) was carried out uniformly for the experimental treatments. Weeds were controlled manually by hoeing as per the situation when weeds intensity was higher. Crop was harvested at harvest maturity before shattering of grains when the spike of all plants turned to yellow color. Data were recorded on spike m^{-2}, plant height, grains spike $^{-1}$, thousand grains weight (g), biological yield (kg ha^{-1}), grain yield (kg ha^{-1}), harvest index (%), soil organic carbon (%), soil organic nitrogen (%), soil PH.

Statistical analysis

The data was analyzed using the procedure of ANOVA, and means were separated using posthoc multiple comparison test i.e. LSD at 5% probability level, when the F-values were significant (Jan et al., 2009).

Results

Plant height (cm)

The influence of fertilizer nitrogen and residue levels on plant height of wheat is given in Table 1. Significant ($P<0.05$) differences were noted for nitrogen fertilizer and residue levels. Among the nitrogen fertilizer tallest plants (100 cm) were observed with the addition of 120 kg N ha^{-1}. Whereas, the shortest plants (94 cm) were measured in plots having no-nitrogen fertilizer. This result further indicated that plants height measured in no-nitrogen fertilizer plots and those received 60 kg N ha^{-1} were statistically non-significant. Similarly, retained crop residue (4 tons ha^{-1}) resulted in taller plant height (100 cm) as compared to plant height measured in plots having either 2 tons ha^{-1} or no residues. It was further noted that the difference between 2 tons ha^{-1} residue and the no residue was not significantly different from each other in term of plant of wheat.

Spike m^{-2}

The application of nitrogen fertilizer, residue levels as well as its interaction had significant effects on spike m^{-2} of wheat (Table 1). Increasing the levels of nitrogen application from 0 to 120 kg ha^{-1}had increased the spike m^{-2} of wheat from 208 to 234, respectively. This indicated that incremental increases in nitrogen fertilizer application had significantly increased the spike m^{-2}, and an increase of 12.7% in spike m^{-2} was noted with the incorporation of 120 kg N ha^{-1}as compared to no N application. Regarding, the residue levels, the spike m^{-2} were more in plots where residue was retained at the rate of 4 tons ha^{-1} (234) or 2 tons ha^{-1} (222) as compared to plots where residue was removed (217). It is further noted that no differences in spike m^{-2} was noted in plots having either 2 or 4 tons ha^{-1} residue was retained. The interaction of nitrogen fertilizer and residue levels indicated that increasing the levels of nitrogen fertilizer from 0 to 120 kg ha^{-1}, the spike m^{-2} increased linearly with all residue levels. However, the increment was greater with residue removed than residue retained. The variations in spikes (m^{-2}) with increasing N levels were greater in 2 tons ha^{-1} residue than 4 tons ha^{-1}.

Grains spike^{-1}

The effect of nitrogen and residue levels on grains spike^{-1} is shown in Table 1. It was observed that nitrogen and residue levels as well as their interaction had significantly affected ($P<0.05$) grains spike^{-1}. The application of nitrogen fertilizer had significantly increased grains spike^{-1} of wheat from 50 to 53 with increasing the N rate from 0 to 120 kg ha^{-1}, respectively. In case of residue levels more grains spike^{-1} (52) was observed from the treatments where residue was retained (2 to 4 tons ha^{-1}) and less grain spike^{-1} (50) was recorded from the plots having no residue retained zero-ton ha^{-1}. The interaction of nitrogen fertilizer and residue levels showed that as nitrogen levels increased from 0 to 120 kg ha^{-1}, grains spike^{-1} increased linearly with all residue levels. However, the increment was lesser with residue removed than residue retained plots. The changes in grain spike^{-1} with increasing N levels were more in plots were 4 tons ha^{-1} residue than no residue.

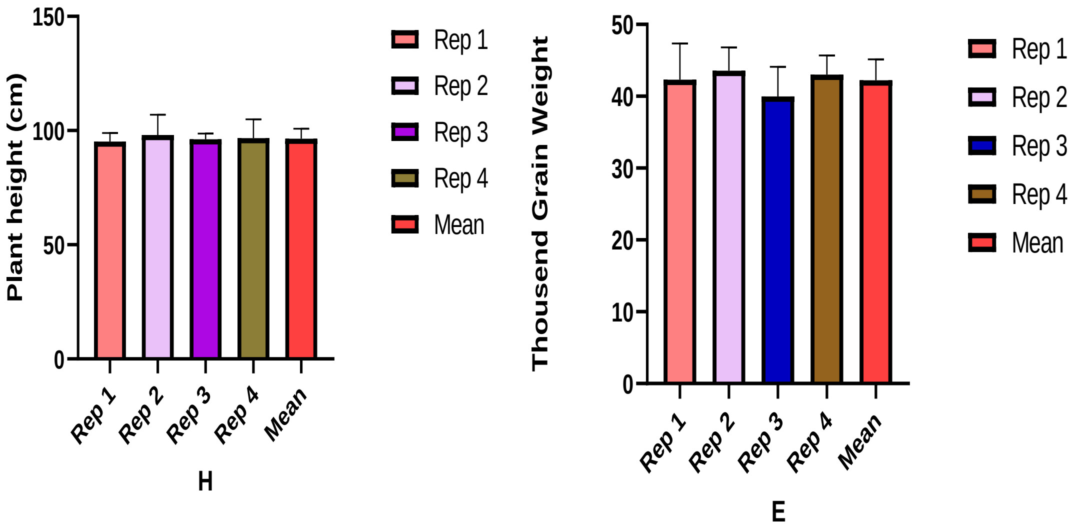
Thousand grains weight (g)

The nitrogen fertilizer and residue levels had significant effects on thousand grains weight of wheat (Table 1). Increasing the nitrogen fertilizer levels from 0 to 120 kg ha^{-1} had increased the thousand grains weight of wheat from 40.17 to 44.91 g, respectively. Regarding, the residue levels, heavier thousand grains were weighed in plots having 4 tons ha^{-1} (44.46 g) or 2 tons ha^{-1} (42.37 g) as compared to the lighter thousand grains weight in plots where residue was removed (39.83).

Table 1. Plant height (cm), spikes (m^{-2}), grains $spike^{-1}$ and 1000 grains weight (g) of wheat in response to nitrogen and residue levels.

Treatments	**Parameters**			
Nitrogen levels (kg ha^{-1})	**Plant height (cm)**	**Spikes (m^{-2})**	**Grains $spike^{-1}$**	**1000 grains weight (g)**
0	94 b	208 b	50	40.17 b
60	95 b	233 a	51	41.57 b
120	100 a	234 a	53	44.91 a
LSD (0.05)	4.97	13.18	1.87	2.63
Residues levels (tons ha^{-1})				
0	93 b	217 b	50 b	39.83 b
2	96 ab	224 ab	52 a	42.37ab
4	100 a	234 a	52 a	44.46 a
LSD (0.05)	4.97	13.18	1.87	2.63
Interaction				
NL x RL	NS	NS	*	NS

Figure 1: Mean comparison of spike (m^{-2}) (H) and grains $spike^{-1}$ (%) (E) as affected by nitrogen and residue levels.



Biological yield (kg ha^{-1})

The Data presented in Table 2 showed that nitrogen and residue levels had significant effects (P<0.05) on biological yield. Generally, increasing the levels of nitrogen fertilizer had increased the biological yield, being maximum (8708 kg ha^{-1}) in plots having 120 kg N $ha^{-1}$and minimum in plots having no nitrogen (6957 kg ha^{-1}). Among the residue levels, the residue retained at the rate of 4 tons ha^{-1} had higher biological yield (8319 kg ha^{-1}) as compared to the lower biological yield (7574 kg ha^{-1}) recorded from the plots having no residues.

Grain yield (kg ha^{-1})

The influence of nitrogen and residue levels on grain yield (kg ha^{-1}) of wheat is reported in Table 2. Statistical data analysis showed that fertilizer nitrogen and residue levels had significantly affected the grain yield of wheat. However, the nitrogen and residue levels interaction were found non-significant. Increasing the application of nitrogen fertilizer from 0 to 120 kg ha^{-1}had linearly increased the grain yield from 2623 to 3478, representing an increase of 32.56% in grain yield with 120 kg N ha^{-1} as compared to no-N application. Among the residue levels, maximum grain yield (3267 kg ha^{-1}) was noted from those plots where 4 tons ha^{-1} residue was retained as compared to the minimum grain yield (2847 kg ha^{-1}) recorded from the plots having no-residue.

Harvest index (%)

Nitrogen and residue levels effects on wheat harvest index is shown in Table 2. Analysis of data showed that significant effect ($P<0.05$) on harvest index was noted in response to nitrogen fertilizer and residue levels. However, the nitrogen fertilizer and residue levels interaction was non-significant for harvest index of wheat. Nitrogen at the rate of 120 kg ha^{-1} had resulted in maximum harvest index (39.90%) followed by (38.63%) with the application of 60 kg N ha^{-1} and minimum in plots having no N fertilizer (37.74%). Likewise, the application of higher amount of mungbean residue have resulted in greater harvest index of wheat (39.20%) as compared to plots having no residue retention (37.72%). It was further noted that the harvest index of wheat was not different in plots having either 2 or 4 tons ha^{-1} residue.

Soil organic carbon (%)

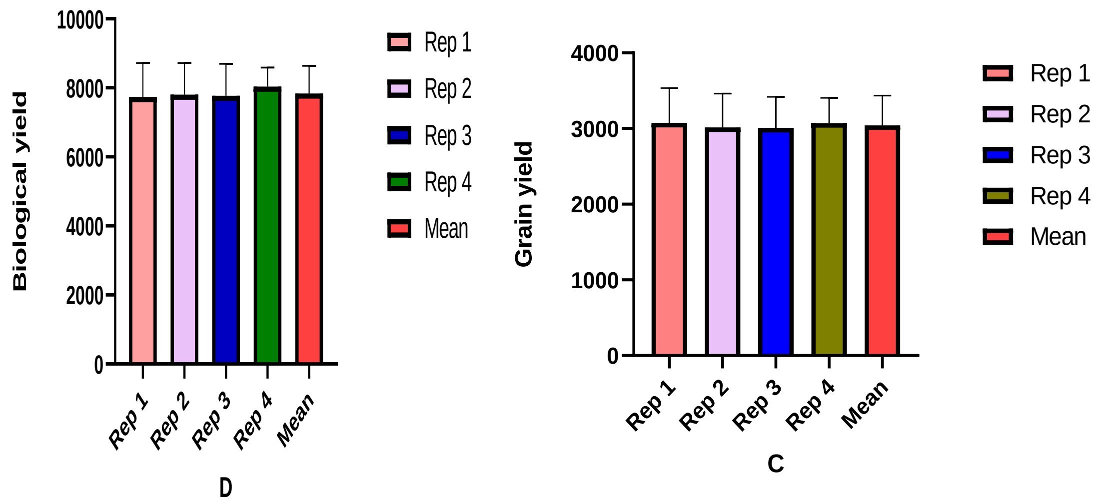
Organic soil carbon as affected by nitrogen fertilizer and mungbean residue levels is presented in Table 2. The mungbean residue application had shown significant differences for soil organic carbon, whereas the nitrogen fertilizer and the interaction between N fertilizer and mungbean residue were found non-significant for soil organic carbon. Mean values indicated that increasing the residue levels from 0 to 4 tons ha^{-1}had significantly increased the soil organic carbon from 0.46 to 0.50%. The result further indicated that doubling the amount of residue from 2 to 4, had increased the soil organic carbon by 8.7%.

Table 2. Biological yield (kg ha^{-1}), grain yield (kg ha^{-1}), harvest index (%) and organic carbon (%) of wheat in response to nitrogen and residue levels.

Treatments	**Parameters**			
Nitrogen levels (kg ha^{-1})	**Biological yield (kg ha^{-1})**	**Grain yield (kg ha^{-1})**	**Harvest index (%)**	**Organic carbon (%)**
0	6957 c	2623 c	37.74 b	0.47
60	7841 b	3027 b	38.63 ab	0.48
120	8708 a	3478 a	39.90 a	0.48
LSD (0.05)	334	138	1.37	NS
Residues levels (tons ha^{-1})				
0	7547 b	2847 c	37.72 b	0.46 b
2	7640 b	3014 b	39.36 a	0.47 b
4	8319 a	3267 a	39.20 a	0.50 a
LSD (0.05)	334	138	1.37	2.63

Interaction				
NL x RL	NS	NS	NS	NS

Figure 2: Mean comparison of biological yield (kg ha^{-1}) (D) and grains yield (kg ha^{-1}) (C) as affected by nitrogen and residue levels.



Soil organic nitrogen (%)

Soil organic nitrogen in response to nitrogen fertilizer and residue levels is reported in Table 3. Results indicated significant effects (P<0.05) of nitrogen fertilizer and residue levels on soil organic nitrogen. However, the interaction between nitrogen fertilizer and residue levels was non-significant. Moreover, the organic soil nitrogen increased from 0.047 to 0.49% with increasing the nitrogen fertilizer from 0 to 120 kg ha^{-1}, respectively. Similarly, the reside application of 4 tons ha^{-1} had maximum soil organic nitrogen (0.065%) plots having no-residue (0.042%).

Soil pH

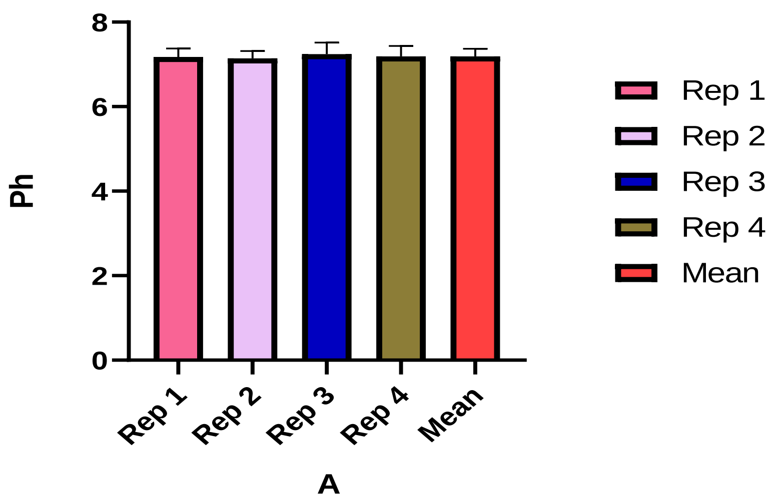
Data on soil pH in response to nitrogen fertilizer and mungbean residue levels is provided in Table 3. The soil pH was significantly (p< 0.05) affected by nitrogen fertilizer and residue levels; however, the nitrogen fertilizer and residue levels interaction were found non-significant for soil pH. High soil pH (7.40) was recorded from the plots where no nitrogen was applied followed by plots having nitrogen applied at the rate of 60 kg ha^{-1}(7.10), whereas the lowest soil pH (7.07) was recorded in plots having 120 kg N ha^{-1}. Similarly, increasing the mungbean residue application, the soil pH decreased. In the same way, the application of 4 tons ha^{-1} mungbean residue had the lowest soil pH (7.11) as compared with 2 tons ha^{-1} residue application (7.31) or no-residue application (7.31).

Table 2. Soil organic nitrogen and PH of wheat in response to nitrogen and residue levels.

Treatments		**Parameters**
Nitrogen levels (kg ha^{-1})	**Organic nitrogen (%)**	**PH**
0	0.047	7.40
60	0.053	7.10

120	0.059	7.07
LSD (0.05)	0.01	0.14
Residues levels (tons ha^{-1})		
0	0.042	0.31
2	0.051	0.15
4	0.065	0.11
LSD (0.05)	0.01	0.14
Interaction		
NL x RL	NS	NS

Figure 2: Mean comparison of Soil pH (A) as affected by nitrogen and residue levels.



Discussion

Data collected on different parameters for improving soil fertility parameters and wheat production as a result of nitrogen fertilizer and the mungbean residue levels is discussed here with appropriate and applicable comparative clarification in the light of collected literature.

Nitrogen fertilizer and residue levels had significantly influenced of the following traits i.e., plant height, spike m^{-2}, grains spike^{-1}, thousands of grains weight, harvest index, and biological yield. However, the interaction was non-significant. Therefore, the maximum plant height was recorded from nitrogen fertilizer treatment (120 kg ha^{-1}) compared to no nitrogen application. Moreover, nitrogen plays a greater role in plant vegetative growth and thus increased plant tallness, where it is associated to the slow release of nutrients from residue, its regular availaibility had increased the crop growth during the growing season and thus increased plant tallness. Furthermore, the tallest plant height was due to the well-nourished crop from the application of nitrogen fertilizer as compared to no N application. Earlier researcher (Shah et al., 2010), had reported tallest plant with nitrogen fertilizer application. More plants and active tillers (Jan & Khan, 2000) were developed by residue incorporation, which could be the result of higher soil organic matter decomposition and nutrients availability. It was observed that (Riaz et al., 2006), published similar findings that plant height increased with increasing levels of nitrogen fertilizer and mungbean residue levels.

Likewise, the use of nitrogen fertilizer 120 kg ha^{-1} produced more spike m^{-2} linked to those plots which received no nitrogen (0 kg ha^{-1}). So, the greater spike m^{-2} might be attributed to the adequate obtainability of nitrogen, which facilitates the wheat crops tillering ability (Jan & Khan, 2000). Therefore, these data are in line with the findings of (Shahdeva et al., 1998) who also obtained higher spikes m^{-2} using higher fertilizer levels.

Similarly, in the N-fertilized plots, the greater grain $spike^{-1}$ can be related to the availability of N at the stage of grain formation. Whereas the results are in line with the highest grain $spike^{-1}$ reported by (AFRIDI et al., 2012) with the cumulative use of organic and inorganic fertilizer sources. Therefore, our data also agree the findings of (Khan, 2005), who obtained heavier $spike^{-1}$ grains in fertilized plots as compared to the control. While the highest nitrogen fertilizer (120 kg ha^{-1}) had attributed to more grains $spike^{-1}$. In addition, Nitrogen is also integral part of the chlorophyll, thus increasing N might have increased the photosynthetic process of the plants, and thus increased the grains $spike^{-1}$. Moreover, the slow release of nutrients from organic sources has encouraged vegetative growth which increased time of filling grains and produce more grains in $spike^{-1}$ (Arif et al., 2006). Eventually, Malik et al. (2007) also documented significant effects of nitrogen fertilizer and residue levels on grains $spike^{-1}$.

Correspondingly, the interaction was found non-significant for thousand grain weight and harvest index. Due to the use of 120 Kg N ha^{-1}, the heavier thousand grain weight (g) was measured when compared to control plots. The higher N application had increased the photosynthetic capability of the plants, and had distributed greater dry matter to the seeds, thus increased the grains weight. Similarly, the application of residue had significantly increased the properties of the soil that promotes root growth and improved absorption of nutrients were possible approaches for improving the thousand grains weight. As s result, Residue levels prevent nutrients losses and slowly release. Therefore, grain weight more from plots of nitrogen fertilizer was attributed to less nitrogen loss by volatilization and leaching over time (Arshad et al., 2004). Researchers like (Parmar & Sharma, 2002; Shah et al., 2010) had reported the highest weight of 1000 grains from residue application. In addition, Riaz et al., 2006 and Rajpar et al., 2010, revealed significant effects of early season use of nitrogen fertilizer and residue on plant growth and crop grain weight.

In the same way, the biological yield is directly related to the individual plant performance, thus increasing the plants stand, growth and photosynthetic capability of the plants might increase the biological yield. Therefore, supplementary yield of biological was obtained from nitrogen fertilizer (120 kg ha^{-1}) tracked by 60 kg N ha^{-1} and least biological yield in control plots. In addition, the N application increase the grain yield by several mechanisms like increasing dry matter via improving the chlorophyll content, increase leaf area and root proliferation and delayed physiological maturity, that increase the growth filling duration and thus increase biological yield of the crop. Similarly, the increased residue application had increased the biological yield and the minimal losses of mineral nitrogen in the residue applied plots, might have ensured the plant growth, and hence the biological yield. Therefore, it was observed highest biological yield from nitrogen fertilizer over the entire crop growing season was attributed to the availability of the necessary amount of nitrogen in residue applied plots. Also the increased biological yield with the application of N fertilizer was also reported by (RASHID et al., 2014). Our findings were agree with (Muhammad et al., 2011), who obtained greater plant height and yield with increase N application in relation to control plots.

Likewise, the yield components and grain yield are the final outcome of the wheat harvest. Therefore, more grain yields were observed from nitrogen fertilizer (120 kg ha^{-1}) application followed by incorporation of nitrogen fertilizer (60 kg ha^{-1}) compared with smaller amount of grain yield from no application of nitrogen. In additions, the increased in grain yield could be attributed to higher leaf area, increase chlorophyll, and improved cell division which increase vegetative growth (Ahmad et al., 2016). Moreover, the grain production of wheat depends mainly on the recommended amount of nitrogen being added. In addition to increasing the plant grain yield, a big issue of adverse effects of N fertilization is the soil ecosystem pollution by the application of chemical fertilizer. Furthermore, to control pollution of the soil ecosystem, organic sources of N might be used instead of commercial fertilizer and to cope this situation, the grain yield improved with the application of higher levels of residue application. Whereas, (Ali et al., 2011) reported more grain yield due to retention of mungbean residue in wheat field as compared to control. The organic nitrogen supply through residue levels has ensured that nitrogen availability at various crop stages, and thus fulfil the N demand of the wheat crop and thus increase the grain yield.

As a result, this makes sure successful crop production in terms of yield components and crop yield. Researchers like (RASHID et al., 2014; Shah et al., 2010) recorded high yield of grain with nitrogen fertilizer application. Similar studies conducted in past had also reported positive effects of nitrogen fertilizer on wheat crop (Islam et al., 2015).

In the same way, harvest index depends on the economic part of the crop as well as the biological part. So, maximum harvest index from the nitrogen application (120 kg ha^{-1}) was observed. As a result, the positive correlation between grain weight and the harvest index was reported by (KOUCHAKI et al., 2006). And the variation in the harvest index was possibly due to the conventional and organic fertilizer application (Dalga et al., 2014). Also, Bibi (2004) concluded an increase in the harvest index with an increase in nitrogen use, which are in line with our findings. Furthermore, the maximum harvest index with residue and N application was also found by (Wang et al., 2004). Eventually, these results are in line with those of (Sing et al., 2011) who reported that different ratio of nitrogen had a major effect on the harvest index.

In the first hand, Soil organic carbon (SOC) has a major role in increasing soil fertility and hence crop productivity. Therefore, the highest SOC was recorded from the plots where 4 tons ha^{-1} residue was retained as compared to plots where residue was removed. However, no differences for SOM were noted across the N treatments. The N availability from the residue (Masciandaro et al., 2018) acted as food for microbes, and thus increased the microbial composition, which indirectly increased the SOM of the soil. Our results demonstrated only small improvement in SOC by crop residues incorporation in soil before sowing of the crop. Our results are in line with the findings of (Diacono & Montemurro, 2011) who found more SOC in response to residue incorporation.

On the other hand, Soil organic nitrogen was non significantly impacted by nitrogen fertilizer, however the effect of mungbean residue was significantly found. Whereas, its interaction was also found non-significant. In case of residue levels more organic nitrogen were noted in plots that retained 2 to 4 tons residue ha^{-1} while minimum was measured in plots having no residue. Therefore, the mineral N been applied to the soil was either taken up by plants or lost. However, the addition of residue had increased the total N, as the residue is a rich source of organic N, and thus its addition increased the soil organic N contents. Our outcomes are in line with the results early documented by (Tarun et al., 2013).

Eventually the alkalinity and acidity basically represent the soil pH. Nitrogen fertilizer, residue levels had significantly affected the soil pH while their interaction has non-significant effects on soil pH. In addition, the increasing of N fertilization had decreased the soil pH. The addition of urea fertilizer acted as buffer and thus increased the acidity of soil. Similarly, plots with more residue retained have low soil pH than plots have low or no residue application. Moreover, the residue has resulted in formation of organic acid upon mineralization, and thus might have increased the acidity of soil, and thereby decreased the soil pH. Furthermore, the cause may be the use of residue-retained organic source of nutrients that decreases soil pH and increases H^+ release after decomposition (Ali et al., 2011). As well as, Mungbean residue has a fundamental cation that decreases the pH of the soil (Dangwal et al., 2010). It was observed that these findings are also in line with Khalid et al., (2010), who indicated that adding residue decreases the pH of the soil.

Conclusions

On the basis of this experimental research output, showed that the application of nitrogen fertilizer has increased the yield contributing parameters, and thus had enhanced the grain yield as compared to the lowest grains yield noted with plots having no nitrogen. Residue retained at the rate of 4-ton ha^{-1} had improved the soil total nitrogen (0.065%), organic carbon (0.5%), and thus had increased the grain yield by 14.75% when compared to plots having no residue. The interactive response of nitrogen and residue levels were found non-significant for most of the parameters, except spike (m^{-2}) and grains spike^{-1}, which increased linearly with increasing nitrogen levels across 0 to 4 tons ha^{-1} residue levels. Based on the results obtained, it was recommended that for improving the grain yield, synthetic fertilizer at the rate of 120 kg ha^{-1} should be used. However, for improving the productivity and soil organic carbon and organic nitrogen, 4 tons ha^{-1} mungbean residue should be applied along with 120 kg ha^{-1} chemical fertilizer in the study area.

Acknowledgement

I am pleased to Mr. Mehran Anjum for his guidance, encouragement and help during the study. I am also thankful to Dr. Shah Fahad and Dr. Dost Muhammad for their generous cooperation & technical support throughout the study.

Ethics approval and consent to participate:

Not applicable.

Consent for publication:

Not applicable.

Competing interests:

The authors declare that they have no competing interests.

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