International Journal of Plant & Soil Science

Volume 35, Issue 17, Page 557-565, 2023; Article no.IJPSS.101443
ISSN: 2320-7035

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

Saloni Yadav [a++*], Usha Kumari [a#], Dev Raj [a#] and Mohit Sharma [a++]

[a] *Department of Soil Science, CCS Haryana Agricultural University, Hisar- 125004, India.*

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i173245

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here:
https://www.sdiarticle5.com/review-history/101443

Review Article

Received: 04/05/2023
Accepted: 15/06/2023
Published: 11/07/2023

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. The

[++] *PhD Scholar;*
[#] *Assistant Scientist;*
**Corresponding author: E-mail: saloniyadav36@gmail.com;*

integrated application of inorganic and organic amendments leads to increase in both the inorganic fractions (ammonical and nitrate nitrogen) as compare to their alone 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 macro aggregates.

Keywords: Fertilizer nitrogen; inorganic fertilizers; nitrogen mineralization; soil organic matter.

1. INTRODUCTION

Sustainability in agriculture encompasses various elements, as a sustainable farming system should not only affect their ability to meet future needs while preserving soil fertility and the natural resources but also tackle a range of other issues including energy consumption, effective use of resources, and nutrient recycling. Compost plays a major role in maintaining soil fertility level due to its impact on organic matter in soil which act as a metric for assessing soil quality [1] and improves soil structure by acting as a significant binding agent to stabilize soil pools. The aggregate formation is influenced by a combination of factors such as plant roots, soil flora, microbes, organic and inorganic binders, ambient factors, and physical forces [2,3]. The stability and dispersion of aggregates are significantly impacted by the application of organic amendments, whether combined with or without chemical fertilization (NPK) [4,5]. Additionally, it raises the total carbon content and controls how it is distributed throughout the aggregates [6,5]. Aggregates of various sizes react differently to the applied amendments because of the differences between aggregates of various sizes and levels of degraded organic matter [7] particularly in relation to nitrogen-related mineralization of aggregates. Nitrogen is a crucial element of organic matter and it added to the soil as an inorganic or organic fraction forms. The type of soil and the source of nitrogen added to the soil determine the availability of nitrogen and its various forms. Changes in the state of organic nitrogen in soils occur due to the usage of both the fertilizers such as organic and inorganic, as well as the farming method, which can be easily identified by changes in the hydrolysis of N-, amino-sugar nitrogen, amino-acid nitrogen and ammonia-nitrogen fractions. Aggregate bound nitrogen is protected from mineralization due to its reduced vulnerability to physical, enzymatic and microbial degradation. Therefore, it is crucial to investigate the total nitrogen bound to aggregates and its response to fertilization, particularly in the context of long-term fertilization practices. A comprehensive assessment of nitrogen quantities within in both the organic and inorganic fractions will provide concrete information about the pattern of nitrogen mineralization in soils and its subsequent availability to plants. This information proves valuable in the development of effective nutrient management strategies.

2. IMPACT OF LONG-TERM APPLICATION OF FYM AND FERTILIZER NITROGEN ON AGGREGATE SIZE DISTRIBUTION

An aggregate refers to a cluster of primary soil particles that exhibit stronger adhesion to one another than to surrounding soil particles. Soil aggregation is caused by numerous aggregate stabilizing substance and the mineral particles that are bonded together [8]. The stability and characteristics of aggregates are measured by quantity and quality of added residue and humus chemicals, as well as their relationship with soil particles. The process that bind the soil particles into stable aggregates are dependent on the applied source materials in soil, moisture, temperature, vegetation, and the management practices. Agricultural techniques like tillage, residue management, and amendments, and fertilization, influence the aggregate size distribution in soil in numerous ways. According to [9], the administration of organic sources and inorganic fertilizers significantly altered the aggregate size distribution as compare to the unfertilized plot (Fig. 1). At two different sample depths, the coarse aggregate size fraction of 0.25-0.05 mm contributed the largest percentage to the total water-stable aggregates (27.3-31.36%), while the fraction of 0.1-0.053 mm contributed the least (2.10-3.87%). The addition of farmyard manure singly or with inorganic sources enhanced the formation of all size aggregate fractions at both sample depths compared to the unfertilized control plot. In the depth of 0-15 cm layer FYM alone enhance the amount of macro-aggregates (5-2 mm) by 165.33%, meso-aggregates (2-1 mm) by 130.68% and micro-aggregated (1-0.5%) by 282.83% as compared to the control treatment. The treatment in which application of FYM and inorganic fertilizers contained a lower proportion of micro-aggregates (0.25-0.1 mm and 0.1-0.053 mm) as compared to treatment in which singly application of inorganic fertilizer. Furthermore, in the surface soil, the administration of FYM decreased the fraction of micro-aggregates (0.25-0.1) by 0.35 to 9.94% and the fraction of size (0.1-0.053 mm) by 0.4 to 30.63%. The presence of coarse aggregates in the soil is attributed to the continuously application of organic residues and increased in root biomass, as they serve as a carbon source for micro-organisms activity and the enhancement of binding agents in soil. Das et al. [10] reported the effects of INM practices on soil aggregates. The results revealed that treatment in which application of 75% of the recommended dose of NPK by the fertilizers along with a 25% substitution of recommended N through FYM or rice straw leads to the larger fraction of the coarse macro-aggregates in the soil layers of 0-7.5 cm (34-36%), 7.5-15 cm (19%), and 15-30 cm (17%), micro-aggregates and silt + clay fractions showed the lower proportions in these treatments. On the other hand, the treatment in which application of 75% of the recommended dose of NPK by use of fertilizers along with a 25% substitution of recommended N through sulphitation press mud (SPM) resulted in significantly higher proportions of small macro-aggregates and lower proportions of large macro-aggregates in the 0 to 7.5 cm and 7.5 to 15 cm soil depth. The treatment involving 75% recommended dose of NPK by the use of fertilizers along with the application of green gram residues after pod-picking showed higher levels of micro-aggregates. Additionally, the treatment in which application of 75% recommended dose of NPK along with a 25% substitution of recommended N by wheat straw had greater effects on the remaining soil layers. Other organic treatments exhibited similar effects to those observed with inorganic nitrogen application. According to Ghosh, et al. [11] the macro-aggregates constituted the larger proportion (51%) as compared to the micro-aggregates. In the surface soil layer 0-5 cm showed the higher amount of water-stable aggregates as compared to the sub-surface soil layer. The significantly larger water-stable macro-aggregates (60%) were founded in the treatment in which application of Palmarosa + farmyard manure at 5 t/ha + vermi-compost at 1.0 t/ha + poultry manure at 2.5 t/ha + minimum tillage + 3-live mulch, as compared to the treatment in which application of Panicum + 100:60:40 (N: P_2O_5:K_2O) + conventional tillage + chemical weed control methods, in both crops in the topsoil. Concurrently, a lower proportion of micro-aggregates was observed in plots treated with Palmarosa + FYM at 5t/ha + minimum tillage + 1-live mulch and Palmarosa + FYM at 5 t/ha + vermi-compost at 1.0 t/ha + minimum tillage + 2-live mulch. As compare to the whole soil the subsurface soil layer constituted the highest proportion of small macro-aggregates, followed by the aggregates smaller than 53mm in the topsoil. Plots treated with Palmarosa + FYM at 5 t/ha + vermi-compost at 1.0 t/ha + poultry manure at 2.5 t/ha + minimum tillage + 3-live mulch had significantly more small micro-aggregates compared to plots treated with Panicum + 100:60:40 (N: P_2O_5:K_2O) + conventional tillage + chemical weed control methods in both soil layers. The treatment in which Palmarosa + FYM at 5t/ha + vermi-compost at 1.0 t/ha + poultry manure at 2.5 t/ha + minimum tillage + 3-live mulch plots exhibited significantly higher large macro-aggregates and showed the decrease in aggregates of 'silt + clay' size, compared to the T_1 plots in the topsoil.

Aulakh et al. [12] studied the distribution of macro-aggregates and micro-aggregates within different size classes of soil layers under conventional tillage and conservation agriculture systems and showed that the fraction of macro-aggregates (0.25 to > 2 mm) was consistently larger than that of micro-aggregates (0.11-0.25 mm) within the size class. Among the macro-aggregates, the fraction ranging from 0.25 to 0.50 mm comprised the highest proportion, followed by the 0.5-1.0 mm fraction, the 1.0-2.0 mm fraction, and finally, the fraction larger than 2 mm, which had the smallest proportion. These findings remained consistent for both the soil layers such as 0-5 cm and 5-15 cm, regardless of whether the land was managed using conventional tillage or conservation agriculture.

3. IMPACT ON AGGREGATE BOUND NITROGEN AND THEIR FRACTIONS BY LONG-TERM APPLICATION OF FYM AND FERTILIZER NITROGEN

The integrated application of inorganic fertilizers with combination of organic manures leads to increase in both ammonical nitrogen and nitrate nitrogen over their alone application. Increase in inorganic forms of nitrogen with combined use of manure and fertilizers were also studied by Manivannan and Sriramachandrasekharan [13]. Durani et al. [14] reported that on available nitrogen there is significant result of integrated application of inorganic and organic fertilizers irrespective of soil depth. The available nitrogen concentration in surface soil (0-15 cm) layer is varied from 88.9 kg/ha to 147.1 kg/ha in control and in 100% NPK + farmyard manure treatment respectively. The combined use of organic manures and recommended mineral fertilizers such as 100% NPK+ straw, 100% NPK+ green gram and 100% NPK + FYM had significant effects on soil available nitrogen as compare to alone application of inorganic fertilizers like 100 % N, 100% NP and 100% NPK. Application of 100% N or 100% NP treatments were showed nonsignificant impact in enhancement of nitrate nitrogen over the control treatment and the addition of potassium with NP in treatment 100% NPK results in significant increase in the concentration of nitrate nitrogen. The application of 50 % higher NPK, 100 % NPK+ straw and 100 % NPK+ green gram increased nitrate nitrogen to 25.0, 27.8 and 29.4 mg/kg respectively and the highest available nitrogen was found in the treatment in which integrated application of inorganic and organic fertilizers such as 100 % NPK + farm yard manure, followed by 100 % NPK + green gram and 100 % NPK + straw. The ammonium form of inorganic nitrogen was comparatively low as compare to the nitrate nitrogen and the highest concentration of nitrate nitrogen found in treatment in which application of 100 % NPK + farmyard manure as compare to other combined use of inorganic and organic fertilizers like 100 % NPK+ green gram and 100 % NPK + straw.

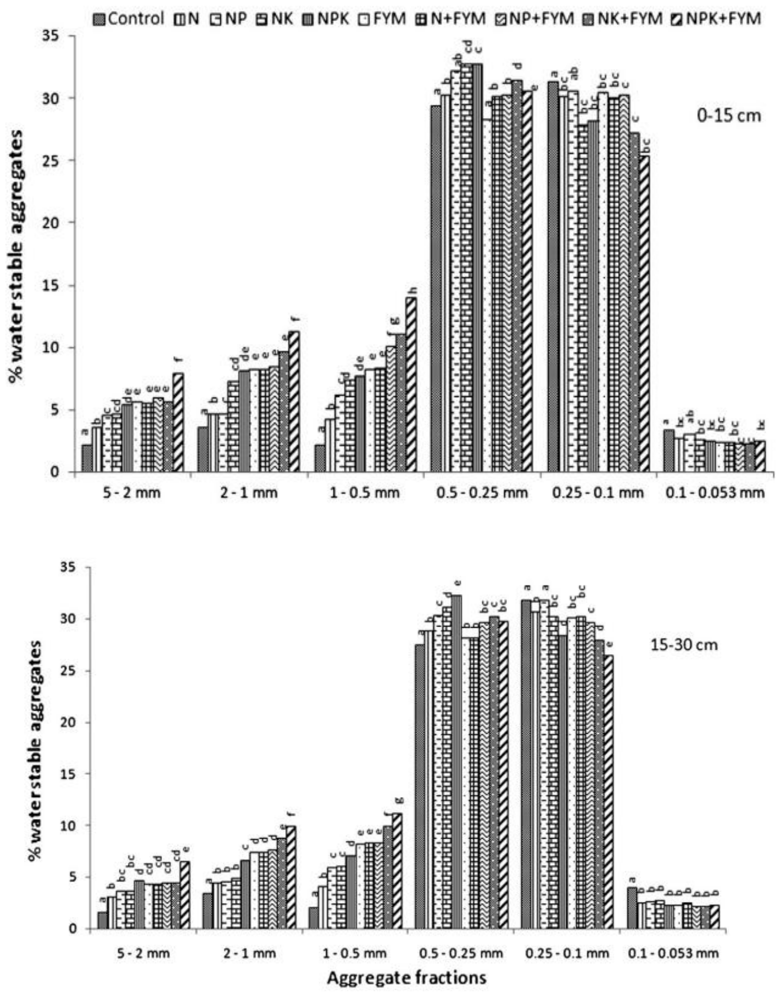

Fig. 1. Effect of application of FYM and inorganic fertilizers on distribution of water-stable aggregates after 41 years of rice-rice system [9]

Table 1. Impacts of long-term application of integrated use of mineral fertilizers and organic manures on depth wise distribution of available nitrogen (mg/kg)

Treatments	Depth(cm)			
	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

Source [14]

Table 2. Effects of long-term application of integrated use of mineral fertilizers and organic manures on depth wise distribution of nitrate nitrogen (mg/kg)

Treatments	Depth(cm)			
	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

Source [14]

Shahid et al. [15] studied the effect of organic and inorganic g=fertilization on nitrogen fractions under 41 years in tropical rice soils and reported that macro-aggregates contained more total nitrogen than micro-aggregates. 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 integrated application of mineral fertilizers and organic manures increased the aggregate bounded nitrogen by 0.43-1.00 g/kg and 0.09-0.44 g/kg in aggregate size fractions 5-2 mm and 0.25-0.1 mm respectively. Organic manures and residues that are added in the soil increase the nitrogen content of the soil by protecting it chemically and physically against microbial degradation. The application of 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 macro-aggregates. Sodhi et al. [16] revealed the impact of continuous application of compost on the concentration of available nitrogen in different aggregate size fractions and found that macro-aggregates had larger nitrogen content as compare to micro-aggregates. The highest nitrogen concentration, excluding control plots, was observed in the size range 1-2 mm fraction, and the content decreased with the decrease in size of aggregates, with micro-aggregates having the lowest nitrogen concentration. The incorporation of organic and inorganic fertilizers leads to improvement in nitrogen concentration across all size aggregate fractions, and the most pronounced effect was shown in the 1-2 mm size fraction and least pronounced in the 0.11-0.25 mm size fraction. Among the treatments, the highest increase in nitrogen content was observed with the incorporation of 8 tons/ha of rice straw compost without rock phosphate, followed by the continuous use of 2 tons/ha of compost and mineral fertilizer. The smallest increase was observed with inorganic fertilizers alone. At wheat harvest, the increase in nitrogen content in the 1-2 mm size fraction ranged from 1.85 to 0.22 g/kg with the application of 2 tons/ha of compost and mineral fertilizer. At rice harvest, the corresponding increase ranged from 1.70 to 0.33 g/kg. In contrast, fertilizer application alone resulted in a lesser increase in nitrogen content, ranging from 0.64 to 0.13 g/kg at wheat harvest and 0.77 to 0.22 g/kg at rice harvest in the 1-2 and 0.11-0.25 mm aggregate size fraction, respectively. Mustafa et al. [17] reported the relationship between soil aggregate formation, soil aggregate stability, and aggregate bound nitrogen concentration and revealed that the soil aggregate size significantly influenced the concentration of aggregate-associated nitrogen. The significantly larger concentration for aggregate bound nitrogen (0.66%) was found in > 250 um macro-aggregates, while the lowest concentration (0.09 g/kg) was found in micro-aggregates <53 µm. The integrated application of inorganic fertilizer and organic manure leads to the higher concentration of aggregate bound nitrogen as compare to the control treatment and the treatment in which application of mineral fertilizer alone. This effect was particularly notable in macro-aggregates larger than 250 µm. For macro-aggregates (>250 um), the nitrogen contents ranged from 0.21 to 0.66 g/kg under the control, mineral fertilizer (NPK) alone and combined use of mineral and organic manures (NPKM) treatments, respectively.In meso-aggregates (250-53 µm), the nitrogen contents varied from 0.13-0.27 g/kg under the different treatments. The lowest nitrogen contents were observed in micro-aggregates of less than 53 µm, ranging from 0.09 to 0.20 g/kg. Specifically, the incorporation of NPK and NPKM results in a 62% and 214% increase in nitrogen concentration for macro-aggregates(>250 um), a 77% and 108% increase for meso-aggregates (250-53 um) and a 100% and 122% increase for aggregates (< 53 um), compared to the control. Joseph et al. [18] reported the effect of biochar application on aggregate bound nitrogen in different aggregate size fraction and showed that the content of aggregate bound total nitrogen in 0-10 cm soil depth, significantly effect by biochar application in the 0.25-0.05 mm aggregate size fraction. The concentration of aggregate bound total nitrogen in different biochar applied treatment such as in 10 t/ha, 20 t/ha and 30 t/ha increased by 32.4%, 23.4 % and 33.5 %, respectively, as compare to the control. In 10-20 cm soil depth, the aggregate bound total nitrogen in 2-0.5 mm aggregate size fractions in 10 t/ha, 20 t/ha and 30 t/ha biochar application treatments (as compare to control) increased significantly by 14.8%, 19.8% and 18.7% respectively, with no significant difference among the treatments and the aggregate bound total nitrogen concentration of 20 t/ha and 30 t/ha biochar application treatments significantly higher by 26.9% and 17.7%, respectively, than control in 0.25-0.05 mm size of aggregates. Gautam et al. [19] reported the effect of organic and mineral fertilizers on soil aggregation, aggregate stability, and aggregate bound nitrogen in different size aggregate fractions and showed that when compared to the control. Organic manure treatment improves aggregate bound total nitrogen content in most of the size fractions. Comparing the high manure (HM; two time prescribed nitrogen rate) treatment to the control (no manure nor fertilizer), the aggregate bound total nitrogen content increased in the size fractions of 4-8 mm, 2-4 mm, 0.5-1mm, 0.25-0.5 mm. and 0.052-0.25 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 0.052-0.25 mm aggregate size fraction 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 bound total nitrogen content was greater in the 2-4 mm, 0.5-1 mm, 0. 25-0.5 mm aggregate size fractions by 17.5%, 14%, and 18.5%, respectively.

Table 3. Impact of long-term application of inorganic and organic fertilizers on depth wise distribution of mineral nitrogen (mg/kg)

Treatments	Depth(cm)			
	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

Source, [14]

4. IMPACT OF LONG-TERM APPLICATION OF FYM AND FERTILIZER NITROGEN ON NITROGEN MINERALIZATION PATTERN IN DIFFERENT SIZE SOIL AGGREGATES

The mechanisms of soil nitrogen mineralization, which transform soil organic nitrogen from soil organic matter into inorganic nitrogen with the aid of soil microorganisms and soil animals, control the availability of nitrogen in to soil to a great extent [20]. The integrated application of organic and inorganic fertilizers significantly influence the cumulative nitrogen mineralization, according to research by Durani et al. [14], 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 incorporation of potassium with nitrogen, phosphorous as in T4 and T5 significantly improved the mineralizable nitrogen (NO_3^--N + NH_4^+-N). Incorporation of a greater dose of NPK did not result in any additional detectable increases in mineral nitrogen. The combined use of inorganic and organic fertilizers such as 100% NPK+ straw, 100% NPK + green gram and 100% NPK + FYM gives significantly better results as compare to alone application of mineral fertilizers and control. The treatment using organic manure with the highest mineral nitrogen concentration was 42.9 mg/kg and 36.9 mg/kg in treatments 100% NPK + FYM (T8) and 100% NPK + green gram (T7), respectively. When compared between T6, T7, and T8 treatments the application of 100% NPK + FYM (T8) had significantly highest mineral nitrogen levels. Integrated use of farmyard manure and 100% NPK leads to decrease in losses of nitrogen from leaching, denitrification, and volatilization. The concentration of mineral nitrogen reduced as soil depth increased, similar to NO_3--N. The mineral nitrogen in surface soil layer, varied from 19.8 mg/kg in the control (T1) to 35.2 mg/kg in the 100% NPK + FYM (T8). In the deeper soil layers (30-45 cm and 45-60 cm), there was no discernible difference in the mineral N content between the treatments. Shahid et al. [15] showed that the combined application of organic and inorganic fertilizers resulted in significantly higher cumulative nitrogen mineralization over control. The highest nitrogen mineralization was observed in the treatment in which integrated application of organic and mineral fertilizers (NPK + FYM) as compared with the 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, it 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 integrated use of NPK + FYM and N+ FYM considerably increased the nitrogen concentration 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.

Though it happened gradually, there was a drop of 22.0 to 28.6% under various treatments at a depth of 15-30 cm as compared to the 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 concentration 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 T1 (control) to 36.0 mg/kg in the NPK+ FYM plot, whereas they ranging 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 T1 (control) to 11.3 mg/kg. Bimüller et al. [21,22] 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 ammonical nitrogen content, which fell to 10 %- 22% of total nitrogen mineralization. The total nitrogen mineralization concentration, which is determined by adding the ammonical nitrogrn and nitrate nitrogen concentrations, did not exhibit any discernible trends during the incubation period. The greater quantities were discovered in the micro-aggregates, where the cumulative mineralized nitrogen concentrations ranged from 6.0 to 9.6 mg. Every sample's mineralized nitrogen reached its lowest level after 224 days. The all aggregate size 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. [12] 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 without crop residue (T4) treatments significantly increased the potentially mineralizable nitrogen concentration from 2.7 mg/kg/7d in control to 2.9, 3.9 and 5.1 mg/kg/7d without crop residue, and to 6.9, 8.4 and 9.7 mg/kg/7d with crop residue (T6, T7 and T8), respectively. The increase of potentially mineralizable nitrogen concentration under conservation agriculture system was from 3.6 mg/kg/7d in control to 3.9, 5.1 and 6.5 mg/kg/7d without crop residue and 8.9, 10.3 and 12.1 mg/kg/7d with crop residue.

5. CONCLUSION

The long- term application of farmyard manure and nitrogen fertilizers significantly enhanced aggregate distribution, aggregate stability and soil aggregation. The integrated application of both inorganic and organic fertilizers increased the proportion of macro-aggregates fractions as compare with the singly application of inorganic fertilizers and the highest impact of fertilization was found on the formation of macro-aggregates (>250 um). As like aggregate the addition of organic materials with fertilization also enhances nitrogen levels and also helps in protect nitrogen from losses through microbial degradation. The continuous application of organic manures with inorganic fertilizers contributes to the physical preservation of nitrogen within macro-aggregates, leading to improved nitrogen availability and stability in the soil. The process of aggregates formation and aggregate stability play a crucial role in nitrogen storage, with larger macro-aggregates showing higher nitrogen concentrations. The integrated application of organic manures and mineral fertilizers enhances nitrogen storage in aggregates, especially in macro-aggregates (>250 um). The incorporation of organic and inorganic fertilizers also significantly enhance the available aggregate bound nitrogen and cumulative mineralized nitrogen. The treatment with NPK (mineral fertilizers) combined with FYM (farmyard manure) showed the highest cumulative nitrogen mineralization as compare to control. The highest cumulative nitrogen mineralization occurred in the surface layer (0-15 cm) depth and decreased with increasing soil depth. The study also highlights dynamic nature of nitrogen mineralization in different size aggregates during incubation. The concentrations of ammonical nitrogen and nitrate nitrogen fluctuated over time, and fine aggregates exhibited higher mineralized nitrogen concentrations compared to other fractions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Riley H, Pommeresche R, Eltun R, Hansen S, Korsaeth A. Soil structure, organic matter and earthworm activity in a comparison of cropping systems with contrasting tillage, rotations, fertilizer levels and manure use. Agric Ecosyst Environ. 2008;124(3–4):275–284.
2. Oades JM. The role of biology in the formation, stabilization and degradation of soil structure. In Soil structure/soil biota interrelationships, Elsevier. 1993;377-400.
3. Six J, Bossuyt H, Degryze S, Denef K. A history of research on the link between (micro) aggregates, soil biota, and soil organic matter dynamics. Soil and Tillage Research. 2004;79(1):7-31.
4. Wang Y, Tang J, Zhang H, Gao Z, Kou T. Aggregate-associated organic carbon and nitrogen impacted by the long-term application of fertilizers, rice straw, and pig manure. Soil science. 2014;179(10-11): 522-528.
5. Xie JY, XU MG, Ciren Q, Yang YANG, Zhang SL, Sun BH, Yang XY. Soil aggregation and aggregate associated organic carbon and total nitrogen under long-term contrasting soil management regimes in loess soil. Journal of Integrative Agriculture. 2015;14(12):2405-2416.
6. Yu H, Ding W, Chen Z, Zhang H, Luo J, Bolan N. Accumulation of organic carbon components in soil and aggregates. Scientific Reports. 2015;5(1):1-12.
7. Lugato E, Simonetti G, Morari F, Nardi S, Berti A, Giardini L. Distribution of organic and humic carbon in wet-sieved aggregates of different soils under long-term fertilization experiment. Geoderma. 2010;157(3-4):80-85.
8. Six JAET, Elliott ET, Paustian K. Soil macroaggregate turnover and microaggregate formation: a mechanism for C sequestration under no-tillage

agriculture. Soil Biology and Biochemistry. 2000;32(14):2099-2103.
9. Tripathi R, Nayak K, Bhattacharyya P, Shukla AK, Shahid M, Raja R. Soil aggregation and distribution of carbon and nitrogen in different fractions after 41 years long-term fertilizer experiment in tropical rice-rice system. Geoderma. 2014;213: 280-286.
10. Das B, Chakraborty D, Singh VK, Aggarwal P, Singh R, Dwivedi BS, Mishra RP. Effect of integrated nutrient management practice on soil aggregate properties, its stability and aggregate-associated carbon content in an intensive rice–wheat system. Soil and Tillage Research. 2014;136:9-18.
11. Ghosh BN, Meena VS, Alam NM, Dogra P, Bhattacharyya R, Sharma NK. Impact of conservation practices on soil aggregation and the carbon management index after seven years of maize–wheat cropping system in the Indian Himalayas. Agri. Ecosys Environ. 2016;216:247-257.
12. Aulakh MS, Garg AK, Shrvan Kumar S. Impact of integrated nutrient, crop residue and tillage management on soil aggregates and organic matter fractions in semiarid subtropical soil under soybeanwheat rotation. Am J Plant Sci. 2013;4:2.
13. Manivannan R, Sriramachandrasekharan M. (). Response of lowland rice to addition of organics and mineral N grown on typic haplusterts soil. Journal of Applied Sciences Research. 2009;5(11):1988–1991.
14. Durani A, Brar BS, Dheri GS. Soil nitrogen fractions in relation to rice-wheat productivity: Effects of long-term application of mineral fertilizers and organic manures. Journal of Crop Improvement. 2016;30(4):399-420.
15. Shahid M, Nayak AK, Puree C, Tripathi R, Lal B, Gautam P, Bhattacharyya P, Mohanty S, Kumar A, Panda BB, Kumar U. Carbon and nitrogen fractions and stocks under 41 years of chemical and organic fertilization in a sub-humid tropical rice soil. Soil and Tillage Research. 2017; 170:136-146.
16. Sodhi GPS, Beri V, Benbi DK. Soil aggregation and distribution of carbon and nitrogen in different fractions under long-term application of compost in rice–wheat system. Soil and Tillage Research. 2009; 103(2):412-418.
17. Mustafa A, Minggang X, Shah SAA, Abrar MM, Nan S, Baoren W, Zejiang C, Saeed Q, Naveed M, Mehmood K, Núñez-Delgado A. Soil aggregation and soil aggregate stability regulate organic carbon and nitrogen storage in a red soil of southern China. Journal of Environmental Management. 2020;270:110894.
18. Joseph UE, Toluwase AO, Kehinde EO, Omasan EE, Tolulope AY, George OO, Zhao C, Hongyan W. Effect of biochar on soil structure and storage of soil organic carbon and nitrogen in the aggregate fractions of an Albic soil. Archives of Agronomy and Soil Science. 2020;66(1):1-12.
19. Gautam A, Guzman J, Kovacs P, Kumar S. Manure and inorganic fertilization impact on soil nutrients, aggregate stability, and organic carbon and nitrogen in different aggregate fractions. Archives of Agronomy and Soil Science. 2022;68(9): 1261-1273.
20. Chapin FS, Matson PA, Mooney HA, Vitousek PM. Principles of terrestrial ecosystem ecology; 2011.
21. Bimüller C, Kreyling O, Kölbl A, von Lützow M, Kögel-Knabner I. Carbon and nitrogen mineralization in hierarchically structured aggregates of different size. Soil and Tillage Research. 2016;160:23-33.
22. Aggarwal RK, Praveen Kumar and Sharma BK. Distribution of nitrogen in some Aridisols. J. Indian Soc. Soil Sc. 1990;38: 430-433.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/101443