Impact of long-term application of FYM and fertilizer nitrogen on soil aggregation and aggregate bound nitrogen fractions and nitrogen mineralization pattern in different size soil aggregates: A Review

Abstract

This review highlights the impact of long-term application of FYM and fertilizer nitrogen on soil aggregation and aggregate bound nitrogen fractions and nitrogen mineralization pattern in different size soil aggregates. Organic manures are an important factor to maintain the soil fertility level because soil organic matter is regarded as a key indicator when assessing soil quality. Combined application of inorganic fertilizers along with organic manures increased both the inorganic forms (ammonical and nitrate) of nitrogen over their individual application. Organic manures and residues that are added to the soil increase the total nitrogen content of the soil by protecting it chemically and physically against microbial degradation. Through FYM and crop root biomass (rhizodeposition), organic matter and fertilizers have been added to the soil on a regular basis during the past 41 years, and the building of nitrogen shows that nitrogen is physically protected within macroaggregates.

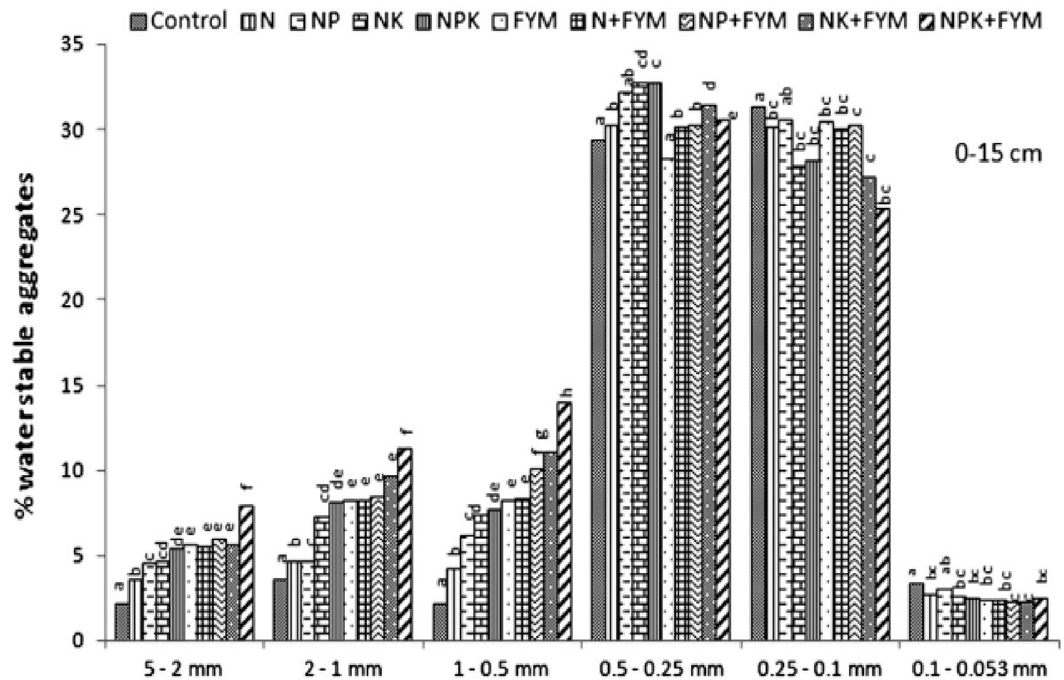
Keywords: fertilizer nitrogen, inorganic fertilizers, nitrogen mineralization, soil organic matter

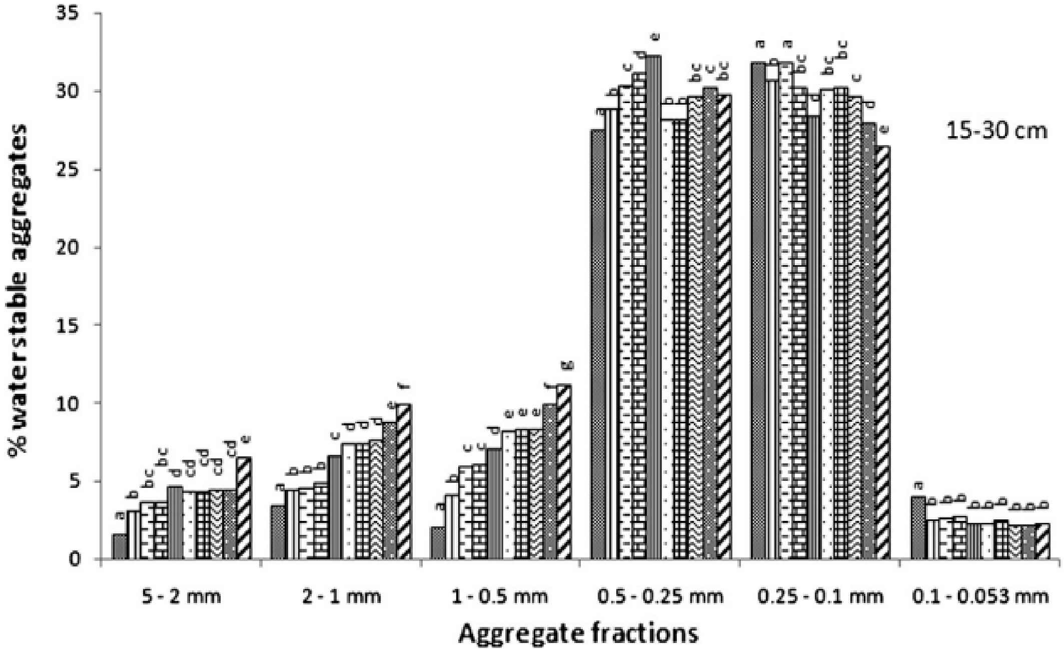
Introduction

Sustainability in agriculture means the inclusion of several aspects, as sustainable agriculture systems must not compromise not only their ability to satisfy future needs by undermining soil fertility and the natural resource base but also sustainable agriculture has had to address a range of other issues including energy use, efficient use, and recycling of nutrients. Organic manures are an important factor to maintain the soil fertility level because soil organic matter (SOM) is regarded as a key indicator when assessing soil quality (Riley *et al*. 2008) and improves soil structure by act as a major binding agent to stabilize soil aggregates. Aggregate formation depends on the soil fauna, microorganisms, roots, organic and inorganic binding agents, and environmental and physical forces (Oades, 1993; Six *et al*. 2004). Soil aggregation plays a critical role in the maintenance of soil structure, as well as in its productivity. The application of organic amendments with or without chemical fertilization (NPK) affect the stability and distribution of aggregates (Wang *et al*. 2014; Xie *et al*. 2015), increases the amount of aggregate carbon, and regulate its distribution within aggregates (Yu *et al*. 2012a; Xie *et al*. 2015). Due to the differential nature of different sized aggregates and amounts of decaying organic materials, aggregates of different sizes respond differently to the applied amendments (Lugato *et al*. 2010) and hence to mineralization of aggregate associated nitrogen. Nitrogen is important component of organic matter and its dynamics is closely related to carbon dynamics as more than 90% nitrogen in soil is present in organic form (Aggarwal *et al*. 1990). Nitrogen added to soil as inorganic or organic fraction is subjected into different forms. Soil type and nitrogen source added to soil determine the availability of nitrogen and its various forms. Changes in soil organic nitrogen status are caused by inorganic and organic fertilizer application, as well as cropping system, which may be easily recognized by changes in hydrolysable - N, amino sugar nitrogen, and amino acid nitrogen and ammonical nitrogen fractions. The aggregate-associated nitrogen is protected from mineralization because of their being less vulnerable to physical, microbial or enzymatic degradation. Therefore, it is important to investigate the aggregate associated total nitrogen as influenced by long-term manuring and fertilization. However, quantification of nitrogen in both organic and inorganic fractions will provide the concrete information about nitrogen mineralization pattern in soil and their availability to plants which can be helpful for making nutrient management strategies.

Effect of long-term application of FYM and fertilizer nitrogen on aggregate-size Distribution

An aggregate is a group of primary particles that cohere to each other more strongly than to other surrounding soil particles. Soil aggregation is caused by a variety of aggregate stabilizing compounds, which work simultaneously at different spatial scales and mineral particles that are bound together (Six et al., 2000). The amount and quality of coarse residues and humic chemicals, as well as the level of their interaction with soil particles, determine the nature and features of aggregates. The mechanisms that cause the primary soil particles to bind together into stable aggregates depend on the parent material of the soil, the climate, the vegetation, and the land management techniques. Land management practices, including tillage methods, residue management, amendments, and fertilization many factors which effect the aggregate size distribution in soil. According to Tripathi *et al*. (2014), the application of FYM and inorganic fertilizers had a substantial impact on the aggregate size distribution compared to the unfertilized control (Fig.1). In total water stable aggregates percentage at two sample depths, an aggregate fraction of 0.25–0.5 mm made up the largest portion (27.3–31.36%), whilst 0.1–0.053 mm fraction made the smallest contribution (2.10–3.87%). In comparison to the unfertilized control, the application of FYM alone or in combination with inorganic fertilizers improved the development of macro and meso-aggregates at both sample depths. In comparison to an unfertilized control in the 0–15 cm soil layer, FYM inclusion alone enhanced the occurrence of macro-aggregates (5-2 mm) by 165.33%, meso-aggregates by 130.68% in the 2-1 mm fraction, and by 282.83% in the 1-0.5 mm fraction. In comparison to plots fertilized with inorganic fertilizer alone, FYM + inorganic fertilized plots had a lower proportion of micro-aggregates (0.25-0.1 mm and 0.1-0.053 mm). In comparison to the unfertilized control in the surface soil, FYM application reduced the micro-aggregate fraction of 0.25-0.1 mm by 0.35 to 9.94% and micro-aggregate fraction of 0.1-0.053 by 0.4-30.63%. As a result of their role as a carbon source for microbial activities and the development of microbially generated binding agents, macroaggregates are said to form in soil when organic matter is regularly added through compost and extra root biomass (Chen *et al* 2010). Das *et al*. (2014) studied the effect of integrated nutrient management practice on soil aggregate and reported that the higher large macro-aggregates recorded in 75% of recommended N, P and K through fertilizers + 25% substitution of recommended nitrogen through FYM and 75% of recommended N, P and K through fertilizers + 25% substitution of recommended nitrogen through rice straw in 0–7.5 (34–36%), 7.5–15 (19%) and 15–30 (17%) cm layers. These treatments had proportionally less small macro-aggregates and significantly lower amounts of microaggregates and silt+ clay fractions. The 75% of recommended N, P and K through fertilizers + 25% substitution of recommended N through sulphitation press mud (SPM) (T5) has significantly higher small macroaggregates and lower large marco-aggregates in 0–7.5 and 7.5–15 cm layers, while higher mM contents were recorded in 75% of recommended N, P and K through fertilizers + incorporation of green gram residues after pod-picking (T6), 75% of recommended N, P and K through fertilizers + incorporation of green gram residues (GR) after pod picking (T7) and 75% of recommended N, P and K through fertilizers + 25% substitution of recommended N through wheat straw (T8) (70.17, 74.34 and 74.76 g 100/g of soil, respectively) in the layer 0–7.5 cm compared to zero and 100% inorganic N treatments. In rest of the layers, 75% of recommended N, P and K through fertilizers + 25% substitution of recommended N through wheat straw (T8) had larger effects while other organic treatments had nearly similar impacts as in inorganic nitrogen application. Ghosh *et al*. (2016) revealed that macro-aggregates accounted the higher proportion (51%) as compare to micro-aggregates. In topsoil (0–5 cm soil layer), the dominant water-stable aggregates as compare to sub-surface soil. Significantly higher (60%) water-stable macroaggregates were recorded in Palmarosa + FYM at 5 t/ ha + vermicompost at 1.0 t/ ha + poultry manure (PM) at 2.5 t/ ha + minimum tillage (MT) + 3-live mulch plots compared with Panicum + 100:60:40 ($N:P_2O_5:K_2O$) + conventional tillage (CT) + chemical method of weed control in both crops in the topsoil, with a concurrent decrease in micro-aggregates in the Palmarosa + (FYM) at 5 t /ha + minimum tillage + 1-live mulch and Palmarosa + FYM at 5 t/ ha + vermi-compost at 1.0 t/ ha + minimum tillage (MT) + 2-live mulch plots. In subsurface soil small macroaggregates were the greatest proportion of the whole soil, followed by aggregates <53mm in topsoil. Plots under Palmarosa + FYM at 5 t/ ha + vermicompost at 1.0 t ha1 + poultry manure at 2.5 t/ ha + MT + 3-live mulch had significantly more and small microaggregates than Panicum + 100:60:40 (N: $P_2O_5:K_2O$) + conventional tillage + chemical method of weed control in both crops plots in both soil layers. The Palmarosa + FYM at 5 t ha1 + vermicompost at 1.0 t /ha + poultry manure (PM) at 2.5 t /ha + MT + 3-live mulch plots had significantly higher large macroaggregates, with a concomitant decrease in 'silt + clay' sized aggregates compared with T1 plots in the topsoil. Mazumdar *et al*. (2021) studied the effect of four long-term nutrient management practices i.e.control, N (nitrogen (N) and no phosphorus (P), and potassium (K)), NPK (N, P and K) and INM (N, P, K + farmyard manure (FYM)). It was depicted that the addition of FYM with NPK improved macro-aggregates by 71%, and associated carbon pools by 30%.the carbon sequestration varied (0.17 to 0.26 t/ ha/ y) under different treatments and was recorded to be highest under INM, indicating long-term soil stability and yield sustainability in the rice-wheat system.





(Fig. 1) Distribution of water stable aggregates as affected by application of FYM and inorganic fertilizers after 41 years of rice–rice system [Source Tripathi *et al*. 2014]

Aulakh *et. al*. (2013) reported that the proportion of macro-aggregates in the size class of 0.25 to >2 mm was higher as compared to micro-aggregate in the size class 0.11-0.25 mm. Among the macro-aggregates, 0.25 -0.50 mm fraction constituted the greatest proportion followed by 0.5 -1.0, 1.0 - 2.0, and >2 mm fraction constituted the least proportion in both 0 - 5 cm and 5 -15 cm soil layers under both conventional tillage and conservation agriculture system. Integrated use of organic and inorganic fertilizers significantly increased total water stable aggregates which was highest in all the macro-aggregate size fractions in 0 - 5 cm and 5 - 15 cm soil layer. Guo *et al*. (2018) reported the effects of long-term application of inorganic fertilizer, straw and manure on water-stable aggregate distribution (> 2 mm, 0.25–2.0 mm, 0.053–0.25 mm, and < 0.053 mm), soil organic carbon (SOC), glomalin-related soil proteins (GRSP) and microbial biomass carbon (MBC) as the major biological binding agents in a vertisol , straw incorporation promoted the formation of > 2 mm macro-aggregates significantly , glomalin related soil proteins and microbial biomass carbon played an important role in the formation and stabilization of 0.25–2.0 mm aggregates.

Impact of long-term application of FYM and fertilizer nitrogen on aggregate bound nitrogen and their fractions

Combined application of inorganic fertilizers along with organic manures increased both the inorganic forms (ammonical and nitrate) of nitrogen over their individual application. Increase in inorganic forms of nitrogen with integrated use of manure and fertilizers were also reported by Manivannan and Sriramachandrasekharan (2009). Incorporation of organic residues helped enhance N content in an alfisol (Sharma, Chander, and Verma 2014). Durani *et al*. 2016 revealed that the continuous application of mineral and organic manures had a significant effect on available nitrogen irrespective of soil depth. Soil available nitrogen concentration in the surface soil (0–15 cm) varied between 88.9 kg/ ha in control (T1) to 147.1 kg/ ha in 100% NPK plus farmyard manure (T8) treatment. The conjunctive use of organic manures and recommended mineral fertilizers (100% NPK plus straw (T6), 100% NPK plus green manure (T7), and 100% NPK plus farmyard manure T8) had significant impacts on soil available nitrogen relative to the application of mineral fertilizers alone (100% N (T2), 100% NP (T3), 100% NPK T4). Application of nitrogen (T2) or NP (T3) had nonsignificant improvement in nitrate nitrogen over the control (T1). Addition of K (T4) with NP significantly increased the concentration of nitrate nitrogen. The application of 50% higher NPK (T5), NPK plus SI (T6), and NPK plus GM (T7) increased nitrate nitrogen to 25.0, 27.8, and 29.4 mg/ kg, but the differences between these treatments were not significant. Among the conjunctive use of mineral fertilizers and organic manures, available nitrogen was highest in 100% NPK plus farmyard manure (T8), followed by 100% NPK plus green manure (T7) and 100% NPK plus straw (T6). NPK plus FYM (T8) significantly increased the concentration of nitrate nitrogen over the other combinations of mineral fertilizers and organic manures (e.g., T6and T7). The comparatively low nitrate nitrogen concentration as compared with ammonium nitrogen.

		Depth(cm)		
Treatments	**0-15**	**15-30**	**30-45**	**45-60**
Control	35.6e	32.4e	31.2e	29.2f
100%N	40.6d	39.3e	34.2d	33.0e
100%NP	42.6d	39.7e	34.3cd	32.9e
100%NPK	46.0c	41.0d	39.3cd	38.3d
150%NPK	46.3c	41.6c	42.0cde	39.3d
100%NPK+ Straw	53.6b	45.6b	44.1bc	41.6c
100%NPK+GM	58.5a	49.5a	47.2ab	44.8b

100%NPK+FYM	58.8a	50.9a	49.5a	48.6a

(Table.1) Effects of Long-Term Application of Mineral Fertilizers and Organic Manures on depth wise distribution of available N (mg/ kg) [Source Durani et al. (2016)]

		Depth(cm)		
Treatments	**0-15**	**15-30**	**30-45**	**45-60**
Control	17.0d	9.6c1	8.3c	7.6b
100%N	20.6cd	17.5bc	17.5ab	8.3ab
100%NP	22.9bcd	19.4b	13.3b	10.2ab
100%NPK	21.3cd	21.7ab	17.2ab	12.5ab
150%NPK	25.0bc	20.8ab	17.5ab	12.5ab
100%NPK+ Straw	27.8bc	23.8ab	15.2ab	13.0a
100%NPK+GM	29.4b	24.5ab	18.2ab	13.2a
100%NPK+FYM	36.4a	28.8a	19.1a	13.2a

(Table. 2)Effects of Long-Term Application of Mineral Fertilizers and Organic Manures on depth wise distribution of nitrate-N (mg/ kg) [Source Durani et al. (2016)]

Shahid *et al*. 2017 reported the nitrogen fractions under 41 years of chemical and organic fertilization in a sub-humid tropical rice soils and revealed that macroaggregates contained more total nitrogen than microaggregates. At both depths, the portion of 5-2 mm size had the highest total nitrogen content (0.27-1.45 g/ kg) while the fraction of 0.25-0.1 mm had the lowest total nitrogen concentration (0.21-0.83 g/ kg). In comparison to the unfertilized control, the combined application of FYM and inorganic fertilizers increased the aggregate associated N by 0.43–1.00 g/ kg and 0.09–0.44 g/ kg in aggregate fractions 5-2 mm and 0.25–0.1 mm, respectively. Organic manures and residues that are added to the soil increase the total nitrogen content of the soil by protecting it chemically and physically against microbial degradation. Through FYM and crop root biomass (rhizodeposition), organic matter and fertilizers have been added to the soil on a regular basis during the past 41 years, and the building of nitrogen shows that nitrogen is physically protected within macroaggregates. Sodhi *et al*. (2009) revealed the effect of long-term application of compost on distribution nitrogen in different fractions in rice–wheat system and showed that macroaggregates were richer in nitrogen content as compared to microaggregates. Highest nitrogen concentration, except in control plots, was observed in 1–2 mm size fraction, and the concentration decreased as the aggregates became smaller in size and micro-aggregates had the least nitrogen concentration. Application of inorganic fertilizer and compost resulted in improved nitrogen concentration in all the aggregate size classes but the effect was maximum in 1–2 mm size fraction and minimum in 0.11–0.25 mm fraction. The increase in nitrogen concentration was greatest with the application of 8 tonnes compost/ ha rice straw compost without rock phosphate at 8 tonnes / ha (8RSC) followed by integrated use of 2 tonnes compost and inorganic fertilizers and least with inorganic fertilizers alone. The trend and magnitude of increase was almost similar at rice harvest. With 2 tonnes/ ha compost application together with inorganic fertilizers the increase in nitrogen concentration at wheat harvest ranged between 1.85 and 0.22 g/kg in 1–2 and 0.11–0.25 mm fractions, respectively. The corresponding increase at rice harvest was between 1.70 and 0.33 g/kg. Fertilizer application alone caused minimum increase in N concentration ranging between 0.64 and 0.13 g/kg at wheat harvest and 0.77 and 0.22 g/kg at rice harvest in 1–2 and 0.11– 0.25 mm fractions, respectively. Nitrogen content in the soil increased after 10 years of 8 tonnes per hectare of rice straw compost application without fertilizer application, and it was maximum at both sampling intervals. A greater input of new compost may be the cause of the higher nitrogen content found after rice harvest than after wheat harvest. Mustafa *et al*. (2020) reported that soil aggregation and soil aggregate stability regulate the nitrogen storage in a red soil and the highest concentration for aggregate-associated nitrogen (0.66 g/kg) was observed in >250 µm macro-aggregates, while the lowest (0.09 g/kg) corresponded to micro-aggregates of 250 µm macro-aggregates <53 µm. Irrespective of the aggregate size, the combined application of mineral plus manure (NPKM) resulted in higher stock of nitrogen in aggregates, as compared to control and mineral fertilizer (NPK) alone; however their effect was more prominent in >250 µm macro-aggregates. These highest N contents recorded in >250 µm macro-aggregates ranged between 0.21 and 0.66 g/kg while the lowest values were observed for <53 µm size micro-aggregates, ranging 0.09–0.20 g/kg nitrogen contents in >250 µm macro-aggregates were 0.21, 0.34, and 0.66 g/kg under control, NPK application and NPKM treatment, respectively, whereas, in meso-aggregates of 250-53 µm size they were 0.13, 0.23 and 0.27 g/kg. More precisely, the application of NPK and NPKM resulted in (62 and 214%) increase in nitrogen contents for macro-aggregates of >250 µm size, 77 and 108% increase for those of 250-53 µm sized meso-aggregates, and 100 and 122% increase for aggregates of <53 compared to control (CK). Joseph *et al*. (2019) the concentrations of aggregate-associated total nitrogen (TN) in 0–10 cm soil depth, biochar application resulted in significant differences only in the 0.25–0.05 mm size fractions, where soil total nitrogen content in 10 t/ha, 20 t/ha and 30 t/ha biochar application increased by 32.4%, 23.4%, and 33.5%, respectively, compared with control. In 10–20 cm soil depth, at 2–0.5 mm aggregate-size fractions, total nitrogen content in 10 t/ha, 20 t/ha and 30 t/ha biochar application treatments (compared with control) increased significantly by 14.8%, 19.8%, and 18.7%, respectively, with no significant difference among the treatments. Similarly, total nitrogen of 20 t/ha and 30 t/ha biochar application treatments were significantly higher by 26.9% and 17.7%, respectively, than control in 0.25–0.05 mm aggregate-size fractions but not in 20–30 cm soil depth. Gautam *et al*. (2020) reported the effect of manure and inorganic fertilization impacts on soil nutrients, aggregate stability, and nitrogen in different aggregate fractions and revealed that when compared to the control (CK), manure treatment enhanced aggregate associated total nitrogen concentration in most of the size fractions. (Figure 2). Comparing the high manure (HM; two times prescribed nitrogen rate) treatment to the control (no manure nor fertilizer CK), the aggregate associated total nitrogen concentration increased in the size fractions of 4-8 mm, 2-4 mm, 1-2 mm, 0.5-1 mm, 0.25-0.5 mm, and 0.053-0.25 mm by 66.5, 63.5, 62, 67, 48.5, and 53%, respectively. Similar to the medium manure (MM; application based on nitrogen requirement) treatment, aggregate associated total nitrogen concentration rose by approximately 11.5, 21.5, 15, and 15% in the 2-4 mm, 0.5-1 mm, 0.25-0.5 mm, and 0.053-0.25 mm size fractions compared to the no manure nor fertilizer (CK). Comparing the low manure (LM; application based on phosphorous requirement) treatment to the control (no manure nor fertilizer CK), the aggregate associated total nitrogen concentration was greater in the 2-4 mm, 0.5-1 mm, and 0.25-0.5 mm size aggregate fractions by roughly 17.5, 14 and 18.5%.

Impact of long-term application of FYM and fertilizer nitrogen on nitrogen mineralization pattern in different size soil aggregates

Soil nitrogen availability is determined to a large extent by the processes of soil nitrogen mineralization, which converts soil organic nitrogen into inorganic nitrogen from soil organic matter (SOM) with the help of soil animals and microorganisms (Chapin III et al., 2011). The rates of nitrogen mineralization are influenced by long term addition of organic and inorganic fertilizers, according to research by Durani *et al*. (2016), adding organic manures to mineral fertilizers over the long term considerably boosted the amount of mineral nitrogen in the soil. In terms of statistics, the mineral nitrogen content in N (T2) and NP (T3) was equal. In comparison to the T2 treatment, the addition of K with NP as in T4 and T5 significantly improved the mineralizable nitrogen (NO_3^--N + NH_4^+-N). Application of a greater dose of NPK did not result in any additional detectable increases in mineral nitrogen.(T5). Mineral fertilizers alone (T2, T3, T4, and T5) and the control (T1) treatments performed statistically better than the combination of mineral fertilizers and organic manures 100% NPK plus straw, 100% NPK plus green manure , 100% NPK plus FYM (T6, T7, and T8). The treatment using organic manure with the highest mineral nitrogen concentration was T8 (42.9 mg/ kg), followed by T7 (37.9 mg/kg) and T6 (36.9 mg/ kg).

When compared to the T6 and T7 treatments, the application of NPK plus FYM (T8) had significantly greater mineral nitrogen levels. Integrated usage of FYM and 100%NPK resulted in increased losses from leaching, volatilization, and denitrification, which caused mineral nitrogen to be lower in 150%NPK than in 100%NPK and FYM. The concentration of mineral nitrogen reduced as soil depth increased, similar to NO_3--N. In the 15–30 cm soil depth, it varied from 19.8 mg/ kg in the control (T1) to 35.2 mg/ kg in the NPK plus FYM treated plots (T8), with comparable treatment effects as shown in the surface soil. (0–15 cm). In the deeper soil depths (30-45 cm and 45-60 cm), there was no discernible difference in the mineral N content between the treatments. Shahid *et al*. (2017) reported that the application of organic and inorganic fertilizers resulted in significantly higher cumulative nitrogen mineralization over control. Nitrogen mineralization was observed in NPK + FYM treatment which was significantly higher than rest of the treatments except N + FYM. The cumulative nitrogen mineralization was highest between 0 and 15 cm, and it declined as soil depth increased under each treatment, ranging from 36.5 to 45.4% between 15 and 30 cm, 45.0 to 54.6% between 30 and 45 cm, and 61.5 to 68.5% between 45 and 60 cm above the surface depth. In comparison to the other treatments, the combined use of NPK + FYM and N + FYM considerably increased the particulate organic nitrogen content in the soil, especially at the 0–15 and 15–30 cm soil depths. Surface soil (0–15 cm) showed a larger deposition of particulate organic nitrogen, which decreased at lower depths.

		Depth(cm)		
Treatments	**0-15**	**15-30**	**30-45**	**45-60**
Control	38.8f	29.4f	25.5e	21.5e
100%N	48.9e	40.8e	37.3ed	23.4de
100%NP	53.0de	43.7de	34.6d	26.0cde
100%NPK	53.3de	47.7de	41.4bc	28.7bcd
150%NPK	58.3cd	49.2cd	41.8bc	28.6bcd
100%NPK+ Straw	64.0bc	55.6bc	41.1bc	29.4bc
100%NPK+GM	67.3b	58.5ab	46.3ab	32.7ab
100%NPK+FYM	79.2a	64.0b	51.5a	37.3a

(Table. 3)Effects of Long-Term Application of Mineral Fertilizers and Organic Manures on depth wise distribution of mineral N (mg/ kg). [Source Durani *et al*. (2016)]

Though it happened gradually, there was a drop of 22.0 to 28.6% under various treatments at a depth of 15 to 30 cm as compared to surface soil (0 to 15 cm), 29.4 to 42.1% at a depth of 30 to 45 cm, and 32.0% to 48.7% at a depth of 45 to 60 cm. In comparison to the other treatments, plots receiving NPK + FYM had considerably increased microbial biomass nitrogen content in both the surface (0–15 cm) and subsurface (15–60 cm) soil. In surface soil (0–15 cm), microbial biomass nitrogen concentrations ranged from 19.3 mg /kg in the control to 36.0 mg/ kg in the NPK + FYM plot, whereas they varied from 12.9 mg/ kg in the control to 21.9 mg kg1 in the NPK + FYM plot, and from 7.4 mg/ kg in the control to 11.3 mg/ kg. Bimüller *et al*. (2016) reported the nitrogen mineralization in different size aggregate on days 0, 28, 56, 84, 112, 154, and 224 of the incubation. NH_4^+-N made for 61%–72% of the total nitrogen mineralization concentration at 0 days. After that, there was no longer any trend in the NH_4^+-N concentrations, which fell to 10%-22% of the total nitrogen mineralization. The total nitrogen mineralization concentration, which is determined by adding the NH_4^+ -N and NO_3-N concentrations, did not exhibit any discernible trends during the incubation period. The greater quantities were discovered in the fine aggregates, where the mean mineralized nitrogen concentrations ranged from 6.0 to 9.6 mg. Every sample's mineralized nitrogen reached its lowest level after 224 days. The fine aggregates and all other fractions showed a substantial difference in the nitrogen mineralization. Additionally, there were notable differences in the nitrogen mineralization per unit mass soil between bulk soil and coarse aggregates as well as between bulk and recombined bulk soil. Aulakh *et. al*. (2013) studied the potentially mineralizable nitrogen content after two years of the experiment and reported that in 0-5 cm soil layer of conventional tillage system, 100% of recommended NP without crop residue(T2), 125% of recommended NP without crop residue(T3) and 100% NP + 10 t FYM ha^{-1} without crop residue(T4) treatments increased the potentially mineralizable nitrogen content from 2.7 mg/kg /7d in control (T1) to 2.9, 3.9 and 5.1 mg/kg $7d^{-1}$ without crop residue, and to 6.9, 8.4 and 9.7 mg/kg/7d with crop residue (T6, T7 and T8), respectively . The corresponding increase of potentially mineralizable nitrogen content under conservation agriculture system was from 3.6 mg/kg/7d in control to 3.9, 5.1 and 6.5 m mg/kg/7d without crop residue and to 8.9, 10.3 and 12.1 mg/kg/7d with crop residue. The trends were similar after 4 years of soybean- wheat experiment indicating a small improvement in potentially mineralizable nitrogen content of different treatments.

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