EFFECT OF NITROGEN MANAGEMENT ON WHEAT PERFORMANCE AND SOIL PROPERTIES

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Abstract- Use of organic and inorganic nitrogen (N) fertilizers in proper combination not only increases wheat yield attributes but also enhances physio-chemical properties of the soil. Field experiments were carried out to study the effect of different N sources, forms and ratios for improving wheat productivity and soil properties at Agronomy Research Farm, The University of Agriculture, Peshawar in winter 2017-2018 and 2018-2019. The experiments were laid out in randomized complete block design with 3 replications. Plot size of 3m x 4m having 10 rows with row to row distance of 30 cm was maintained. Wheat variety Pirsabak-2015 was sown on 22nd November during both years at the seed rate of 120 kg ha^{-1}. Organic sources of nitrogen (rice residue, mungbean residue and cattle manure) in two forms (compost and non-compost) with different N ratios (100% organic: 0% inorganic, 75% organic: 25% inorganic, 50% organic: 50% inorganic, 25% organic: 75% inorganic, 0% organic: 100% inorganic) were tested in the experiments. Urea was used as inorganic fertilizer source. A total of 120 kg N ha^{-1} was maintained from different nitrogen sources. The results of the experiment revealed significant effect of different sources, forms and ratios of nitrogen on wheat and soil properties. Among different organic sources of nitrogen, application of cattle manure enhanced leaf area tiller^{-1} (140.1 cm^2), leaf area index (3.8), plant height (97.3 cm), biological yield (8540 kg ha^{-1}), grain yield (3546 kg ha^{-1}), grain nitrogen content (2.26%) and soil electrical conductivity (0.229 dS m^{-1}) with reduced soil bulk density (1.17 g cm^{-3}). Use of organic nitrogen sources in compost form improved plant height (96.1 cm), leaf area tiller^{-1} (138.4 cm^2), leaf area index (3.7), biological yield (8400 kg ha^{-1}), grain yield (3514 kg ha^{-1}), grain nitrogen content (2.21%), total nitrogen uptake (144.6 kg ha^{-1}), soil pH (7.83) and electrical conductivity (0.227 dS m^{-1}) with reduced soil bulk density (1.17 g cm^{-3}). Considering N ratios, 50% organic and 50% inorganic nitrogen application produced taller plants (97.2 cm) with higher leaf area (140 cm^2), leaf area index (3.79), biological yield (8652 kg ha^{-1}), grain yield (3762 kg ha^{-1}), grain nitrogen content (2.28%), total nitrogen uptake (146.8 kg ha^{-1}) and soil electrical conductivity (0.231 dS m^{-1}). Plots that received sole organic nitrogen limited soil bulk density (1.16 g cm^{-3}). It is concluded that wheat crop performed better in soil applied with cattle manure as organic nitrogen source in compost form coupled with inorganic nitrogen in 50:50 ratios and hence recommended for further studies to authenticate higher wheat yield with better soil properties in the agro climatic conditions of Peshawar-Pakistan.

Index Terms- Organic Nitrogen, Soil EC, Soil pH, Straw Nitrogen, Grain nitrogen, Total Nitrogen uptake

I. INTRODUCTION

II. Worldwide, cereal crops are considered as a major source of staple food which contribute greater portion (i.e., more than 50%) of human calories intake. Among cereal crops, wheat is widely grown throughout the world on more than 215 million hectares area annually (Tester and Langridge, 2010; Nezhad ahmadi *et al.*, 2013). According to Pakistan Economic Survey (2020), wheat production in Pakistan was 24.946 million tons harvested from an area of 8.825 million hectares. Wheat productivity and area under production for year 2019-20 was 2.5% and 1.7% higher than previous year's production (24.349 million tons) and cultivated area (8.678 million hectares). The average wheat production which is about 2823 kg ha^{-1} (MNFSR, 2018) is not satisfactory to fulfill the food demands of increasing population. Hence, dire research initiatives are needed to be undertaken to increase and sustain the high quality of wheat production as well as ensure soil health.

III. The demand for higher crop production tends to increase as the population increases and thus the two major challenges that the current agriculture faces are higher yield and sustainability. There are many reasons for low yield in the country; however, the low soil fertility and imbalance use of fertilizers are of great concern. Most of the cultivable soil of Pakistan is scarce in organic matter. Similarly, macronutrients such as nitrogen (N), potassium (K) and phosphorus (P) are also low in Pakistan's soil. The primary reason for this lower soil organic matter and crop nutrients is the injudicious use of chemical fertilizers (Khan and Qasim, 2008). Moreover, there is no residues left in the soil as the farmers do not apply organic material to the crops which are the main causes of low organic matter in the soil. Every agriculture system requires judicious nutrients fertilization for improved production. Among nutrients, Nitrogen is a major macro-nutrient and its unavailability is often the main limiting factor in crop production. Hence, improving crop yield, grain strength, seed integrity and milling properties are greatly related with improving N supply to the crop.

IV. Organic fertilizers have got attention in recent era as they are important for improving crop yield and soil health on sustainable basis (Rasool *et al*., 2007). The agricultural and crop management practices differ in accordance with soil types, farmers' resources and crop rotations (Dong *et al*., 2006), however irrespective of soil, crop and growing season, organic amendments such as cattle manures, poultry manure and crop residues etc. are more important for improving soil organic matter status and C dynamics as compared to chemical fertilizers (Aslam *et al*., 2010). The effectiveness of these organic amendments is completely different in their non-composted form and composted form (Farhad *et al*., 2011). Compost is produced by decomposing the organic materials under controlled biological conditions. Compost acts as a source of organic fertilizers which readily supply nutrients and improve organic matter content in soil (Ahmad *et al*., 2008). Compost is highly effective in improving soil physico-chemical and biological properties (Ramasanta *et al*., 2017), organic matter and crop mineral nutrition (Sood, 2013) and thus may benefits conventional agriculture by improving the efficiency of synthetic fertilizers (Soheil *et al*., 2012).

V. Integrated nutrient management (INM) is a strategy involving the co-application of organic and inorganic nutrients sources with the objective of increasing sustainable crop production as well as preventing any damage to soil health and fertility. It includes application and conservation of nutrients and new technologies to improve availability of plants required essential nutrients and thereby enhance the nutrients uptake and use efficiency. Ensuring food security for the current and coming generations requires balance between higher crop production and sustaining soil health and environment (Dong *et al*., 2006; Ayeni *et al*., 2008). The integrated application of chemical and organic fertilizers ensures to improve higher crop production, sustaining soil health and environment by improving soil organic carbon pool (Pan *et al*., 2009), nutrients availability and the efficiency of applied fertilizers (Bayu *et al*., 2006).

VI. IDENTIFY, RESEARCH AND COLLECT IDEA

It's the foremost preliminary step for proceeding with any research work writing. While doing this go through a complete thought process of your Journal subject and research for it's viability by following means:

1) Read already published work in the same field.
2) Goggling on the topic of your research work.
3) Attend conferences, workshops and symposiums on the same fields or on related counterparts.
4) Understand the scientific terms and jargon related to your research work.

VII. WRITE DOWN YOUR STUDIES AND FINDINGS

MATERIALS AND METHODS

Description of experimental site

Two years field experiments on effect of nitrogen management on wheat performance and soil properties were carried out in the fields of Agronomy Research Farm, The University Agricultural Peshawar – Pakistan during 2017-18 and 2018-19. This research farm is located at 33.02° N latitude and 72.23° E longitude at an altitude of 361 m above sea level. Soil of the experimental site is clay – loam, calcareous, alkaline and low in NPK and organic matter. Climatic conditions of the area are semi-arid. The mean monthly data of rainfall (mm), minimum and maximum temperature is presented in Figure 1, while physicochemical properties of the experimental field are given in Table 1 and nutrients concentration of the organic materials used are given in Table 2.

Table 1. Soil physicochemical properties of the experimental site and field.

Description	Values
Silt (%)	49.5
Sand (%)	8.4
Clay (%)	42.1
Textural class	Silty clay loam
Organic matter (g kg^{-1})	0.827
Total nitrogen (%)	0.046
$CaCo_3$ (%)	-
pH	7.89
Electrical conductivity (dS m^{-1})	0.23
Phosphorus (mg kg^{-1})	4.02
Potassium (mg kg^{-1})	98.6
Zinc (mg kg^{-1})	0.79

Table 2. N, P and K (%) content of the organic materials used in experiment

Nitrogen sources	Nutrients content (%)		
	N	P	K
Rice residues	0.61	0.47	0.52
Mungbean residues	0.92	0.71	0.8
Cattle manures	1.09	0.67	0.91

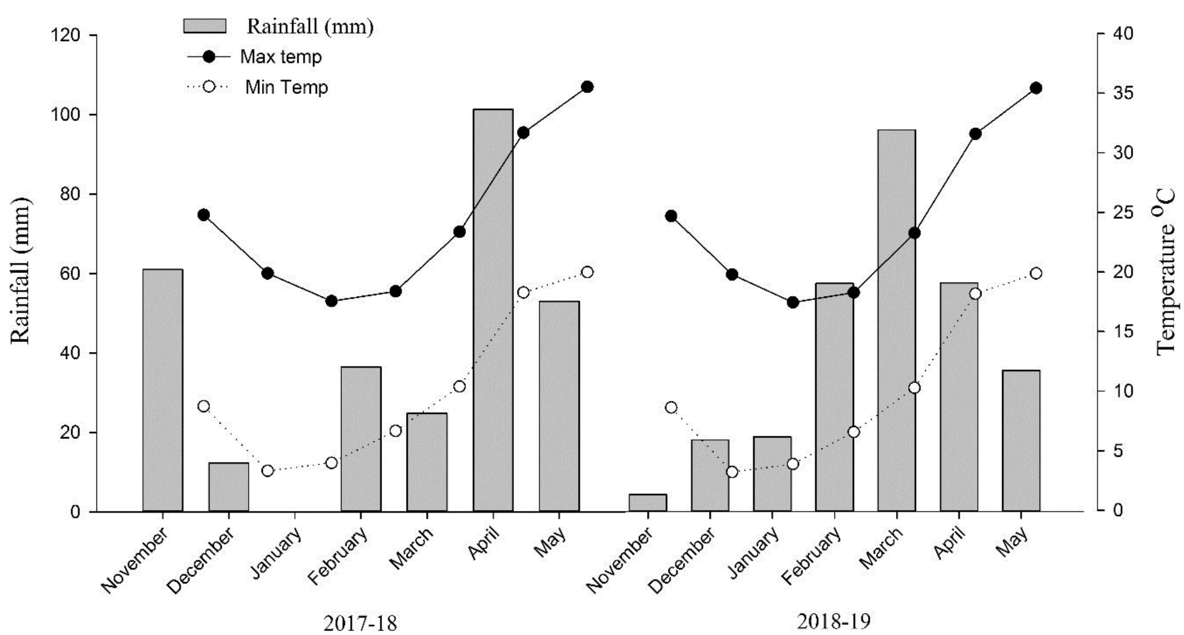

Fig. 1. Monthly rainfall (mm), minimum and maximum temperature (°C) during growing season 2017-18 and 2018-19.

Experimental design and field agronomic practices

Each experiment was laid out in Randomized complete block (RCB) design and each treatment was replicated three times. The field was ploughed twice at proper field capacity level with the help of local cultivator. Treatments were allocated to the respective plots and organic fertilizers sources were applied one day before sowing the crop. Plot size of 12 m^2 was maintained. Each plot had 10 rows with row-row distance of 30 cm. Recommended seed rate of 120 kg ha^{-1} was used for sowing wheat variety Pirsabak-2015. A total of 120 kg N ha^{-1} was maintained from different organic (rice residue, mungbean residue, cattle manure) and inorganic (urea) nitrogen sources. Inorganic nitrogen was split into two doses; half was applied at sowing and remaining half was applied after first irrigation. Phosphorus and potassium were applied at @ of 90 and 60 kg ha^{-1} during seedbed preparation (Super phosphate (SSP) and sulfate of potash (SOP) were used as a source of P and K respectively). Other agronomic practices such as weeding, irrigation and thinning etc. were performed in all treatments uniformly. To avoid the fallow period between two consecutive wheat seasons, maize was sown at 30 kg ha^{-1} seed rate. However, it was not the part of this experiment and dissertation.

Compost preparation

In order to prepare compost, pits were made. The composting materials (rice residue, mungbean residue and cattle manure) were dumped in separate pits in moist condition and the pits were covered with plastic and were buried in the soil for one month. The composted material was turned over on weekly basis in order to speed up the decomposition process.

Chemical analysis of organic sources

The organic sources were analyzed for different nutrients i.e., N, P and K (Table 2). A composite soil sample was collected and analyzed for different physicochemical properties before sowing. Post crop harvest soil samples were also collected in both years and were analyzed for different parameters studied in the experiment.

Tillers m^{-2}

For tillers m^{-2}, three rows, each 1 meter long were randomly selected in each treatment and number of tillers emerged were counted and converted into tillers m^{-2} accordingly.

Plant height (cm)

The height (from base to the top spikelet, excluding awns) of ten randomly selected plants in each experimental treatment was measured using an accurate meter rod. The data noted was then averaged and plant height was determined.

Leaf area tiller^{-1} (cm^2)

Leaves of five plants selected randomly in each experimental unit were collected at anthesis stage. Leaf area of all the collected leaves was measured and then converted into leaf area tiller^{-1} using following formula.

$$\text{Leaf area tiller}^{-1}(cm^2) = \frac{\text{Avg. leaf length (cm)} \times \text{Avg. leaf width (cm)} \times \text{No. of leaves} \times 0.65}{\text{Number of tillers}}$$

Leaf area index (LAI)

Leaf area index of each plot was determined by substituting the values in the following formula.

$$\text{Leaf area index (LAI)} = \frac{\text{leaf area tiller}^{-1}(cm^2) \times \text{no. of tillers m}^{-2}}{10{,}000\ \text{cm}^2}$$

Biological yield (kg ha^{-1})

After reaching harvest maturity, the six central rows of each experimental plot were manually harvested with help of hand-sickle, tied into small bundles and properly sun-dried. After on, their weight was found and converted into kg ha^{-1} through following formula.

$$\text{Biological yield (kg ha}^{-1}) = \frac{\text{Bioloical yield of six rows}}{\text{R} - \text{R} \times \text{No. of rows} \times \text{row length}}\, x\ 10{,}000$$

Grain yield (kg ha^{-1})

After finding biological yield, the harvested materials of each plot were separately threshed and grains were collected, cleaned and weighed. The recorded weight was then converted into kg ha^{-1} through following formula.

$$\text{Grain yield (kg ha}^{-1}) = \frac{\text{Grain yield of six rows}}{\text{R} - \text{R} \times \text{No. of rows} \times \text{row length}}\, x\ 10{,}000$$

Grain, Straw and total nitrogen determination

The representative plant samples were taken from each treatment when the crop reached to physiological maturity stage. The various parts of plant such as leaves, stem and grains were separated and dried in laboratory for 24 hours at 100ºC in oven. The dried materials were then grounded to powder form, and sieved through a sieve of 0.2 mm to remove any solid particles. The fine powder of leaves, stem and grains was used for nitrogen contents determination through Kjeldahl method (Westerman, 1990). Nitrogen percentage was determined by using the formula;

$$\text{N (\%)} = \frac{(\text{N} - \text{Blank}) \times \text{ normalityof acid } \times \text{ volume made } \times \text{N mol. weight}}{\text{Sample in mg}} \times 100$$

Straw nitrogen uptake was determined by the formulas

$$\text{Straw N uptake (kg ha}^{-1}) = \frac{\text{Straw N (g kg}^{-1}) \times \text{ Straw yield (kg ha}^{-1})}{1000}$$

Total nitrogen uptake was calculated as the sum of straw nitrogen and grain nitrogen uptake.

Soil pH

Soil pH was determined with the help of pH meter through method described by McLean (1982) in soil water suspension (1:5).

Soil electrical conductivity (dS m^{-1})

The soil water suspension prepared for determining soil pH was also used for recording soil electrical conductivity (EC) with the help of EC meter.

Soil bulk density (g cm^{-3})

Soil bulk density was recorded for each experimental unit using soil core – 42. The core samplers were driven into soil at three different locations selected randomly in each plot and the inner metal cylinder was filled. After, the soil samples were transported into laboratory and both fresh and dried weights of the samples were noted. The bulk density of soil was calculated using the method of (Blake and Hertge, 1965) and following formula.

$$\text{Soil bulk density} = \frac{\text{Oven dry mass of the soil}}{\text{volume of the soil core}}$$

Statistical Analysis

The recorded observations on agronomic, soil and quality traits were statistically analyzed according to the procedures of randomized complete block (RCB) design. Test employed for mean comparisons in case of significant differences was least significance difference (LSD) test at 5% significance level (Jan *et al*., 2009).

RESULTS

Tillers m^{-2}

Data regarding tillers m^{-2} as affected by various sources, forms and ratios of nitrogen are shown in Table 3. Statistical analysis of data showed that tillers m^{-2} differed significantly among various nitrogen sources, forms and ratios. The planned mean comparison of control vs rest was found significant. Similarly, year as a source of variation also differed significantly. However, all the possible interactions between different nitrogen sources, forms and ratios were not significant. Mean values of organic nitrogen sources showed that tillers m^{-2} of wheat were maximum (268) with application of animal manure, followed by mungbean residues (261). Whereas, minimum tillers m^{-2} were recorded in plots incorporated with rice residues (260). Tillers m^{-2} were higher (265) in plots where composted nitrogen was incorporated as compared with non-composted nitrogen incorporated plots (261). Regarding the different ratios of nitrogen, integrated application of organic-mineral nitrogen in 25:75 produced higher tillers m^{-2}. Application of sole organic nitrogen produced lower tillers m^{-2} (251) of wheat. The difference between control vs rest indicated that tillers m^{-2} were higher (263) in fertilized plots as compared to control plots (238).

Plant height (cm)

The different nitrogen sources, forms and ratios significantly affected plant height of wheat (Table 3). Likewise, the planned mean comparison of control vs rest and year as a source of variation also differed significantly. However, all the possible interactions between nitrogen sources, forms and ratios were non-significant except S x F. Mean values of data for nitrogen sources suggested that cattle manure produced taller plants, followed by mungbean residues, whereas, rice residues produced short statured plants. Compost incorporated plots produced taller plants as compared with plots where non-composted organic manures were incorporated. Among various nitrogen ratios, combined application of 50% organic and 50% mineral nitrogen produced taller plants, which were followed by nitrogen application 25% from organic and 75% from mineral source. Application of only organic nitrogen produced short statured plants. The mean comparison of control vs rest indicated dwarf plants in control plots as compared to fertilized plots. The interaction between sources and forms of nitrogen showed increase in plant height with addition of organic sources in composted form, however this increase was more prominent with cattle manure.

Leaf area tiller^{-1} (cm^2)

The different sources, forms and ratios of nitrogen had significantly varied the leaf area tiller^{-1} of wheat (Table 3). The planned mean comparison of control vs rest and year as a source of variation were also found significant, however all the possible interactions between nitrogen sources, forms and ratios were not significant. Among N sources, cattle manure produced higher leaf area tiller^{-1}, which was followed by mungbean and rice residues. Organic sources applied in composted form produced higher leaf area tiller^{-1} of wheat as compared to non-composted form. Regarding nitrogen ratios, nitrogen applied in 50:50 ratios from organic and mineral source produced higher leaf area tiller^{-1}, which was followed by sole mineral N application. Sole organic nitrogen produced lower leaf area tiller^{-1}. The mean comparison of control vs rest effect showed that control plots produced lower leaf area tiller^{-1} than fertilized plots (Table 3).

Leaf area index

Data regarding leaf area index as affected by various sources, forms and ratios of nitrogen are reported in Table 3. Analysis of data showed significant effect of various nitrogen sources, forms and ratios on leaf area index of wheat. The planned mean comparison of control vs rest was found significant. Similarly, year as a source of variation was also significant. All the possible interaction of different nitrogen sources, forms and ratios were not significant except Y x NR. Mean values of nitrogen sources showed that leaf area index of wheat was higher with addition of animal manure, which was followed by mungbean residues. Rice residues produced statistically similar leaf area index with mungbean residues. Leaf area index was higher in plots where composted nitrogen was incorporated than non-composted nitrogen incorporated plots. Regarding different nitrogen ratios, combine application of organic-inorganic nitrogen in 50:50 ratios produced higher leaf area index, which was followed by and statistically similar nitrogen application 25% from organic and 75% from inorganic source and 100% inorganic nitrogen application. Lower leaf area index was produced with application of sole organic nitrogen. The interaction of Y with NR showed that increasing the proportion of inorganic nitrogen up to 50% increased the leaf area index in both years. However, the increase was more prominent with addition of nitrogen in 50:50 ratios from organic and inorganic source. The sole inorganic nitrogen performed in similar trend in both years.

Biological yield (kg ha^{-1})

Biological yield (BY) of wheat varied significantly among different N sources, forms and ratios (Table 3). The difference between control vs rest was found significant. The year as a source of variation also differed significantly. However, all the possible interactions between nitrogen sources, forms and ratios were not significant except S x F and Y x NR. Among nitrogen sources, addition of cattle manure produced higher biological yield, followed by mungbean residues, whereas rice residues yielded lower biological yield and was statistically similar with mungbean residues. Compost amendment significantly enhanced crop biological yield and produced higher biological yield of wheat as compared to non-composted manures. Regarding nitrogen ratios, combine application of nitrogen from organic and mineral source in 50:50 produced higher biological yield, followed by integrating 25% organic fertilizers with 75% chemical fertilizers. Sole use of organic nitrogen produced lower biological yield. The mean comparison of control vs rest effect showed that fertilized plots produced higher biological yield than control plots. S x F showed that biological yield increased with addition of organic sources in composted form, except rice residue in which the composted and non-composted form performed almost in similar trend. This increase was more prominent in cattle manures. Likewise, Y x NR indicated that increasing the proportion of inorganic nitrogen up to 50% increased the biological yield in both years, except the sole inorganic nitrogen which showed a slight decrease in biological yield in second year. However, the increase was more prominent with addition of organic and mineral N in 50:50 ratio.

Grain yield (kg ha^{-1})

Table 3 represent data regarding the effect of various sources, forms and ratios of nitrogen on grain yield (GY) of wheat. Analysis of variance showed significant variation in grain yield in response to different nitrogen sources, forms and ratios. The planned mean comparison of control vs rest was found significant and indicated that grain yield of fertilized plots was higher than control plots. Similarly, year as a source of variation was also significant. All the possible interaction were not significant except S x F and S x NR. Mean values of nitrogen sources showed that grain yield of wheat was higher with addition of animal manure, which was followed by mungbean residues. Rice residues produced lower grain yield. Grain yield was higher in plots where composted nitrogen was incorporated as compared to non-composted nitrogen applied plots. Regarding N ratios, combine application of 50% organic and 50% mineral N produced higher grain yield, followed by combine application of organic-inorganic nitrogen in 25:75 ratio and sole mineral nitrogen. Addition of sole organic N produced lower grain yield. S x F suggested that grain yield was increased with addition of organic sources in composted form, except rice residue in which the composted and non-composted form performed almost in similar trend. However, this increase was more prominent in cattle manure. The interaction effect of S x NR indicated that increasing the proportion of organic and mineral nitrogen up to 50% respectively, increased the grain yield, however the increase was more prominent when 50% nitrogen from cattle manure was coupled with 50% nitrogen from urea. The cattle manure performed better than other organic sources when applied either alone or in integration with mineral N except its combine application (25%) with 75% inorganic nitrogen.

Grain nitrogen (%)

Grain nitrogen content of wheat was significantly affected by various sources, forms and ratios of nitrogen (Table 4). The mean comparison effect of control vs rest and year as a source of variation was also found significant. However, all the possible interactions between nitrogen sources, forms and ratios were not significant except S x NR and F x NR. Mean values of the data for nitrogen sources indicated that addition of cattle manure produced grains with higher nitrogen content. Rice residues produced grains with lower nitrogen content which were statistically at par with mungbean residues. Organic sources applied in composted form produced higher grain nitrogen content as compared to non-composted form. Regarding nitrogen ratios, combine application of nitrogen from organic and inorganic source in 50:50 and 25:75 ratios produced higher and statistically similar grain nitrogen content, which was followed by 75% organic and 25% inorganic nitrogen and sole inorganic nitrogen. Incorporation of sole organic nitrogen produced grains with lower nitrogen content. The mean comparison of control vs rest showed that fertilized plots produced higher grain nitrogen content than control plots. The S x NR showed that increasing the proportion of organic and inorganic nitrogen up to 50% respectively, increased the grain nitrogen concentration of grains irrespective of the nitrogen source. However, this increase was more promising when 50% nitrogen from cattle manure was coupled with 50% nitrogen from urea. Likewise, the F x NR suggested increase in grain nitrogen content with decreasing the proportion of organic nitrogen from 100% up to 50% in both composted and non-composted form. However, the increase was more noticeable with addition of nitrogen 25% in composted form and 75% from urea.

Straw nitrogen (%)

Data concerning to straw nitrogen content as affected by various sources, forms and ratios of nitrogen are given in Table 4. Analysis of data depicted significant effect of various nitrogen sources, forms and ratios on straw nitrogen content of wheat. The planned mean comparison of control vs rest was found significant. Similarly, year as a source of variation was also significant. All the possible interaction of different nitrogen sources, forms and ratios were not significant except S x F and F x NR. Mean values of nitrogen sources showed higher straw nitrogen content with addition of animal manure, which was statistically similar with mungbean residues. Rice residues produced lower straw nitrogen content. Nitrogen content in wheat straw was higher in plots where composted nitrogen was incorporated as compared to non-composted nitrogen incorporated plots. Regarding the different nitrogen ratios, combine application of nitrogen 50% from organic and 50% from urea produced higher straw nitrogen content, which was statistically at par with combine application of organic-inorganic nitrogen in 75:25 ratios and sole application of inorganic nitrogen. Addition of sole organic nitrogen produced lower straw nitrogen content. The comparison of control vs rest indicated that fertilized plots produced straw with higher nitrogen content than control plots. S x F suggested that straw nitrogen concentration was increased with addition of organic sources in composted form, except rice residue in which the composted and non-composted form performed almost in similar trend. However, this increase was more prominent in cattle manure. Similarly, the interaction of F with NR suggested that increase in straw nitrogen concentration with decreasing the proportion of organic nitrogen from 100% to 50% in both composted and non-composted form. However, the increase was more prominent with addition of nitrogen 50% from composted manures and 50% from urea.

Total nitrogen uptake (kg ha^{-1})

The total nitrogen uptake of wheat was significantly affected by various sources, forms and ratios of nitrogen (Table 4). The mean comparison effect of control vs rest was significant. Year as a source of variation was also significant. All the possible interactions between nitrogen sources, forms and ratios were not significant except F x NR and Y x NR. Mean values of the data for nitrogen sources indicated higher total nitrogen uptake with addition of cattle manure, which was followed by mungbean residues. Rice residues had lower total nitrogen uptake. Organic sources applied in composted form showed higher total nitrogen uptake as compared to non-composted form. Regarding nitrogen ratios, combine application of organic-inorganic nitrogen in 50:50 ratio indicated higher total nitrogen uptake, which was followed by 75% organic and 25% inorganic nitrogen. Addition of sole organic or inorganic nitrogen had lower total nitrogen uptake. The mean comparison of control vs rest effect showed that fertilized plots had higher total nitrogen uptake than control plots. The interaction of S with NR showed that increasing the proportion of inorganic nitrogen up to 50% increased the total nitrogen uptake regardless of the nitrogen source. However, this increase was more prominent when 50% nitrogen from cattle manure was coupled with 50% nitrogen from urea. Likewise, Y x NR indicated that increasing the proportion of inorganic nitrogen up to 50% increased the total nitrogen uptake in both years, except the sole inorganic nitrogen which showed decrease in total nitrogen uptake in second year. However, this increase was more prominent with addition of organic-inorganic nitrogen in 75:25 ratios.

Soil pH

Data regarding soil pH after wheat harvest as affected by different nitrogen sources, forms and ratios are presented in Table 4. Analysis of data showed significant effect of different nitrogen sources, forms and ratios on soil pH. Year as a source of variation was also significant. However, the mean comparison of control vs rest and all the possible interactions were not significant. Mean values of data for nitrogen sources reflected higher soil pH with addition of mungbean residues, which was followed by cattle manure and rice residues. Soil pH of compost incorporated plots was higher than non-composted plots. Regarding nitrogen ratios, addition of inorganic nitrogen alone resulted in higher soil pH, followed by organic nitrogen alone and its co-application with inorganic nitrogen in 50:50 ratios. Nitrogen application in 75:25 and 25:75 ratios from organic-inorganic source indicated lower and statistically similar soil pH.

Soil electrical conductivity (dS m^{-1})

The soil electrical conductivity (EC) after wheat harvest significantly varied in response to various nitrogen sources, forms and ratios (Table 4). The mean difference of control vs rest and year as a source of variation also varied significantly. Likewise, the interaction effect of S withs F was also significant, whereas the rest of all possible interactions were not significant. About nitrogen sources, the soil EC was higher with addition of cattle manure. Rice residues indicated lower soil EC which was statistically similar with mungbean residues. Plots treated with composted organic sources had higher soil EC as compared with non-composted organic sources. Mean values of data of nitrogen ratios indicated that nitrogen soil EC was higher with integrated application of organic and inorganic nitrogen in 50:50 ratio, which was followed by nitrogen ratio of 75:25. Lower soil EC was recorded in sole inorganic-nitrogen fertilized plots. The difference between control vs rest suggested that soil EC of fertilized plots was higher than control plots. S x F showed that soil EC increased with addition of organic sources in composted form except mungbean residues, however the increase was more prominent with addition of composted rice residues.

Bulk density (g cm^{-3})

Statistical analysis of data revealed significant effect of different sources, forms and ratios of nitrogen on soil bulk density recorded after wheat harvest (Table 4). The mean comparison effect of control vs rest and year as a source of variation was also significant. However, all the possible interactions between nitrogen sources, forms and ratios were found not significant. Mean values of data for nitrogen sources indicated higher soil bulk density with addition of rice residues, which was statistically similar with mungbean residues. Cattle manure indicated lower soil bulk density. Application of organic nitrogen sources in composted form resulted in lower soil bulk density as compared to non-composted form. Regarding nitrogen ratios, inorganic nitrogen alone had higher soil bulk density, which was followed by organic and inorganic nitrogen in 25:75 ratios. Plots fertilized with 100% organic nitrogen had lower soil bulk density. Fertilized plots indicated lower soil bulk density than control plots.

Table 3. Effect of different sources, forms and ratios of nitrogen on tillers (m^{-2}), plant height (cm), leaf area tillers^{-1}, leaf area index (LAI), biological yield (kg ha^{-1}) and grain yield (kg ha^{-1}) of wheat.

Nitrogen Sources	**Tillers m^{-2}**	**Plant Height (cm)**	**Leaf area tillers^{-1} (cm^2)**	**LAI**	**BY (kg ha^{-1})**	**GY (kg ha^{-1})**
Rice residue	260 b	91.7 c	135.7 b	3.5 b	8102 b	3263 c
Mung bean residue	261 b	94.4 b	135.9 b	3.6 b	8169 b	3351 b
Cattle manure	268 a	97.3 a	140.1 a	3.8 a	8540 a	3546 a
Forms						
Composted	265 a	96.1 a	138.4 a	3.7 a	8400 a	3514 a
Non-composted	261 b	92.8 b	136 b	3.6 b	8141 b	3259 b
Nitrogen Ratios (%) (Organic : Inorganic)						
100:0	251 c	92.1 c	134.4 b	3.4 b	7939 c	3049 d
75:25	256 c	92.4 b	135.1 b	3.5 b	8082 bc	3192 c
50:50	270 ab	97.2 a	140.0 a	3.8 a	8652 a	3762 a
25:75	273 a	96.3 ab	137.3 ab	3.8 a	8410 ab	3525 b
0:100	264 b	94.3 b	139.4 a	3.7 a	8269 b	3404 b
LSD (0.05)						
Sources	4.88	1.72	2.76	0.106	205.8	101.0
Forms	3.99	1.40	2.25	0.086	168.0	82.2
Nitrogen Ratios	6.30	2.22	3.56	0.137	265.6	130.4
Interactions						
S x F	NS	**	NS	NS	*	**
S x NR	NS	NS	NS	NS	NS	*
F x NR	NS	NS	NS	NS	NS	NS
S x F x NR	NS	NS	NS	NS	NS	NS

Table 4. Effect of different sources, forms and ratios of nitrogen on grain nitrogen (%), straw nitrogen (%), total nitrogen uptake (kg ha^{-1}), soil pH, soil electrical conductivity (dS m^{-1}) and bulk density (g cm^{-3}).

Nitrogen Sources	Grain N content (%)	Straw nitrogen content (%)	Total nitrogen uptake (kg ha^{-1})	Soil pH	Soil EC (dS m^{-1})	Bulk density (g cm^{-3})
Rice residue	2.07 b	0.47 b	135.7 b	7.75	0.224 b	1.205 a
Mung bean residue	2.11 b	0.50 ab	138.6 b	7.83	0.221 b	1.196 a
Cattle manure	2.26 a	0.52 a	144.4 a	7.78	0.229 a	1.17 b
Forms						
Composted	2.21 a	0.53 a	144.6 a	7.83 a	0.227 a	1.17 b
Non-composted	2.08 b	0.47 b	134.5 b	7.74 b	0.223 b	1.21a
Nitrogen Ratios (%) Organic : Inorganic)						
100:0	2.01 c	0.45 b	134.4 c	7.81 ab	0.224 b	1.16
75:25	2.12 b	0.48 b	141.9 ab	7.73 b	0.225 ab	1.18
50:50	2.28 a	0.53 a	146.8 a	7.78 ab	0.231 a	1.19
25:75	2.21 a	0.51 ab	141.4 b	7.76 b	0.224 b	1.2
0:100	2.12 b	0.52 ab	133.4 c	7.86 a	0.221 b	1.22
LSD (0.05)						
Sources	0.059	0.032	4.1	NS	0.0045	0.016
Forms	0.048	0.027	3.3	0.053	0.004	0.013
Nitrogen Ratios	0.076	0.0042	5.3	0.083	0.0058	0.02
Interactions						
S x F	NS	**	NS	NS	***	NS
S x NR	**	NS	*	NS	NS	NS
F x NR	**	**	NS	NS	NS	NS
S x F x NR	NS	NS	NS	NS	NS	NS

DISCUSSION

Nitrogen is important for crop growth and development (Keskinen *et al*., 2020) because of its key role in various physiological and biochemical processes (Melander *et al*., 2020). Addition of nitrogen increased plant height by 11.5% as compared to control plots. Likewise, leaf area tiller^{-1} and leaf area index were increased by 17.0 and 29.6% respectively, in N-fertilized plots as compared to control treatments. Nitrogen application promotes plant vigorous growth (Lloveras *et al*., 2001), improve soil water holding capacity (Kumar and Goh, 2000) and availability of macro and micro nutrients (Ali *et al*., 2018), due to which N-fertilized plots produced taller plants than control plots (Matsi *et al*., 2003; Iqtidar *et al*., 2006). Another possible reason might be the prolonged phenological stages enabled the plant to carry out more photosynthesis and hence produced taller plants with broader leaves and canopy cover. Hossain *et al*. (2002) reported taller plants and higher leaf area index with nitrogen application than control plots. Similarly, Anjum and Khan (2020) reported that application of either synthetic (urea) or organic nitrogen (FYM) increased leaf area, LAI and plant height of wheat. Addition of nitrogen increased the nutrients uptake (Singh and Agarwal, 2001) and photosynthetic performance (Wen *et al*., 2016) and thus caused increase in leaf area, LAI and plant height (Akhtar *et al*., 2019). Our results indicated that cattle manure performed better than mungbean and rice residues and increased plant height by14.9%, leaf area tiller^{-1} by 19.4% and leaf area index by 35% as compared with control plots. Likewise, the composted organic sources applied plots had 3.6% taller plants, 1.8% higher leaf area and 3.5% higher leaf area index than non-composted organic sources. Organic manures are excellent source of different macro and micro nutrients especially nitrogen (Ahmad *et al*., 2007), and its type as well as quality greatly influence the soil quality and crop growth (Hussain *et al*., 1995). As the different organic sources have different nutrients composition and decay rate, therefore, the nutrients availability from these sources and their uptake vary considerably (Pang and Letey, 2000). The increase in wheat growth, plant height and leaf area index with cattle manure might be due to its enriched nutrients composition and optimum C:N ratio than that of other organic sources (Hussain, 2001). Organic materials addition either compost or manures reduced the nutrients losses by increasing nutrients use efficiency (Muneshwar *et al*., 2001) and improved the crop growth and physiological indices such as leaf area and leaf area index (Nevens and Reheul, 2003). Similarly, Loecke *et al*. (2004) and Ibrahim *et al*. (2008) also found significant improvement in plant height and wheat growth with addition of compost. According to Abedi *et al*. (2010) compost have positive effect on soil biological and physico-chemical properties which mostly caused better crop growth. Aslam *et al*. (2013) concluded from his research study that plant height and growth of wheat increased with organic manures incorporation either alone or coupled with various inorganic fertilizers sources. The findings of Sharma *et al*. (2013) suggested that supplementation of nutrients from farmyard manure enhanced the leaf area, leaf area index and yield parameters of wheat. Jamil *et al*. (2008) indicated that growth (leaf area, plant height and leaf area index) of wheat was increased with organic fertilizers incorporation. Results showed that combined application of organic and chemical nitrogen increased the crop growth. Among nitrogen ratios, nitrogen application in 50:50 ratios marked the highest increase of 14.8, 19.3 and 35.9% in height of plants, leaf area and leaf area index, respectively over control treatments. The possible reason for producing taller plants with combined organic and chemical nitrogen might be that synthetic source provided the nutrients at early stages of crop growth, while organic sources decomposed slowly with time and fulfilled the nutrients requirements at later stages. Thus, excellent vegetative growth was attained which resulted in plants with maximum height, maximum leaf area as well as leaf area index. According to the findings of Maurya *et al*. (2019), organic and mineral sources of nitrogen were highly effective on plant height and leaf area when co-applied. Our findings are in line with Zafar *et al*. (2011) and Kaur *et al*. (2015) who observed considerable increase in crop growth with integrated use of organic and chemical nutrients. Incorporation of organic materials improved biological activities and organic matter in soil (Bending *et al*., 2004), thus its addition coupled with synthetic fertilizers enhanced the soil health and crop productivity (Das *et al*., 2015; Kakraliya *et al*., 2017). The increase in crop growth, leaf area and leaf area index has been widely observed and documented by Singh *et al*. (2008) and Nawab *et al*. (2011).

Nitrogen being macro nutrients is required by crop for higher growth and yield (Zotarelli *et al*. 2012). Our results indicated that nitrogen sources had significant effect on yield and yield related attributes of wheat. Addition of cattle manure proved to be superior over other sources and increased the tillers m^{-2} (12.7%) and spikes number per unit area (18.2%) than control plots. Most of the cultivated soil is deficit in organic matter and essential nutrients, therefore, addition of nutrients from organic materials improved the crop growth and so the spikes numbers and yield. In our study, plots treated with compost increased the tillers by 1.6% over non-compost. Decomposition of organic materials greatly influenced the soil fertility and productivity (Aziz *et al*., 2010). Composted organic materials decompose easily and quickly release nutrients as compared to residues or manures (Guzman *et al*., 2006), therefore, its addition increased water retention (Gooding *et al*., 2007), nutrients availability (Ahmad *et al*., 2008) and soil fertility (Jackson *et al*., 2004) and decreased soil compaction and nutrients losses (Jagadamma *et al*., 2007). Pandiaraj *et al*. (2015) also indicated higher grain and biological yield with optimum supply of nitrogen. According to Iqbal *et al*. (2010), the vigorous vegetative growth and biological yield due to nitrogen supplementation causes formation of more photosynthates which are translocated to grains and thus higher and healthy grains are formed. Khan *et al*. (2008) found that N fertilization to wheat brought significant increase in wheat biological and grain yield. Li *et al*. (2001) observed that soil fertilization with sufficient amount of nitrogen during early vegetative growth accelerated the crop growth rate and thus resulted in higher grain yield in wheat. Similar results are reported by Mohammad *et al*. (2012). Addition of cattle manure proved to be superior over other sources and increased the tillers m^{-2} (12.7%), spikes number per unit area (18.2%), grains number per spike (44.3%) and thousand grains weight (16.1%) than control plots. Iqtidar *et al*. (2006) reported higher grain and biological yield of wheat with nitrogen supplementation. Lloveras *et al*. (2001) said that increased in crop yield and yield related parameters might be due positive effect of nitrogen from cattle manure which promoted crop vigorous growth. Our results are in conformity with the findings of Dolan *et al*. (2006) who observed that cattle manure improved the nutrients availability and soil water holding capacity due to which the biological and grain yield were increased.

Improving the quality of wheat is the most important objective along with increasing yield and production. Grain and straw nitrogen and total N uptake was increased by 40.0 34.0 and 46.5% respectively, as compared to control plots. Blankenau *et al*. (2002) found the nitrogen fertilization at higher rates was more effective in increasing grain nitrogen and total N uptake by plants. Our results are in line with Yang *et al*. (2011) who evaluated different spring wheat varieties and found increase in grain and straw nitrogen content with nitrogen fertilization. Our results indicated that addition of cattle manure enhanced the grain quality by increasing the nitrogen content of grain & straw and total N uptake. Brady and Weil (2005) linked the higher seed quality with improved soil fertility, nutrients availability and nutrients uptake through organic manures incorporation which also increased crop growth. Our study suggested that the grain quality of composted organic manures was higher than non-composted organic manures applied plots. The possible reason might be the enriched nutrients composition of compost and their ability to improve nutrients availability and uptake (Rocio *et al*., 2011). Similarly, the straw nitrogen and total N uptake was higher with integrated nitrogen application in 50:50 ratios. Nitrogen from sole organic source had grains with poor quality. Organic manures coupled with mineral fertilizers improved the seed quality by increasing the effectiveness of chemical fertilizers through enhanced availability and uptake of plants nutrients (Alam *et al*., 2006). Another possible reason might be the higher synergism and synchronization between release of nutrients and plant recovery (Huang *et al*., 2007). Behera *et al*. (2007) reported that higher grain and straw N concentration might be due to application of both sources (organic & inorganic) in combination which continuously supplied nutrients for longer time. Similar results have been documented by Ahmad *et al*. (2011) and Holik and Kunzová, (2018).

Organic manures and residues amendment in soil has been found to have many advantages like improved soil health, organic matter, aeration and reduced bulk density (Agbede *et al*., 2008). Addition of organic manures can greatly alter the soil physico-chemical and biological characteristics such as soil texture, structure, pH, water holding capacity, microbial activity and cation exchange capacity which may lead to formation of fertile and productive soil (Muhammad and Khattak, 2009). Results indicated that changes in soil pH was not changed significantly in response to organic N sources, however N ratios significantly varied soil pH. Sole use of either organic or mineral fertilizers indicated higher soil pH than integrated amendment of both sources. Addition of organic manures increases soil calcium carbonate content which causes increase in buffering and thereby increased soil pH (Adeli *et al*., 2008). Similar to our findings, Whalen *et al*. (2000) also reported that soil pH was higher in plots continuously supplied with organic manures than integrated use of nutrients. Similarly, Han *et al*. (2016) found that organic manures increased soil pH and available potassium content. However, they further elaborated that application of mineral NPK fertilizers reduced soil pH which goes in contrast to our results. Similarly, the findings of Liu *et al*. (2010) also suggested that soil pH increased with natural manures incorporation and decreased with mineral fertilizers. Our study cleared that addition of cattle manures increased soil electrical conductivity (EC) and reduced soil bulk density as compared with other N sources. Similarly, composted organic manures showed higher soil EC and lower bulk density as compared to non-composted manures. Antil and Singh (2007) found significant increase in soil EC while decline in soil bulk density through continuous use of manures for 10 years. Furthermore, they reported nil to marginal increase in EC with continuous chemical fertilizers use. The apparent increase in soil EC might be due to availability of higher salt content from cattle manures than other applied organic sources (Hao *et al*., 2008). The reason behind decline in bulk density might be the stability of aggregates due to higher organic matter content. Papini *et al*. (2011) observed that organic materials composted for 30 days resulted in improved physico–chemical characteristics of experimental site's soil, including higher soil EC, reduced bulk density and soil compaction as compared to un-composted organic residues. Kaur *et al*. (2005) and Rasoulzadeh and Yaghoubi (2010) found considerably lower particle and bulk density with addition of cattle manure, whereas organic matter, electrical conductivity and porosity were increased. Gangwar *et al*. (2006) and Matsi (2012) reported that higher soil bio-spores, organic carbon, aeration and better soil aggregate through cattle manure amendment might be the reason for reduced soil bulk density which ultimately improved soil health and fertility status. Regarding nitrogen ratios, organic manures coupled with mineral fertilizers in 50:50 ratios increased soil EC, whereas sole use of either source had lower soil EC. Similarly, soil bulk density was higher in sole mineral fertilized plots while lower in 100% organic fertilized treatment. Our findings are supported by Arif *et al*. (2020) who found that soil EC increased with addition of 50% PM/FYM and 50% mineral fertilizers. Zhang *et al*. (2016) found reduced soil bulk density in wheat-maize rotation after integrated use of NPK and FYM for 13 years, as compared to sole NPK and control treatments. Conversely, Kukal and Benbi (2009) reported that bulk density in maize-wheat and rice-wheat rotation system showed indifferent changes in response to organic manures addition. Considerable increase in soil EC was recorded in FYM + 100% NPK treatments as compared to control or other fertilized treatments in soybean-wheat-maize rotation system (Behera *et al*., 2007). Laxminarayana and Patiram (2005) and Blanco-Canqui *et al*. (2020) also supports our results, who found reduced soil bulk density with soil organic manures incorporation.

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CONCLUSION

Based on the data obtained from the experiment, it can be concluded that;

I. Application of nitrogen from cattle manures improved wheat yield by 53.2% as compared with control followed by mungbean residues (44.8%). Cattle manure addition also increased the soil total N and N uptake and soil EC.

II. Application of organic N sources in the form of compost improved wheat yield by 40.8% and 7.8% as compared with control and non-compost form, respectively.

III. The organic material in compost forms increased soil EC (1.9%), with reducing soil bulk density (2.6%) as compared to non-compost form.

IV. Application of N 50% from organic and 50% from inorganic (Urea) source increased wheat yield (62.5%) as compared to control treatments.

V. Application of 100% N from organic sources increased soil total N content and soil EC while reduced soil bulk density as compared with other treatments as well as control treatments.

VI. It is concluded that application of cattle manure in composted form coupled with inorganic N in 50:50 ratio improved crop performance and soil properties under Peshawar valley conditions.

APPENDIX

Appendixes, if needed, appear before the acknowledgment.

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The preferred spelling of the word "acknowledgment" in American English is without an "e" after the "g." Use the singular heading even if you have many acknowledgments.

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REFERENCES

T. Abedi, A. Alemzadeh and S.A. Kazemeini, Effect of organic and inorganic fertilizers on grain yield and protein banding pattern of wheat, 2010, Aus. J. Crop. Sci. 4: 384–389.

A. Adeli, C.H. Bolster, D.E. Rowe, M.R. McLaughlin and G.E. Brink, Effect of long-term swine effluent application selected soil properties, 2008, Soil Sci. 173(3): 223-235.

T.M. Agbede, S.O. Ojeniyi and A.J. Adeyemo, Effect of poultry manure on soil physical and chemical properties, growth and grain yield of sorghum in southwest, Nigeria, 2008, Amer-Eur. J. Sust. Agric. 25(5): 72-77.

A.H. Ahmad, A. Wahid, F. Khalid, N. Fiaz and M.S.I. Zamir, Impact of organic and inorganic sources of nitrogen and phosphorus fertilizers on growth, yield and quality of forage oat (*Avena sativa* L.), 2011, Sarhad. J. Agric. 44(3): 39-49.

R. Ahmad, G. Jilani, M. Arshad, Z.A. Zahir and A. Khalid, Bio-conversion of organic wastes for their recycling in agriculture: An overview of perspectives and prospects, 2007, Ann. Microbiol. 57(4): 471-479.

R. Ahmad, M. Naveed, M. Aslam, Z.A. Zahir, M. Arshad and G. Jilani, Economizing the use of nitrogen fertilizer in wheat production through enriched compost, 2008, Ren. Agric. Food. Sys. 23(3): 1-7.

K. Akhtar, W. Wang, A. Khan, G. Ren, M.Z. Afridi, Y. Feng and G. Yang, Wheat straw mulching offset soil moisture deficient for improving physiological and growth performance of summer sown soybean. Agric, 2019, Water Manage. 211: 16-25.

M.M. Alam, J.K. Ladha, Foyjunnessa, Z. Rahman, S.R. Khan, H. Rashid, A.H. Khan and R.J. Buresh, Nutrient management for increased productivity of rice–wheat cropping system in Bangladesh, 2006, Field. Crops. Res. 96: 374-386.

Anjum and A. Khan, Phenology, crop stand and biomass of wheat in response to farmyard manure and soil amendments, 2020, Sarhad J. of Agric. 36(3): 777-788.

R.S. Antil and M. Singh, Effects of organic manures and fertilizers on organic matter and nutrients status of the soil, 2007, Arch. Agron. Soil. Sci. 53(5): 519-528.

M. Arif, S. Ali, M. Ilyas, M. Riaz, K. Akhtar, K. Ali, M. Adnan, S. Fahad, I. Khan, S. Shah and H. Wang, Enhancing phosphorus availability, soil organic carbon, maize productivity and farm profitability through biochar and organic–inorganic fertilizers in an irrigated maize agroecosystem under semi-arid climate, 2020, Soil Use Manage.00:1-16.

M. Aslam, M.A. Khan, I.U. Awan, E.A. Khan, A.A. Khan and G. Jilani, Effect of single and combined use of various organic amendments on wheat grown over green manured soil: I. Growth and yield attributes, 2013, Pak. J. Nutr. 10(7): 640-646.

M. Aslam, N. Hussain, M. Zubair, S.B. Hussain and M.S. Baloch, Integration of organic and inorganic sources of phosphorus for increased productivity of mungbean (*Vigna radiata*), 2010, Pak. J. Agri. Sci. 47(2): 111-114.

L.S. Ayeni, O.M. Ayeni, O.P. Oso and S.O. Ojeniyi, Effect of sawdust and wood ash applications in improving soil chemical properties and growth of cocoa (*Theobroma cacao*) seedling in the nurseries, 2008, Medwell. Agric. J. 3(5): 323 -326.

T. Aziz, S. Ullah, A. Sattar, M. Nasim, M. Farooq and M.M. Khan, Nutrient availability and maize (*Zea mays* L.) growth in soil amended with organic manures, 2010, Int'l J. Agric. Biol. 12(4): 621-624.

W. Bayu, N.F.G. Rethman, P.S. Hammes and G. Alemu, Effects of farmyard manure and inorganic fertilizers on sorghum growth, yield, and nitrogen use in a semi-arid area of Ethiopia, 2006, J. Plant Nutr. 29:391-407

G.D. Bending, M.K. Turner, F. Rayns, M.C. Marx and M. Wood, Microbial and biochemical soil quality indicators and their potential for differentiating areas under contrasting agricultural management regimes, 2004, Soil Bio. Biochem. 36(11): 1785-1792.

G.R Blake and K.H. Hartge, Bulk density In Methods of Soil Analysis, Part 1: Physical and Mineralogical Methods, 1986, SSSA Book Series, 5.

H. Blanco-Canqui, D.A. Laird, E.A. Heaton, S. Rathke and B.S. Acharya, Soil carbon increased by twice the amount of biochar carbon applied after 6 years, 2020, Field evidence of negative priming. GCB Bioenergy. 12: 240–251.

K. Blankenau, H.W. Olfs and H. Kuhlmann, Strategies to improve the use efficiency of mineral fertilizer nitrogen applied to winter wheat, 2002, J. Agron. Crop Sci. 188:146-154.

N.C. Brady and R.R. Weil, The nature and properties of soil, 13th edn, 2005, Macmillan Publishing Co, New York.

D. Das, B.S. Dwivedi, M.C. Meena, V.K. Singh and K.N. Tiwari, Integrated nutrient management for improving soil health and crop productivity, 2015, Indian. J. Fert. 11(4): 64-83.

M.S. Dolan, C.E. Clapp, R.R. Allmaras, J.M. Baker, and J.A.E. Molina. 2006. Soil organic carbon and nitrogen in a Minnesota soil as related to tillage, residue and N management. Soil and Till. Res. 89 (2):221-231.

W. Farhad, M.A. Cheema, M.F. Saleem, H.M. Hammad and M.F. Bilal, Response of maize hybrids to composted and non-composted poultry manure under different irrigation regimes, 2011, Int. J. Agric. Biol. 13: 923-928.

K.S. Gangwar, K.K. Singh, S.K. Sharma and O.K. Tomar, Alternative tillage and crop residue management in wheat after rice in sandy loam soils of IndoGengetic plains, 2006, Soil Till. Res. 88: 242-252.

M.J. Gooding, P.J. Gregory, K.E. Ford and R.E. Ruske, Recovery of nitrogen from different sources following applications to winter wheat at and after anthesis, 2007, Field Crop Res. 100:143-154.

J.G. Guzman, C.B. Godsey, G.M. Pierzynski, D.A. Whitney and R.E. Lamond, Effects of tillage and N management on soil chemical and physical properties after 23 years of continuous sorghum, 2006, Soil and Till. Res. 91:199-206.

S.H. Han, J.Y. An, J. Hwang, S.B. Kim and B.B. Park, The effects of organic manure and chemical fertilizer on the growth and nutrient concentrations of yellow poplar (*Liriodendron tulipifera* Lin.) in a nursery system, 2016, Forest Sci. and Tech. 12:3: 137-143.

X. Hao, S. Liu, J. Wu, R. Hu, C. Tong and Y. Su, Effect of long-term application of inorganic fertilizer and organic amendments on soil organic matter and microbial biomass in three subtropical paddy soils, 2008, Nutr. Cycl. Agroecosys. 81: 17-24.

L. Holik and E. Kunzová, The effect of mineral fertilizers and farmyard manure on winter wheat grain yield and grain quality, 2018, Plant. Soil. Environ. 64: 491-497.

S.M.A. Hossain, A.M.A. Kamal, M.R. Islam and M.A. Mannan, Effects of different levels of chemical and organic fertilizers on growth, yield and protein content of wheat, 2002, J. BioI. Sci. 2: 304-306.

T. Hussain, G. Jilani, J.F. Parr and R. Ahmad, Transition from conventional to alternative agriculture in Pakistan: The role of green manures in substituting for inorganic N fertilizers in a rice-wheat farming system, 1995, Am. J. Alternat. Agri. (now Renew. Agri. Food Sys. 10(3): 133-137.

M. Ibrahim, A. Hassan, M. Iqbal and E. Elahi, Response of wheat growth and yield to various levels of compost and organic manure, 2008, Pak. J. Bot. 40(5): 2135-2141.

H. Iqtidar, K.M. Ayyaz and K.E. Ahmad, Bread wheat varieties as influenced by different nitrogen levels, 2006, J. Zhejiang Univer. Sci. 7: 70-78.

A. Iqbal, N. Akbar, H.Z. Khan and M.A. Bakar, Influence of nitrogen fertilization on growth and yield of two wheat varieties, 2010, Crop and Environ. 1(1): 57-58.

L.E. Jackson, I. Ramirez, R. Yokota, S.A. Fennimore, S.T. Koike, M. Henderson, W.E. Chaney, F.J. Calderon and K. Klonsky, On-farm assessment of organic matter and tillage management on vegetable yield, soil, weeds, pests, and economics in California, 2004, Agric. Ecosys. and Environ. 103:443-463.

S. Jagadamma, R. Lal, R.G. Hoeft, E.D. Nafziger and E.A. Adee, Nitrogen fertilization and cropping systems effects on soil organic carbon and total nitrogen pools under chisel-plow tillage in Illinois, 2007, Soil and Till. Res. 95:348-356.

M. Jamil, M. Qasim and M.S. Zia, Utilization of pressmud as organic amendment to improve physico-chemical characteristics of calcareous soil under two legume crops, 2008, J. Chem. Soc. Pak. 30(4): 577-583.

M.T. Jan, P. Shah, P.A. Hollington, M.J. Khan and Q. Sohail, Agriculture Research: Design and Analysis, A monograph, 2009, Agric. Univ. Pesh. Pak.

S.K. Kakraliya, N. Kumar, S. Dahiya, S. Kumar, D.D. Yadav and M. Singh, Effect of integrated nutrient management on growth dynamics and productivity trend of wheat (*Triticum aestivum* L.) under irrigated cropping system, 2017, J. of Plant Dev. Sci. 9(1): 11-15.

K. Kaur, K.K. Kapoor and A.P. Gupta, Impact of organic manure with and without mineral fertilizers on soil chemical biological properties under tropical conditions, 2005, J. Plant Nutr. Soil Sci. 168(1):117-122.

S. Kaur, B.S. Brar and G.S. Dheri, Effect of long-term use of inorganic and integrated fertilization on soil phosphorus fractions in rice-wheat cropping system, 2015, Agric. Res. J. 52: 39-43.

R. Keskinen, T. Suojala-Ahlfors, M. Sarvi, M. Hagner, J. Kaseva, T. Salo and K. Rasa, Granulated broiler manure based organic fertilizers as sources of plant available nitrogen, 2020, Environ. Tech. and Innovation. 10: 7-34.

Khan, A., M.T. Jan, K.B. Marwat, M. Arif and A. Jan, Phenology and crop stand of wheat as affected by nitrogen sources and tillage systems, 2008, Pak. J. Bot. 40: 1103-1112.

S.S. Kukal and D.K. Benbi, Soil organic carbon sequestration in relation to organic and inorganic fertilization in rice-wheat and maize-wheat systems, 2009, Soil. Till. Res. 102(1): 87-92.

K. Kumar and K.M. Goh, Crop residues and management practices: effects on soil quality, soil nitrogen dynamics, crop yield and nitrogen recovery, 2000, Adv. Agron. 68: 197-319.

K. Laxminarayana and Patiram, Influence of inorganic, biological and organic manures on yield and nutrient uptake of groundnut (*Arachis hypogaea*) and soil properties, 2005, Ind. J. Agric. Sci. 75:218-221.

C. Li, W. Cao, and T. Dai, Dynamic characteristics of floret primordium development in wheat, 2001, Field Crops Res. 71:71-76.

E. Liu, C. Yan, X. Mei, W. He, S.H. Bing, L. Ding, Q. Liu, S. Liu and T. Fan, Long-term effect of chemical fertilizer, straw, and manure on soil chemical and biological properties in northwest China, 2010, Geoderma. 158(3):173-180.

J. Lloveras, A. Lopez, J. Ferran, S. Espachs and J. Solsona, Breadmaking wheat and soil nitrate as affected by nitrogen fertilization in irrigated Mediterranean conditions, 2001, Agron. J. 93: 1183-1190

T.D. Loecke, M. Liebman, C.A. Cambardella and T.L. Richard, Corn growth responses to composted and fresh solid swine manures, 2004, Crop Sci. 44(1): 177-184.

W. Mohammad, S.M. Shah, S. Shehzadi and S.A. Shah. 2012. Effect of tillage, rotation and crop residues on wheat crop productivity, fertilizer nitrogen and water use efficiency and soil organic carbon status in dry area (rainfed) of north-west Pakistan. J. of soil Sci. and Plant Nutr. 12(4): 715-727.

T. Matsi, Liquid Cattle Manure Application to Soil and Its Effect on Crop Growth, Yield, Composition, and on Soil Properties, Soil Fertility Improvement and Integrated Nutrient Management-A Global Perspective, 2012, Dr. Joann Whalen (Ed.) 945-955.

T. Matsi, A.S. Lithourgidis, and A.A. Gagianas, "Effect over of injected liquid Cattle manruse on growth and yield of winter wheat and soil characteristics" 2003, Agron. J. 95: 592-599.

R.N. Maurya, U.P. Singh, S. Kumar, A.C. Yadav and R.A. Yadav, Effect of integrated nutrient management on growth and yield of wheat (*Triticum aestivum* L.), 2019, Int'l. J. Chem. Stud. 7(1): 770-773.

E.O. McLean, S.W. Dumford and F. Coronel, A comparison of several methods of determining lime requirements of soils, 1966, Soil. Sci. Soc. America. J. 30(1): 26-30.

B. Melander, I.A. Rasmussen and J.E. Olesen, Legacy effects of leguminous green manure crops on the weed seed bank in organic crop rotations, 2020, Agric. Ecosys. Environ. 302: 107-118.

MNFSR, Agriculture statistics of Pakistan for 2018-19. Ministry of National Food Security and Research (Economic wing) Islamabad, 2018.

D. Muhammad and R.A. Khattak, Growth and nutrient concentration of maize in press mud treated saline-sodic soils, 2009, Soil Environ. 28: 145-155

K. Nawab, Amanullah, P. Shah, A. Rab, M. Arif, M. A. Khan, A. Mateen and F. Munsif, Impact of integrated nutrient management on growth and grain yield of wheat under irrigated cropping system, 2011, Pak. J. Bot. 43(4): 1943-1947

F. Nevens, and D. Reheul, The application of vegetable, fruit and garden waste (VFG) compost in addition to cattle slurry in a silage maize monoculture: nitrogen availability and use, 2003, Eur. J. Agron. 19: 189-203.

A. Nezhad ahmadi, Z.H. Prodhan and G. Faruq, Drought tolerance in wheat, 2013, The Scientific World J. 6: 182-189.

T. Pandiaraj, S. Selvaraj and N. Ramu. 2015. Effects of crop residue management and nitrogen fer tilizer on soil nitrogen and carbon content and productivit y of wheat (*Triticum aestivum* L.) in two cropping systems. J. Agric. Sci. Tech. 17: 249-260.

G. Pan, P. Smith and W. Pan, The role of soil organic matter in maintaining the productivity and yield stability of cereals in China, 2009, Agric. Ecosyst. Environ. 129: 344-348.

R. Papini, G. Valboa, F. Favilli and G. Labate, Influence of land use on organic carbon pool and chemical properties of Vertic Cambisols in central and southern Italy, 2011, Agric. Ecosyst. Environ. 140: 68-79.

R. Rasool, S.S. Kuka and G.S. Hira, Soil physical fertility and crop performance as affected by long-term application of FYM and inorganic fertilizers in rice-wheat system, 2007, Soil Til. Res. 96: 64-72.

A. Rasoulzadeh and A. Yaghoubi, Effect of cattle manure on soil physical properties on a sandy clay loam soil in North-West Iran, 2010, J. of Food, Agric. Environ. 8(2): 976-979.

V. Rocio, L. Jorge, M. Ricardo and Z. Hilda, Effect of sewage sludge and sewage sludge compost amendment on soil properties and *Zea mays* L., plants (heavy metals, quality and productivity), 2011, Rev. Int'l Contam. Ambi. 27(4):303-311.

R.R. Romasanta, B.O. Sander, Y.K. Gaihre, M.C. Alberto, M. Gummert, J. Quilty, V.H. Nguyen, A.G. Castalone, C. Balingbing, J. Sandro, T. Correa, R. Wassmann, How does burning of rice straw affect CH4 and N2O emissions? A comparative experiment of different on-field straw management practices, 2017, Agric. Ecosyst. Environ. 239: 143-153.

G.D. Sharma, R. Thakur, S. Raj, D.L. Kauraw and P.S. Kulhare, Impact of integrated nutrient management on yield, nutrient uptake, protein content of wheat (*Triticum aestivum*) and soil fertility in a typic Haplustert, 2013, The Bioscan. 8(4): 1159-1164.

F. Singh, R. Kumar and S. Pal, Integrated nutrient management in rice-wheat cropping system for sustainable productivity, 2008, J. Ind. Soc. Soil Sci. 56:205-208

R. Singh and S.K. Agarwal, Growth and yield of wheat (*Triticum aestivum* L.) as influenced by levels of farmyard manure and nitrogen, 2001, Ind. J. Agron. 46: 462-467.

R. Soheil, M.H. Hossien, S. Gholamreza, H. Leila, J. Mozhdeh and E. Hassan, Effects of composted municipal waste and its leachate on some soil chemical properties and corn plant responses, 2012, Int'l J. of Agric. Res. and Review. 2 (6): 801-814.

J. Sood, Not a waste until wasted. Down to Earth. 2013, Available http://www.downtoearth.org.in/content/not-waste-until-wasted (Accessed 15 June 2020).

M. Tester and P. Langridge, Breeding technologies to increase crop production in a changing world, 2010, J. Animal Plant Sci. 20(3): 818-822.

Z. Wen, J. Shen, M. Blackwell, H. Li, B. Zhao and H. Yuan, Combined applications of nitrogen and phosphorus fertilizers with manure increase maize yield and nutrient uptake via stimulating root growth in a long-term experiment, 2016, Pedosphere. 26: 62-73.

R.L.E. Westerman, Soil Testing and Plant Analysis. Madison, WI: 1990, Soil Science Society of America.

Y.C. Yang, M. Zhang, L. Zheng, D.D. Cheng, M. Liu and Y.Q. Geng, Controlled release urea improved nitrogen use efficiency, yield, and quality of wheat, 2011, Agron. J. 103:479-485.

M. Zafar, M.K. Abbasi, A. Khaliq and Z. Rehman, Effect of combining organic materials with inorganic phosphorus sources on growth, yield, energy content and phosphorus uptake in maize at Rawalakot Azad Jammu and Kashmir, Pakistan, 2011, Arch. Appl. Sci. Res. 3(2): 199-212.

Y. Zhang, C. Li, Y. Wang, Y. Hu, P. Christie, J. Zhang and X. Li, Maize yield and soil fertility with combined use of compost and inorganic fertilizers on a calcareous soil on the North China Plain, 2016, Soil and Till. Res. 155: 85-94

L. Zotarelli, N.P. Zatorre, R. M. Boddey, S. Urquiaga, C. P. Jantalia, J.C. Franchini and B.J. Alves, Influence of no-tillage and frequency of a green manure legume in crop rotations for balancing N outputs and preserving soil organic C stocks, 2012, Field Crops Res. 132: 185-195.

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