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Effect of different organic sources on soil properties, yield and nutrient uptake by onion in inceptisol

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Abstract
"Effect of different organic sources on soil properties, yield, and nutrient uptake by onion in Inceptisol" is the topic of the current study. In the kharif of 2024, the experiment was carried out at the Post Graduate Institute Research Farm's Department of Soil Science, Mahatma Phule Krishi Vidyapeeth, Rahuri. Eight treatments and three replications were used in the Randomized Block Design (RBD) experiment. The treatments comprised of T_1: Absolute control, T_2: GRDF (100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1} and 20 t FYM ha^{-1}), T_3: 100% RDF + Press mud compost @ 2.5 t ha^{-1}, T_4: 100% RDF + Press mud compost @ 5 t ha^{-1}, T_5: 75% RDF + Poultry manure @ 2.5 t ha^{-1}, T_6: 75% RDF + Poultry manure @ 5 t ha^{-1}, T_7: 75% RDF + PROM @ 0.5 t ha^{-1}, T_8: 75% RDF + PROM @ 1.0 t ha^{-1}. Organic manures were applied as per treatments 30 days before sowing in all treatments except treatment T_1 which was absolute control. As regards significantly highest, bulb yield (28.87 t ha^{-1}), straw yield (21.88 q ha^{-1}), bulb weight (72.82 g), polar diameter (5.20 cm), and equatorial diameter (5.93 cm) were recorded with the application of treatment T_2 (GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} + 20 t ha^{-1} FYM). The organic carbon (0.61%), nutrient availability (Nitrogen 196.13 kg ha^{-1}, Phosphorus 22.97 kg ha^{-1}, Potassium 436 kg ha^{-1}, Micronutrient availability of Fe, Mn, Zn and Cu (4.99, 5.92, 0.85 and 2.73 mg kg^{-1} respectively) were higher in the treatment T_2 (GRDF (100:50:50 kg $N:P_2O_5:K_2O$ ha^{-1} + 20 t FYM ha^{-1}). Nitrogen, phosphorus, and potassium uptake (138.10, 17.38, and 121.12 kg ha^{-1} respectively) were higher in the treatment T_2 (GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} + 20 t ha^{-1} FYM). Whereas, micronutrient uptake of Fe, Mn, Zn and Cu (1512, 682, 372 and 126 g ha^{-1}, respectively) were higher at the treatment T_2 (GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} + 20 t ha^{-1} FYM). Significantly highest microbial population (28.29 cfu x 10^{-4}, 31.13 cfu x 10^{-4}, 33.43 cfu x 10^{-6} g^{-1} of total fungi, actinomycetes and bacteria, respectively) were recorded in treatment T_2 (GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} + 20 t ha^{-1} FYM). The highest gross monetary returns (Rs. 346440-ha^{-1}), net monetary returns (Rs. 201669-ha^{-1}), and B: C ratio (2.39) were recorded in treatment T_2 (GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} + 20 t ha^{-1} FYM) helped for increasing the yield of onion grown in Inceptisol, which is economically feasible than other treatments.

Keywords: PROM, onion, phosphorus, yield, available macronutrients, nutrient uptake

Introduction
Onion (*Allium cepa* L.) is one of the major bulbous vegetable and spice crops cultivated globally, belonging to the family Alliaceae. Its origin is believed to be in Central Asia, specifically the region between Turkmenistan and Afghanistan, where wild relatives are still found. From this region, the ancestral form of onion is thought to have spread to the Near East (Grubben and Denton, 2004; Bagali *et al.*, 2012) [8, 3]. It is an indispensable ingredient in culinary practices, widely valued for enhancing the flavour of numerous dishes, which has earned it the title "Queen of Kitchen." Nutritionally, onion is rich in essential components, containing calcium (180 mg 100 g^{-1}), phosphorus (50 mg 100 g^{-1}), iron (0.7 mg 100 g^{-1}), carbohydrates (11.0 g 100 g^{-1}), protein (1.2 g 100 g^{-1}), dietary fibre (0.6 g 100 g^{-1}), vitamin C (11 mg 100 g^{-1}), along with several other minerals (0.4 g 100 g^{-1}).

Onion cultivation has played a vital role in enhancing the economic condition of farmers across different parts of the country. The leading onion-producing states include Maharashtra, Karnataka, Madhya Pradesh, Gujarat, Bihar, Andhra Pradesh, Rajasthan, Haryana, and Telangana.

Among these, Maharashtra contributes about 26% of the total area under onion cultivation and 29% of national production. The *rabi* season accounts for nearly 60% of onion output, while *kharif* and late *kharif* seasons together contribute around 20%. Although onion cultivation in India is predominantly concentrated in the winter season, Maharashtra stands out by producing onions across all three seasons-*rabi* (summer), late *kharif* (rangada), and *kharif*. In contrast, the demand for onions remains consistent throughout the year, as their consumption does not fluctuate significantly.

Press mud also known as filter cake/mud produced by sugar mills and has been used as a fertilizer and ameliorant in saline-sodic soils (Raman *et al*., 1999) [18]. More CO_2 is produced due to microbial activities that may increase solubility of lime and its effectiveness in reclaiming saline-sodic soils. Press mud compost improves soil nutrient availability and uptake by plants. It also helps to improve soil macro and micronutrients and uptake of N, P and K (Tompe and More, 1996) [24].

Phosphate Rich Organic Manure (PROM) is generated through the composting of diverse organic wastes along with finely powdered, high-grade rock phosphate. The final product generally contains 10.4% phosphorus, 7.9% organic carbon, and 0.4% nitrogen. Acting as a sustainable alternative to diammonium phosphate (DAP), PROM enhances soil texture, maintains nutrient availability over a longer duration, and plays a vital role in sustaining soil fertility and productivity. Unlike synthetic fertilizers, PROM provides a natural and cost-efficient substitute for DAP. It is produced by co-composting press mud and distillery residues with rock phosphate, resulting in a value-added product standardized to 18% P_2O_5 with 22% moisture content. When high-grade rock phosphate (32% $P_2O_5 \pm 2\%$) in finely ground form is co-composted, phosphorus-rich organic manure is obtained. Due to its efficiency, PROM is considered a potential replacement for conventional phosphate fertilizers such as single superphosphate (SSP) and DAP.

Plant nutrients, particularly nitrogen, are abundant in poultry manures. The loss of nitrogen due to ammonia volatilization and denitrification lowers the fertilizer value of manure. It has been discovered that aerobic composting of poultry manure with chemical and biological additions significantly lowers the manure's nitrogen loss (Mahimairaja *et al*., 1994) [13]. Numerous studies have demonstrated that phosphate rock (PR)

Plant nutrients, particularly nitrogen, are abundant in poultry manures. The loss of nitrogen due to ammonia volatilization and denitrification lowers the fertilizer value of manure. It has been discovered that aerobic composting of poultry manure with chemical and biological additions significantly lowers the manure's nitrogen loss (Mahimairaja *et al*., 1994) [13]. Phosphate rock (PR) has been shown in numerous investigations. Numerous studies have demonstrated that phosphate rock (PR) composted with organic manure improves crop phosphorus uptake and output, mostly due to the increased availability of P from phosphate rock. Phosphate rock dissolving is probably aided in field circumstances by the availability of exchange sites and plant uptake of P and calcium, which act as sinks for PR dissolution products (Ca and H_2PO_4) (Misra and Banger, 1985) [14].

Organic manures boost onion nutrition by improving soil health and providing essential nutrients. They enhance soil structure, microbial activity, and nutrient availability. This leads to higher yields, better nutrient uptake and potentially increased protein and micronutrient content in onion. Key areas for research include manure composition, application rates, and integration with other sustainable practices.

Materials and Methods

The field experiment was carried out at PGI Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahilyanagar, Maharashtra (India) during the 2024 *kharif* season. Surface (0-15 cm depth) soil samples were randomly taken from specific locations around the experimental area in order to ascertain the soil parameters of the experimental soil before to seeding. A sample of composite soil was created, and its different soil qualities were analyzed. In addition to having a low salt concentration (0.29 dS m^{-1}), the soil had a moderately alkaline pH of 8.15, was medium in calcium carbonate (7.35%), and was medium in organic carbon (0.55%). The soil has very high levels of accessible potassium (420 kg ha^{-1}), moderate levels of available phosphorus (17.40 kg ha^{-1}), and low levels of available nitrogen (176.26 kg ha^{-1}). The soil had adequate levels of DTPA-extractable Fe, Mn, Zn, and Cu (4.87, 4.65, 0.72, and 2.63 mg kg^{-1}, respectively). Eight treatments and three replications were used in the Randomized Block Design (RBD) experiment. T_1 (absolute control) and T_2 were the treatments. GRDF at 20 t ha^{-1} FYM and 100:50:50 N:P_2O_5:K_2O kg ha^{-1} (T_3)-100% RDF + composted press mud at 2.5 t ha^{-1}, (T_4)-5 t ha^{-1} of press mud compost and 100% RDF (T_5) 2.5 t ha^{-1} of-75% RDF + poultry manure (T_6) and 5 t ha^{-1} of-75% RDF + poultry manure (T_7)-75% RDF + PROM at 0.5 t ha^{-1} and (T_8) at 1.0 t ha^{-1}. With the exception of treatment (T_1), which served as the absolute control, all treatments received organic manures 30 days prior to transplanting.

Onion seeds of Phule Samarth variety obtained from the Chief Scientist (Seed), Mahatma Phule Krishi Vidyapeeth, Rahuri. The recommended spacing of 15 cm x 10 cm was adopted for sowing of test crop. The recommended dose of fertilizer (100:50:50 kg ha^{-1} N, P_2O_5 and K_2O, respectively) were given to onion as per treatment details except absolute control (T_1) at the time of transplanting.

Results and Discussion

Effect of Different Organic Sources on Yield of onion in Inceptisol

The application of different organic sources with recommended dose of fertilizer has significantly influenced the bulb and straw yield of onion. The data presented in Table 1.

The findings showed that treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM produced a considerably greater bulb yield (28.87 t ha^{-1}), which was statistically comparable to the bulb yield (25.79 t ha^{-1}) seen in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. The absolute control treatment (16.67 t ha^{-1}) had the noticeably lowest bulb yield.

Similar trend was observed in straw yield of onion. Significantly higher straw yield (21.88 q ha^{-1}) was observed in treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM and it was statistically at par with straw yield (18.19 q ha^{-1}) recorded in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. Significantly lowest straw yield (11.32 q ha^{-1}) was recorded in treatment (T_1) absolute control.

This could be because FYM and RDF have a positive impact on soil macro and micronutrient availability during cropping. It could have been caused by increased food production and subsequent sink partitioning. Consequently, the implementation of FYM led to a notable improvement in nearly every crop growth parameter. Similar yield-related findings were previously published by Sanni *et al*. (2015) [20] and Koireng *et al*. (2018) [11].

Table 1: Effect of different organic sources on yield of onion in Inceptisol

Tr. No.	Treatments	Yield	
		Bulb (t ha^{-1})	Straw (q ha^{-1})
T_1	Absolute control	16.67	11.32
T_2	GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1}and 20 t ha^{-1} FYM	28.87	21.88
T_3	100% RDF + Press mud compost @ 2.5 t ha^{-1}	23.51	16.44
T_4	100% RDF + Press mud compost @ 5 t ha^{-1}	25.79	18.19
T_5	75% RDF + Poultry manure @ 2.5 t ha^{-1}	21.92	14.96
T_6	75% RDF + Poultry manure @ 5 t ha^{-1}	23.25	16.15
T_7	75% RDF + PROM @ 0.5 t ha^{-1}	22.72	13.69
T_8	75% RDF + PROM @ 1.0 t ha^{-1}	24.17	14.68
	SE(m)±	1.39	1.32
	CD at 5%	4.24	4.02

Effect of different organic sources on yield attributing characters of onion in Inceptisol

Bulb Weight

The data presented (Table 2) revealed that bulb weight was ranged from 49.53 to 72.82 g. The results at harvest of onion revealed that significantly higher bulb weight (72.82 g) was observed in treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM and it was statistically at par with bulb weight (69.82 g) recorded in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. Significantly lowest bulb weight (49.53 g) was recorded in treatment (T_1) absolute control.

Easily accessible water-soluble nutrients from the application of various organic sources may be the cause of the increase in the average weight of onion bulbs, according to Deshmukh *et al.* (2019) [5]. These nutrients improve vegetative growth, increase the net assimilation rate, and accelerate the accumulation of photosynthates in the bulbs' storage organs, increasing the bulb's diameter and weight. Furthermore, our findings strongly align with those reported by Diwakar (2013) [7], Deshmukh *et al.* (2019) [5], and Shinde *et al.* (2013) [22].

Polar Diameter

Treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had the highest mean polar diameter (5.20 cm), which was statistically comparable to the mean polar diameter (5.00 cm) of treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. The absolute control treatment (T_1) had the noticeably lowest mean polar diameter (3.20 cm).

Given that the bulb is the onion's storage organ, any carbohydrates produced in the leaves were stored there, resulting in larger bulbs as indicated by the diameter. This may have contributed to the relatively significant increase in height and number of green leaves brought about by the GRDF 100:50:50 N:P_2O_5:K_2O kg ha^{-1} + 20 t ha^{-1} FYM.

According to Deshmukh *et al.* (2019) [5], the bulb is the onion storage organ, so whatever carbohydrates were synthesized in the leaves were stored in the bulbs, resulting in larger bulbs as indicated by the diameter. This may have contributed to the relatively significant increase in height and number of green leaves caused by the GRDF 100:50:50 N:P_2O_5:K_2O kg ha^{-1} + 20 t ha^{-1} FYM. These findings closely match those of Deshmukh *et al.* (2019) [5], Abd El-Samad *et al.* (2011) [1], Diwakar (2013) [7], and Shinde *et al.* (2013) [22].

Equatorial Diameter

Treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had the highest mean equatorial diameter (5.93 cm), which was statistically comparable to treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}, which had the mean equatorial diameter (5.82 cm). In treatment (T_1) absolute control, the mean euqatorial diameter was significantly lower (4.13 cm).

The growth and development of bulb is directly proportional to the rate of supply of food. The nutrients absorbed by the plants that leads to increase in size of the bulbs in horizontal as well as vertical direction. Increase in availability of balanced nutrition through treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM fastens the photosynthetic activity. Increase in equatorial diameter may be attributed to the better utilization of photosynthates and increased allocation of photosynthates towards the storage organ, that is onion bulb, Biswas *et al.*, 2020 [4].

Table 2: Effect of different organic sources on yield attributing characters of onion in Inceptisol

Tr. No.	Treatments	Bulb weight (g)	Polar diameter (cm)	Equatorial diameter (cm)
T_1	Absolute control	49.53	3.20	4.13
T_2	GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1}and 20 t ha^{-1} FYM	72.82	5.20	5.93
T_3	100% RDF + Press mud compost @ 2.5 t ha^{-1}	68.20	4.37	5.51
T_4	100% RDF + Press mud compost @ 5 t ha^{-1}	69.82	5.00	5.82
T_5	75% RDF + Poultry manure @ 2.5 t ha^{-1}	63.32	4.23	5.23
T_6	75% RDF + Poultry manure @ 5 t ha^{-1}	65.38	4.30	5.45
T_7	75% RDF + PROM @ 0.5 t ha^{-1}	62.19	4.20	5.20
T_8	75% RDF + PROM @ 1.0 t ha^{-1}	64.21	4.23	5.31
	SE(m)±	1.11	0.16	0.04
	CD at 5%	3.36	0.49	0.15

Effect of different organic sources on available nutrient in soil at harvest of onion in Inceptisol

The data presented in Table 3 represents available nitrogen, phosphorus, and potassium content of soil as influenced by application of different organic sources with recommended dose of fertilizers. The initial available nitrogen, phosphorus, and potassium status of soil were 176.26 kg ha^{-1}, 17.40 kg ha^{-1}, and 420 kg ha^{-1} respectively

Available Nitrogen

The available nitrogen ranged from 135.70 to 196.13 kg ha^{-1}, according to the data shown (Table 3). At onion harvest, the results showed that treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had significantly higher available nitrogen (196.13 kg ha^{-1}), which was statistically comparable to the available nitrogen (192.12 kg ha^{-1}) found in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. Significantly less nitrogen was available (135.70 kg ha^{-1}) in the absolute control treatment (T_1).

The release of nitrogen following the breakdown of organic manures may be the cause of the increased available nitrogen content in soil, which in turn may have increased the pool of available soil nutrients. These results are consistent with what was seen (Ramesh *et al*. 2009) [17].

Available Phosphorus

The available phosphorus ranged from 13.92 to 22.97 kg ha^{-1}, according to the data shown (Table 3). Results at onion harvest showed that treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had significantly higher available phosphorus (22.97 kg ha^{-1}), which was statistically comparable to available phosphorus (21.31 kg ha^{-1}) found in treatment (T_8) 75% RDF + PROM @ 1.0 t ha^{-1} and available phosphorus (20.68 kg ha^{-1}) found in treatment (T_6). In treatment (T_4), 100% RDF + Press mud compost @ 5 t ha^{-1} and 75% RDF + poultry manure @ 5 t ha^{-1} were noted. The absolute control treatment (T_1) has the significantly lowest available phosphorus (13.92 kg ha^{-1}).

Phosphate Rich Organic Manure (PROM) is a very important organic alternative indigenous source of chemical phosphatic fertilizers which is prepared by composting the rock phosphate with fresh cow-dung and during composting, a major part of Rock phosphate-P solubilizes for plant uptake. Application of 3.5 Mg ha^{-1} PROM along with recommended dose of N and K increases the P availability at 90 DAS and at harvesting of cluster bean crop. It also increases the relative agronomic efficiency, sustainability yield index and total uptake of P in grain and straw of cluster bean and wheat crops. To obtain maximum P use efficiency it should be applied at low rate (2.0 Mg ha^{-1}) in proper way. Its residual effect is also observed in succeeding wheat crop. Above results are in consonance with those of (Bairwa *et al*. 2021) [2].

Available Potassium

The available potassium ranged from 413 to 436 kg ha^{-1}, according to the data shown (Table 3). At onion harvest, the results showed that treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had significantly higher available potassium (436 kg ha^{-1}), which was statistically comparable to the available potassium (432 kg ha^{-1}) found in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. The treatment absolute control (T_1) had the noticeably lowest available potassium (413 kg ha^{-1}).

Because organic acids and inorganic acids created during the breakdown of organic manures aid in the release of mineral-bound insoluble potassium and also lessen potassium fixation, the available K was higher in the soil plot that received organic manures than in the control plot (Vasant *et al*. 2012). Gupta *et al*. have observed similar findings regarding soil available K (2020) [9].

Table 3: Effect of different organic sources on soil available nutrients after harvest of onion in Inceptisol.

Tr. No.	Treatments	Soil available nutrients (Kg ha^{-1})		
		N	P	K
T_1	Absolute control	135.70	13.92	413
T_2	GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1}and 20 t ha^{-1} FYM	196.13	22.97	436
T_3	100% RDF + Press mud compost @ 2.5 t ha^{-1}	183.30	20	427
T_4	100% RDF + Press mud compost @ 5 t ha^{-1}	192.12	20.15	432
T_5	75% RDF + Poultry manure @ 2.5 t ha^{-1}	172.07	17.27	428
T_6	75% RDF + Poultry manure @ 5 t ha^{-1}	178.24	20.68	430
T_7	75% RDF + PROM @ 0.5 t ha^{-1}	163.80	18.69	426
T_8	75% RDF + PROM @ 1.0 t ha^{-1}	166.78	21.31	431
	SE(m)±	1.93	0.94	2.05
	CD at 5%	5.88	2.87	6.21
	Initial	176.26	17.40	420

Table 4. Effect of different organic sources on DTPA extractable micronutrients in soil at harvest of onion in Inceptisol.

The values presented in Table 4 indicated that DTPA extractable Fe, Mn, Zn and Cu content of soil as influenced by incorporation of different organic sources with recommended dose of fertilizers to onion. Initially, the DTPA extractable Fe, Mn, Cu and Zn content were 4.87, 4.65, 0.72 and 2.63 mg kg^{-1}, respectively.

DTPA Extractable Fe

DTPA extractable Fe ranged from 4.71 to 4.99 mg kg^{-1}, according to the findings shown (Table 4). At onion harvest, the results showed that treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had significantly higher DTPA extractable Fe (4.99 mg kg^{-1}), which was statistically comparable to the DTPA extractable Fe (4.93 mg kg^{-1}) found in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. DTPA extractable Fe (4.71 mg kg^{-1}) was significantly lower in treatment (T_1) absolute control.

Increase in available Fe content of soil may be due to the conversion of ferric iron to ferrous iron. This increase in Fe may be due to different chemical and biochemical changes occurred as application of organic manures. The similar observations with respect to DTPA iron were also made by Dey *et al*. (2019) [6].

DTPA Extractable Mn

The data presented (Table 4.) revealed that DTPA extractable Mn was ranged from 4.82 to 5.92 mg kg^{-1}. The results at harvest of onion revealed that significantly higher DTPA extractable Mn (5.92 mg kg^{-1}) was observed in treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM and it was statistically at par with DTPA extractable Mn (5.85 mg kg^{-1}) recorded in (T4) treatment 100% RDF + Press mud compost @

5 t ha^{-1}. Significantly lowest DTPA extractable Mn (4.82 mg kg^{-1}) was recorded in treatment (T_1) absolute control.

This is might be attributed to the conversion of higher oxides of manganese to Mn^{2+} as a result of microbial and chemical reduction and certain organic acids released during decomposition of organic matter present in organic manures. The similar observations on DTPA Mn were made by Dey *et al.* (2019) [6].

DTPA Extractable Cu

DTPA extractable Cu ranged from 2.39 to 2.73 mg kg^{-1}, according to the findings shown (Table 4). At onion harvest, the results showed that treatment (T_2) GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} and 20 t ha^{-1} FYM had significantly higher DTPA extractable Cu (2.73 mg kg^{-1}), which was statistically comparable to the DTPA extractable Cu (2.68 mg kg^{-1}) found in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. DTPA extractable Cu was significantly lower in treatment (T_1) absolute control (2.39 mg kg^{-1}).

Cu availability increased as a result of the addition of organic manures. The addition of organic matter may have enhanced microbial proliferation, which in turn caused the release of chelating agents that stopped micronutrients from precipitating, oxidizing, and leaching, leading to a rise in the DTPA Cu level of the soil. Dey and colleagues (2019) [6] reported similar findings.

DTPA Extractable Zn

According to the data (Table 4), the range of DTPA extractable zinc was 0.68 to 0.85 mg kg^{-1}. At onion harvest, the results showed that treatment (T_2) GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha-1 and 20 t ha^{-1} FYM had significantly higher DTPA extractable Zn (0.85 mg kg^{-1}), which was statistically comparable to the DTPA extractable Zn (0.84 mg kg^{-1}) found in treatment (T_6) 75% RDF + Poultry manure @ 5 t ha^{-1} and Zn (0.82 mg kg^{-1}) found in treatment (T_5) 75% RDF + Poultry manure @ 2.5 t ha^{-1}. DTPA extractable zinc was significantly lower in treatment (T_1) absolute control (0.68 mg kg^{-1}).

The addition of organic manures may have contributed to the rise in zinc by causing a high rate of mineralization over time, which improved the soil's availability of zinc. Dey *et al.* (2019) [6] reported similar findings.

Table 4: Effect of different organic sources on DTPA extractable micronutrients in soil at harvest of onion in Inceptisol

Tr. No.	Treatments	Available micronutrients (mg kg^{-1})			
		Fe	Mn	Cu	Zn
T_1	Absolute control	4.71	4.82	2.39	0.68
T_2	GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} and 20 t ha^{-1} FYM	4.99	5.92	2.73	0.85
T_3	100% RDF + Press mud compost @ 2.5 t ha^{-1}	4.83	5.72	2.59	0.78
T_4	100% RDF + Press mud compost @ 5 t ha^{-1}	4.93	5.85	2.68	0.80
T_5	75% RDF + Poultry manure @ 2.5 t ha^{-1}	4.83	5.55	2.45	0.82
T_6	75% RDF + Poultry manure @ 5 t ha^{-1}	4.85	5.68	2.52	0.84
T_7	75% RDF + PROM @ 0.5 t ha^{-1}	4.80	5.54	2.42	0.76
T_8	75% RDF + PROM @ 1.0 t ha^{-1}	4.85	5.61	2.48	0.78
	SE(m)±	0.02	0.05	0.04	0.01
	CD at 5%	0.07	0.16	0.12	0.03
	Initial	4.87	4.65	2.63	0.72

Effect of different organic sources on total nutrient uptake by onion in Inceptisol

The application of different organic sources with recommended dose of fertilizer has significantly influenced uptake of nitrogen, phosphorus, and potassium by onion. The data presented in Table 5.

Total Nitrogen uptake

Total nitrogen intake ranged from 64.73 to 138.10 kg ha^{-1}, according to the results shown in Table 5. The findings showed that treatment (T_2) GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} and 20 t ha^{-1} FYM had a significantly higher total uptake of nitrogen (138.10 kg ha^{-1}), which was statistically comparable to the total uptake of nitrogen (125.86 kg ha^{-1}) observed in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}.

The increase in nitrogen intake may have resulted from the soil's maximum NPK availability as well as increased nutrient availability, which had a favourable impact on yield and eventually increased nitrogen uptake. Moinuddin and Kaleem also found similar outcomes (2019) [15].

Total Phosphorus uptake

The data presented (Table 5) revealed that total phosphorus uptake of onion was ranged from 6.21 to 17.38 kg ha^{-1}. The results revealed that significantly higher total uptake of phosphorus (17.38 kg ha^{-1}) was observed in treatment (T_2) GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} and 20 t ha^{-1} FYM and it was statistically at par with total uptake of phosphorus (15.73 kg ha^{-1}) recorded in (T_4) treatment 100% RDF + Press mud compost @ 5 t ha^{-1}. According to Ramphisa *et al.* (2020) [19], the adoption of alternative P sources as fertilizers depends on the effective exploitation of phosphorus (P) from organic wastes. Plant responses in terms of P absorption and growth must be predictable.

Total Potassium uptake

The total potassium intake of onions ranged from 54.66 to 121.12 kg ha^{-1}, according to the results shown in Table 5. The findings showed that treatment (T_2) GRDF @ 100:50:50 $N:P_2O_5:K_2O$ kg ha^{-1} and 20 t ha^{-1} FYM had a significantly higher total uptake of potassium (121.12 kg ha^{-1}), which was statistically comparable to the total uptake of potassium (108.86 kg ha^{-1}) observed in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}.

The highest in potassium uptake can be linked to the application of organic matter, which improved the soil's physical, chemical, and biological properties. This led to higher concentrations of potassium in the soil solution and in the exchangeable potassium complex, facilitating potassium ion uptake by the plants. The findings are consistent with those reported by Singh and Singh (2012) [23].

Table 5: Effect of different organic sources on total nutrient uptake by onion in Inceptisol

Tr. No.	Treatments	Total nutrient uptake (kg ha^{-1})		
		Nitrogen	Phosphorous	Potassium
T_1	Absolute control	64.73	6.21	54.66
T_2	GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM	138.10	17.38	121.12
T_3	100% RDF + Press mud compost @ 2.5 t ha^{-1}	105.15	11.86	88.98
T_4	100% RDF + Press mud compost @ 5 t ha^{-1}	125.86	15.73	108.86
T_5	75% RDF + Poultry manure @ 2.5 t ha^{-1}	102.41	11.75	86.92
T_6	75% RDF + Poultry manure @ 5 t ha^{-1}	123.76	15.26	105.13
T_7	75% RDF + PROM @ 0.5 t ha^{-1}	90.65	12.50	76.83
T_8	75% RDF + PROM @ 1.0 t ha^{-1}	96.15	13.87	80.47
	SE(m) ±	3.26	0.44	3.12
	CD at 5%	9.94	1.36	9.48

Effect of different organic sources on total micronutrient uptake of onion in Inceptisol

The application of different organic sources with recommended dose of fertilizer has significantly influenced uptake of Fe, Mn, Zn and Cu by onion. The data presented in Table 4.7 and depicted in Fig 4.5.

Total Fe uptake

Total Fe intake ranged from 936 to 1512 g ha^{-1}, according to the data shown (Table 6). The findings showed that treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had a significantly higher total uptake of Fe (1512 g ha^{-1}), which was statistically equivalent to the total uptake of Fe (1480 g ha^{-1}) observed in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. The increasing uptake of iron may be due to dry matter output and plant and seed concentrations of iron. Kumar *et al*. (2015) [12] observed similar findings.

Total Mn uptake

Total Mn intake ranged from 502 to 682 g ha^{-1}, according to the data shown (Table 6). The findings showed that treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had a considerably greater total uptake of Mn (682 g ha^{-1}), which was statistically equivalent to the total uptake of Mn (637 g ha^{-1}) observed in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. The concentration of manganese in plants and seeds may be the cause of the rising manganese absorption. The outcomes are comparable to those of Mortvedt's (1992) [16] tests.

Total Zn uptake

Total Zn intake ranged from 210 to 372 g ha^{-1}, according to the results shown (Table 6). The findings showed that treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had a considerably greater total uptake of Zn (372 g ha^{-1}), which was statistically equivalent to the total uptake of Zn (362 g ha^{-1}) observed in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}. The increased uptake of zinc may be caused by the concentration of zinc in seeds and plants. Jitao *et al*. (2015) [10] noted similar pattern.

Total Cu uptake

According to the findings (Table 4.7), the range of total Cu uptake was 80-126 g ha^{-1}. The findings showed that treatment (T_2) GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} and 20 t ha^{-1} FYM had a considerably greater total uptake of Cu (126 g ha^{-1}), which was statistically equivalent to the total uptake of Cu (122 g ha^{-1}) noted in treatment (T_4) 100% RDF + Press mud compost @ 5 t ha^{-1}.

Sankaran *et al*. (2019) [21] Reported that copper application increased total nutrient uptake (including Cu) in onion by improving root growth and membrane permeability. Application of 5 kg Cu ha^{-1} resulted in an uptake of 22.4 g ha^{-1}, with improved dry matter and chlorophyll content.

Table 6: Effect of different organic sources on total micronutrient uptake of onion in Inceptisol

Tr. No.	Treatments	Total micronutrient uptake (g ha^{-1})			
		Fe	Mn	Zn	Cu
T_1	Absolute control	936	502	210	80
T_2	GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1}and 20 t ha^{-1} FYM	1512	682	372	126
T_3	100% RDF + Press mud compost @ 2.5 t ha^{-1}	1391	630	326	112
T_4	100% RDF + Press mud compost @ 5 t ha^{-1}	1480	637	362	122
T_5	75% RDF + Poultry manure @ 2.5 t ha^{-1}	1210	595	310	106
T_6	75% RDF + Poultry manure @ 5 t ha^{-1}	1460	626	350	116
T_7	75% RDF + PROM @ 0.5 t ha^{-1}	1145	558	265	95
T_8	75% RDF + PROM @ 1.0 t ha^{-1}	1266	589	290	102
	SE(m) +	16.72	16.72	6.91	1.59
	CD at 5%	51.45	50.75	21.03	4.84

Conclusion

On the basis of experimental results, it was concluded that application of GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} along with FYM 20 t ha^{-1} to onion in Inceptisol had significant effect with respect to growth, yield contributing characters, yield of onion, total nutrient uptake, improvement in chemical and biological properties of soil and higher monetary returns of onion. Further, 100% RDF + Press mud compost @ 5 t ha^{-1} was found statistically at par with GRDF @ 100:50:50 N:P_2O_5:K_2O kg ha^{-1} + FYM 20 t ha^{-1} in term yield, total nutrient uptake, soil properties and monetary return of onion.

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