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ENRICHMENT OF FARM YARD MANURE THROUGH DISTILLERY BYPRODUCTS AND ITS EFFECT ON SOIL ORGANIC NITROGEN FRACTIONS IN VERTISOLS

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ABSTRACT

The field experiment was laid out to know the "Enrichment of Farm yard manure through distillery byproducts and its effect on soil organic fractions in vertisols" at Regional Agricultural Research Station (RARS), Vijayapura, during *rabi* seasons of 2020-21. The treatments were consisted; FYM @ 3t ha^{-1}; Pressmud@ 3 t ha^{-1}; Spentwash@ 5ml kg^{-1} of soil (1:10 dilution spentwash: water); 3 t ha^{-1} (Spentwash+FYM (1:3 mixing and curing for 25 days)); 3 t ha^{-1} (Spentwash+Pressmud (1:3 mixing and curing for 25 days)); and 100 % RDF along with above treatments and Absolute control. Nitrogen fraction are sensitive indicators of soil nitrogen pools which affect soil fertility and nutrient cycling. Nitrogen is one of the most important nutrients in natural and agricultural ecosystems. Approximately 90 percent of total soil N is composed of soil organic N, which plays an important role in N retention and transformation. Given the diverse origin/resources and complex composition of N components, organic nitrogen immobilization and mineralization have been neglected until the organic nitrogen fractions received considerable attention (Pansu *et al,* 2003). The result of the experiment revealed that the amino acid-N, Amino sugar-N, Ammonia-N, Hydrolysable-N, Total Hydrolysable unknown-N and Acid insoluble-N in terms of mg kg^{-1} were high when only with combination of spentwash with FYM and pressmud (both the combination were cured and mixed at 1:3 ratio (3 t ha^{-1}) for 25 days) as compared to without combinations were applied and similar trends were followed at 24, 48, 72 DAS and after harvest. Irrespective of organic manures and their combinations with spentwash, spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers invariably showed higher amino acid-N Amino sugar-N, Ammonia-N, Hydrolysable-N, Total Hydrolysable unknown-N and Acid insoluble-N in terms of mg kg^{-1} content over all other organic manures. Highest accumulation of amino acid-N in soil was observed where only spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers (61.8 %) applied followed by the combinations of FYM + spentwash (60 %) and pressmud + spentwash (58.6 %) in both at 3: 1 ratio for mixing and curing for 25 days over control after harvest of the crop.

***Key words*:** Farm Yard Manure, Distillery spentwash, Amino acid, Amino sugar, Ammonia

Introduction

Sorghum is known as Jowar and become a king of millets. Sorghum is the second most important crop in Karnataka after paddy. The total area under sorghum cultivation is 26 percent of the cultivated area. Sorghum being cultivated in during *Kharif* (area 3.20 lakh ha) and *rabi* (12.19 lakh ha) seasons. The average sorghum yield in India is 1064 kg ha^{-1}, which is substantially lower (1460 kg ha^{-1}) than the global average (Bhat *et al.,* 2023). In India sorghum is third most important cereal after rice and wheat. India has a largest share in (32.30 %) worlds sorghum area and ranks fifth in production. It is an important grain and forage crop of semi- arid regions due to its high adaptability and suitability to rain-fed low input agriculture

Sugarcane industry is the major agro-based industries making an appreciable contribution towards the socio-economic development of many countries. Sugar industry is involved in the processing of sugar. Additionally, this industry produced many byproducts such as bagasse, pressmud and distillery spent wash (DSW). Among these byproducts, DSW is produced in a large quantity and contains a huge organic load that makes it an important source as an agricultural input. DSW is the unwanted residual liquid waste generated during alcohol production, but pollution caused by it is one of the critical environmental issues. DSW contain large load of both organic and inorganic substances. Also, DSW contains sufficient number of macronutrients (N, P, K, Ca, Mg, S) and micronutrients (Zn, Cu, Fe, Mn), which in turn improves the growth and yield of crops.

Indian sugar industries have the potential to generate an average of 40697 million litters of spent wash., The spent wash generation depends on the type of fermentation, process, type of distillation process, distillation with or without reboiler, evaporation system molasses quality, yeast culture and recycle. (Source: All India distillery Association New Delhi). DSW is acidic in nature and have a brown color due to the pigment called "melanoidin" which is refractory in nature to the biological treatment. And it is used as a source of plant nutrients and organic matter for various agriculture crops. The composition of this effluent found very similar to that of farm yard manure. It has high organic matter of 31.50 per cent and has narrow C:N ratio of 15.75 (Rajkkannu and Manickam, 1996) so it helps in the faster decomposition of the organic manure and ready availability of the nutrients.

Spent wash is non-toxic, biodegradable, purely of plant origin and contains large quantities of soluble organic matter and plant nutrients, which the sugarcane plant has absorbed from the soil. The salts commonly present in this effluent are of K and SO_4 apart from N, P and micronutrients and all these elements are essential nutrients of plants. Therefore, its fertilizer potential can suitably be harnessed in agriculture by controlled land application following proper methods (pre-plant application or with proper dilution). Hence, utilization of distillery effluents in agriculture would save cost on fertilizers and facilitate reduction in pollution load (Baskar *et al*., 2003).

Materials and Methods

The experiment was conducted at Regional Agricultural Research Station, Vijayapur, comes under Northern Dry Zone of Karnataka (Zone 3), situated at 16° 49' N latitude and 75° 43' E longitude and at an altitude of 593.8 m above the mean sea level. The soil was low in organic carbon (4.28 g kg^{-1}) and available nitrogen (58.0 mg kg^{-1}) and medium in available P (5.8 mg kg^{-1}), while it was high in K (165.8 mg kg^{-1}) and sulphur (15.25 mg kg^{-1}). The exchangeable calcium, magnesium and sodium were 20.20, 13.2 and 5.34 c mol (p^+) kg^{-1}. The DTPA extractable micronutrient content *viz*., iron, manganese, zinc and copper were 2.85, 2.21, 0.52 and 1.85 mg kg^{-1}, respectively. The experiment comprising 11 treatments were laid out in randomized complete block design with three replications. The treatments were consisted of T_1: FYM @ 3t ha^{-1}; T_2: Pressmud @ 3 t ha^{-1}; T_3: Spentwash @ 5ml kg^{-1} of soil (1:10 dilution spentwash: water); T_4: 3 t ha^{-1} (Spentwash + FYM (1:3 mixing and curing for 25 days)); T_5: 3 t ha^{-1} (Spentwash + Pressmud (1:3 mixing and curing for 25 days)); T_6 - $T_{10,}$ consists 100 % RDF to above treatments and T_{11}: Absolute control. The distillery byproducts such as distillery spentwash and pressmud are taken from the Godavari Biorefinery Ltd. Sameeravadi, Mudhol (T), Bagalkot (D). DSW was mixed and cured with FYM and PM in 1:3 ratio for 25 days before application to the field. The characteristics of the FYM, press mud (PM), distillery spent wash (DSW) and their combination were presented in the Table 1.

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Soil organic nitrogen fractions

Different nitrogen fractions *viz*. acid insoluble-N, hydrolysable NH_3-N, amino acid-N, amino sugar-N, hydrolysable unknown-N and total hydrolysable-N were determined as per fractionation procedure given by (Stevenson, 1994). The details are given below:

Preparation of soil hydrolyzate: Twenty gram of soil was taken in distillation flask, to which add 2-3

Table 1: Characterization of FYM, press mud (PM), distillery spent wash (DSW), FYM+DSW, PM+DSW and DSW: Water=1:10 dilution.

Sl. No.	Particulars	FYM	Press mud	DSW	*FYM+DSW	*PM+DSW	*DSW: W =1:10
(I) Chemical Properties							
1.	pH	6.9	6.5	4.2	6.5	6.0	6.8
2.	EC dS m^{-1}	1.08	0.34	30.5	5.5	20.02	20.12
3.	OC (%)	22.25	35.08	35.5	28.12	33.20	22.21
4	C:N ratio.	15.1	19.44	15.8	28.12	17.47	21.77
(II) Major Nutrients (%)							
4.	Nitrogen	0.76	1.80	2.0	1.00	1.9	1.02
5.	Phosphorus	0.25	1.02	0.23	0.36	0.75	0.18
6.	Potassium	0.68	1.28	9.6	4.72	7.72	3.62
(III) Secondary Nutrients (%)							
7.	Calcium	0.82	10.25	2.05	1.25	8.02	1.08
8.	Magnesium	0.44	3.20	1.7	0.62	2.82	0.72
9.	Sulphur	0.28	6.99	3.2	1.32	5.42	0.52
10	Sodium	0.22	0.42	0.49	0.21	0.30	0.11
(IV) Micro Nutrients (mg kg^{-1})							
12	Zinc	58.30	119.4	17.00	55.12	100.0	6.01
13	Iron	1230.00	1202	54.14	1120.21	1025.3	21.2
14	Copper	18.10	77.4	0.9	16.21	69.2	0.51
15	Manganese	424.4	253.2	9.85	400.32	214.2	3.3
16	BOD (mg/L)			5500			
17	COD (mg/L)			15750			

* FYM+DSW: FYM + Distillery Spent wash (DSW) (3:1 ratio mixing of FYM and DSW and curing for 25 days)
* PM+DSW: Press mud (PM) + Distillery Spent wash (3:1 ratio mixing of PM and DSW and curing for 25 days)
*DSW: Water =1:10: Dilution with water

drops of octyl alcohol and 20 ml of 1M HCl were added before refluxing it for 6 hours on constant low heat (80 ^oC) on a Soxhlet by placing it on crushed ice. The final volume was made to 100 ml with distilled water without neutralizing the sample to avoid precipitation with 5 M NaOH. The hydrolyzate was then stored in freezer for determination of different forms of organic nitrogen. The neutralization of the hydrolyzate was done at the time of estimation of different organic nitrogen fractions on Kjeldahl's distillation unit.

Acid-Insoluble Nitrogen (Non-Hydrolyzable N) : This form of nitrogen is obtained by the difference between total soil N and total hydrolysable N.

Hydrolysable NH_3-Nb: After adding approximately 0.5 g of MgO to 10 ml of hydrolysate and calculated amount of 5 M NaOH for neutralization, the kjeldahl flask was connected to the steam distillation apparatus. The amount of ammonia-N was determined as described in Fig. 1.

Amino acid-N: In five ml of the hydrolysate, 1 ml of 0.5 M NaOH was added in 100 ml digestion flask and heated in boiling water bath until the volume of the sample was reduced to 2 to 3 ml after cooling the flask, 500 mg of citric acid and 100 mg of ninhydrin was added, and the flask was again placed in a vigorously boiling water bath. After cooling, 1.25 g of the phosphate-borate buffer mixture and 10 ml of the deionized water was added. Finally, after adding one ml more than the required amount of 5 M NaOH for neutralization, the flask was immediately connected to the steam distillation apparatus and quantified as described in Fig. 1. Amino sugar-N: This form of N was taken as the difference between the amounts of N recovered in ammonia + amino sugar-N and ammonia-N fractions. Hydrolysable unknown-N: This form of N was taken as the difference between total hydrolysate N and the N accounted for as (NH_3 + amino acid + amino sugar-N). Total hydrolysable-N: Five ml of hydrolyzate was placed in a 100 ml distillation flask. After adding 0.5 g of K_2SO_4 catalyst mixture and 2 ml of concentrated H_2SO_4, the flask was cautiously heated on a water bath until the mixture cleared. After digestion, the flask was allowed cooling and 10 ml of distilled water was added. Total hydrolyzate N was determined by steam distillation after adding 10 ml of 10 M NaOH and distillate was collected in 4 per cent boric acid indicator solution and its amount was determined by titration with 0.005 N H_2SO_4. Organic N fractions were determined by following the flow chart as mentioned in Fig. 1

The data collected from the experiment and laboratory analysis was subjected to statistical analysis as described by Gomez and Gomez (1984). The level of significance used in 'F' test was 0.05. A critical difference value was calculated wherever the 'F' test found to be significant.

Result and Discussion

Soil organic nitrogen (SON) plays a key role in terms of plant nutrition through direct and indirect effects on microbial activity and nutrient availability. Knowledge about the amounts and distributions of the organic forms of N, therefore should contribute to a better understanding of the soil productivity (Bremner 1965). Similarly, (Manjunath, 1999)reported that the soil profile of Northern Transition Zone of Karnataka contained total hydrolysable-N between 84.1 to 86.0 per cent of total N out of which 36.0 to 48.8 percent was amino acid-N, 39.0 to 53.0 per cent was amino sugar-N, hydrolysable NH^{4+}-N ranged from 14.1 to 25.5 per cent, unidentified N ranged from 13.0 to 56.0 per cent and acid insoluble-N ranged from 47.0 to 58.0 per cent of total N. Soil organic N fractions through organic manures are composed mainly unstable forms that are readily mineralizable and stable forms (acid insoluble-N, hydrolysable NH_3-N, amino acid-N, amino sugar-N, hydrolysable unknown-N and total hydrolysable-N) understanding effect of organic manures on the interplay between different form of organic N is a prerequisite for managing N inputs in a given soil.

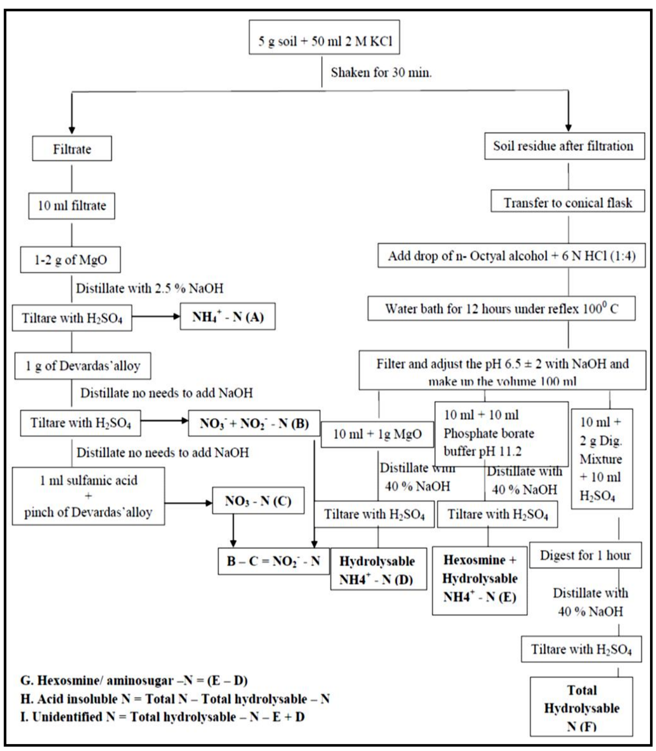

Fig. 1: Flow chart of the fractionation of soil organic nitrogen fractions was carried out by an adopted version of the procedure given by Page *et al.*, (1982).

Amino acid – N (mg kg^{-1})

The amino acid-N was high when only with combination of spentwash with FYM and pressmud (both the combination was cured and mixed at 1:3 ratio (3 t ha^{-1}) for 25 days) as compared to without combinations were applied and similar trends were followed at 24, 48, 72 DAS and after harvest. Irrespective of organic manures and their combinations with spentwash, spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers invariably showed higher amino acid-N content over all other organic manures. Highest accumulation of amino acid-N in soil was observed where only spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers (61.8 %) applied followed by the combinations of FYM + spentwash (60 %) and pressmud + spentwash (58.6 %) in both at 3: 1 ratio for mixing and curing for 25 days over control after harvest of the crop.

Nitrogen occurs in the environment in organic and inorganic forms. The organic form is a major component of soil organic matter and may account for greater than 95 percent of the total N in most surface soils. It is estimated that about 20-40 per cent of the total N in soils is present in the form of amino acids, but only a small portion of the amino acids is present in a "free" state; the major portion is bound to soil organic matter (Bremner, 1951), The bound amino acids are most likely present in the form of proteins and/or peptides associated with clay-organic matter complexes. Amino acids are essential components of both organic manures and their humic substances, the hypothesis has been formulated that the protein and amino acid turnover in the soil has a decisive influence on the level of soil organic matter (Scheller, 2001). The principal forms of organic N in soils are amino acids and amino sugars that may become available to plants from microbial mineralization to NH_4^+ and the subsequent nitrification of NH_4^+ to NO_2^- and NO_3. With new and improved analytical techniques, a significant portion of the soil organic N can be quantitatively separated into various amino acids. Litle information is available, however, on the distribution of amino acid N of organic matter of soils under different management systems.

Amino sugar-N (mg kg^{-1})

The amino sugar-N was high when only with combination of spentwash with FYM and pressmud (both the combination were cured and mixed at 1:3 ratio (3 t ha^{-1}) for 25 days) as compared to without combinations were applied and similar trends were followed at 24, 48, 72 DAS and after harvest. Irrespective of organic

Table 2: Effect of FYM and distillery by-products on nitrogen fractions.

Treatments	Amino acid-N (mg kg^{-1})				Amino sugar-N (mg kg^{-1})				Ammonia-N (mg kg^{-1})			
	24 DAS	48 DAS	72 DAS	After harvest	24 DAS	48 DAS	72 DAS	After harvest	24 DAS	48 DAS	72 DAS	After harvest
T_1: FYM @ 3t ha^{-1}	53.6	60.4	55.0	49.7	16.1	19.1	18.7	13.4	40.9	44.6	41.4	36.5
T_2: Press mud @ 3 t ha^{-1}	46.3	53.5	50.2	42.3	15.7	17.7	17.2	11.5	34.7	40.4	34.9	33.1
T_3: Spent wash @ 5ml kg^{-1} of soil *	68.6	87.9	85.1	53.8	26.6	30.8	27.8	23.2	54.7	73.1	58.6	49.0
T_4: 3 t ha^{-1} (Spentwash + FYM)**	64.0	71.7	71.1	52.7	22.5	30.3	24.6	18.1	50.1	66.6	55.1	43.1
T_5: 3 t ha^{-1} (Spentwash+Pressmud)**	57.0	63.1	57.6	50.7	18.1	22.8	20.4	13.9	40.8	50.9	41.7	38.1
T_6: T_1 + 100 % RDF	58.3	63.8	63.1	52.4	17.6	22.5	20.4	15.3	44.0	48.7	44.4	40.2
T_7: T_2 + 100 % RDF	50.4	59.8	53.0	47.8	16.7	21.2	18.5	12.8	38.9	44.4	39.9	35.9
T_8: T_3 + 100 % RDF	71.8	92.4	87.9	55.5	27.8	36.7	32.4	25.5	57.4	75.1	60.7	51.7
T_9: T_4 + 100 % RDF	65.6	75.8	73.1	53.0	23.5	30.4	26.6	21.1	51.8	70.1	56	45.1
T_{10}: T_5 + 100 % RDF	60.0	66.3	60.2	51.2	19.1	24.1	23.4	15.4	43.7	52.5	44.6	40.1
T_{11}: Absolute control	25.2	31.1	28.9	21.2	11.5	15.0	13.2	10.3	17.4	25.6	21.4	14.0
CD @ 5%	8.7	7.5	4.4	7.7	4.2	6.8	6.9	3.7	6.8	5.92	4.8	7.8
S.Em. ±	2.9	2.5	1.5	2.6	1.2	2.3	2.3	1.3	2.3	2.03	1.6	2.6

*1:10: spentwash: water dilution **1:3 ratio for mixing and curing for 25 days

manures and their combinations with spentwash, spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of NP fertilizers invariably showed higher amino sugar-N content over all other organic manures. Highest accumulation of amino acid-N in soil was observed where only spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers (59.6%) applied followed by the combinations of FYM + spentwash (51.2%) and pressmud + spentwash (33.1%) in both at 3:1 ratio for mixing and curing for 25 days over control after harvest of the crop.

The most prominent amino sugars detected in soils are D-glucosamine and D-galactosamine, with the former occurring in greater amounts (Stevenson 1994). Amino sugars represent a major constituent of microbial cell walls (*e.g.*, chitin, peptidoglycan) and they are present in large quantities in soil organic matter. Application of NP fertilizers in conjunction with organic manures resulted in significant increase in amino sugar-N in soil over the control or no application. Organic N is associated with the more resistant pool of organic fractions and constitutes a major portion of protein and other complex molecules. A high amount is present as amine groups ($-NH_2$) in amino acids and amino sugars are bonded to carbon in ring and chain structures. Soil organic N has been difficult to quantify in terms of plant availability (Carski and Sparks, 1987), but access to advanced analytical techniques has enabled separations of organic N into broader fractions (*e.g.*, humic and fulvic acids) and individual amino acids. Amino sugars are one of important indicators to microbial, turnover of biomass and organic manures and their heterogeneity so that large amounts of amino sugars are stabilized in soil. These results support by (Lydia *et al.*, 2012) that amino sugars are important microbial C and N sources and drivers of C and N cycling in soils. The results corroborate the finding of (Glaser *et al.*, 2004; Liang *et al.*, 2007; Wang *et al.*, 2010)

Ammonia-N (mg kg^{-1})

The ammonia-N was high when only with combination of spentwash with FYM and pressmud (both the combination was cured and mixed at 1:3 ratio (3 t ha^{-1}) for 25 days) as compared to without combinations were applied and similar trends were followed at 24, 48, 72 DAS and after harvest. Irrespective of organic manures and their combinations with spentwash, spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of NP fertilizers invariably showed higher ammonia-N content over all other organic manures. Highest accumulation of ammonia-N in soil was observed where only spentwash at 5ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers (73%) applied followed by the combinations of FYM + spentwash (69%) and pressmud + spentwash (65%) in both at 3:1 ratio for mixing and curing for 25 days over control after harvest of the crop.

Ammonia-N (NH_4-N) content in soil differed with

Table 3: Effect of FYM and distillery by-products on soil nitrogen fractions.

Treatments	Hydrolysable-N (mg kg^{-1})				Total hydrolysalbe unkonw-N (mg kg^{-1})				Acid insoluble-N (mg kg^{-1})			
	24 DAS	48 DAS	72 DAS	After harvest	24 DAS	48 DAS	72 DAS	After harvest	24 DAS	48 DAS	72 DAS	After harvest
T_1: FYM @ 3t ha^{-1}	161.2	173.2	162.3	145.1	45.9	55.8	51.0	41.1	47.6	57.7	50.8	45.6
T_2: Press mud @ 3 t ha^{-1}	143.5	154.8	145.7	129.3	40.7	51.0	45.9	36.8	42.1	51.8	45.3	41.8
T_3: Spent wash @ 5ml kg^{-1} of soil *	260.6	283.9	263.2	200.3	68.1	83.2	68.3	58.7	54.5	71.8	60.8	53.8
T_4: 3 t ha^{-1} (Spentwash + FYM)**	212.4	264.0	226.1	196.8	59.1	72.2	64.6	53.4	51.7	65.7	55.5	50.2
T_5: 3 t ha^{-1} (Spentwash+Pressmud)**	162.8	181.7	167.3	145.5	47.1	61.1	53.1	44.0	48.1	58.6	49.6	42.8
T_6: T_1 + 100 % RDF	167.6	180.8	170.6	156.8	47.4	58.9	55.3	45.2	51.2	61.1	53.4	48.0
T_7: T_2 + 100 % RDF	150.5	166.2	153.6	134.1	44.2	54.2	48.6	39.6	46.1	57.3	51.6	45.7
T_8: T_3 + 100 % RDF	267.2	291.5	274.1	208.5	71.9	88.1	73.2	61.6	56.0	73.8	64.3	55.0
T_9: T_4 + 100 % RDF	222.2	266.7	235.9	201.0	63.9	75.7	66.4	54.1	53.4	70.1	57.9	53.5
T_{10}: T_5 + 100 % RDF	172.0	185.7	173.1	153.6	53.0	64.1	56.3	48.4	52.7	64.5	54.5	48.9
T_{11}: Absolute control	82.2	94.1	92.5	69.2	23.4	30.1	28.6	21.0	19.3	25.1	23.5	19.1
CD @ 5%	9.2	12.3	11.8	15.7	7.9	9.0	8.5	9.2	6.7	6.4	7.0	8.3
S.Em. ±	3.1	4.1	4.0	5.3	2.7	3.0	2.9	3.1	2.2	2.1	2.4	2.8

*1:10: spentwash: water dilution **1:3 ratio for mixing and curing for 25 days

the application of DSW alone or in combination with FYM and PM or with the chemical fertilizer at all the stages of *rabi* sorghum. Among the treatments NH_4-N content of soil increases with the crop growth stages and its content were maximum at 48 DAS and decreased at harvest of the crop it may be because of grand growth period of the crop. Application organic manures (DSW, FYM and PM) alone or in combination or in combination with chemical fertilizers recorded highest NH_4-N content in soil as compared to control it might be due to the enhanced mineralization rate of DSW, FYM and PM to release the nitrogen fraction of organic manures. Addition of DSW at 5 ml kg^{-1} soil with NP fertilizers shows higher content of NH_4-N in soil as compared to other organic manures (FYM and PM) it may be due to the mineralization of N was higher with the addition of DSW. Combined application of organic manures (DSW, FYM and PM) with chemical fertilizers increases the NH_4-N content in soil, which was ascribed to increased microbial activity and resultant enhanced in mineralization process with a reduction in leaching loss. (Appel and Mengel, 1992) found that the soil organic N pool does not indicate that the fraction is not turning over and external supplying N to plants. Our results also indicated that organic manures amendment applied in conjunction with NP fertilizers increases ammonia-N content in soil. The (lignin + polyphenols) and N ratio had the highest influence on release of N fractions. Addition of organic manures increases the lignin and polyphenols into soil and it helps to substrates for soil microbes. The transition from N immobilization in the form to organic N fractions is regulated through the soil microbial biomass by the ratio of available C to N substrates (Handayanto *et al.,* 1995).

Hydrolysable-N (mg kg^{-1})

The hydrolysable-N was high when only with combination of spentwash with FYM and pressmud both at 1:3 ratio for mixing and curing for 25 days as compared to without combinations were applied and similar trends were followed at 24, 48, 72 DAS and after harvest. Irrespective of organic manures and their combinations with spentwash, spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers invariably showed higher hydrolysable-N content over all other organic manures. Highest accumulation of hydrolysable-N in soil was observed where only spentwash at 5ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers (66.8%) applied followed by the combinations of FYM + spentwash (65.5%) and pressmud + spentwash (55%) in both at 3:1 ratio for mixing and curing for 25 days over control after harvest of the crop.

Hydrolysable organic N in soil solution is found in mobile water flowing through pores, cracks and channels, and in immobile water within pores in soil peds. The role of hydrolysable organic N in N cycling and there is a blockage of N losses processes from soil and subsequent ammonification and nitrification of organic N in soil N supply to the crops. A significant increase in hydrolysable-

N was observed with the application of NP fertilizers in conjunction with organic manures. (Kher and Minhas, 1992) stated that the hydrolysable-N which accounted for 75.8 to 82.8 percent of the total N content of soil was constituted by 32.7 percent of amino acid-N and 30.4 per cent of hydrolysable NH_4^+ -N in the long-term fertilizer plots after 13 years of cropping on an acid soil of Palampur, reported that most of the added urea N was transformed into hydrolysable organic N fractions which were the major sources of plant available N. The results are in line with the earlier findings reported by (Prieto *et al*., 1997). A significant increase in exchangeable $NH4^+$-N and hydrolysable $NH4^+$-N fractions with increasing levels of N applied either as chemical fertilizer alone or along with organic manure was also reported by (Umesh *et al*., 2014). The continuous addition of organic manures along with fertilizers may stimulate mineralization and immobilization of plant nutrients (Srivastava and Lal, 1998) thereby affecting their amount in different organic and inorganic forms in soil. Hydrolysable organic N from organic manures latchets dominantly composed of decay-resistant organic acids formed by partial decomposition of plant, microbial and animal tissues (Currie *et al*., 1996). Hydrolysable -N increases with the organic manure application (DSW, FYM and PM) this might be due to the addition of organic manures and also reported the existence of a metastable equilibrium between immobilization and mineralization processes going on in individual fraction with a clear perceptible shift towards greater immobilization and consequent accumulation of N. The results support the views that increasing organic N residues ultimately increase the amount of hydrolyzable amino compounds in soils (Allison, 1973; Campbell *et al*., 1991; Gupta and Reuszer, 1967; Stevenson, 1982).

Total Hydrolysable unknown-N (mg kg^{-1})

The total hydrolysable unknow-N was high when only with combination of spentwash with FYM and pressmud both at 1:3 ratio for mixing and curing for 25 days as compared to without combinations were applied and similar trends were followed at 24, 48, 72 DAS and after harvest. Irrespective of organic manures and their combinations with spentwash, spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers invariably showed higher total hydrolysable unknow-N content over all other organic manures. Highest accumulation of total hydrolysable unknow-N in soil was observed where only spentwash at 5ml kg^{-1}of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers (66%) applied followed by the combinations of FYM + spentwash (61.2%) and pressmud + spentwash (56.6%) in both at 3:1 ratio for mixing and curing for 25 days over control after harvest of the crop.

Acid insoluble-N (mg kg^{-1})

The acid insoluble-N was high when only with combination of spentwash with FYM and pressmud both at 1:3 ratio for mixing and curing for 25 days as compared to without combinations were applied and similar trends were followed at 24, 48, 72 DAS and after harvest.Irrespective of organic manures and their combinations with spentwash, spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers invariably showed higher acid insoluble-N content over all other organic manures. Highest accumulation of acid insoluble-N in soil was observed where only spentwash at 5ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers (65.2%) applied followed by the combinations of FYM + spentwash (64.3%) and pressmud + spentwash (61%) in both at 3:1 ratio for mixing and curing for 25 days over control after harvest of the crop.

Conclusion

The amino acid-N, Amino sugar-N, Ammonia-N, Hydrolysable-N, Total Hydrolysable unknown-N and Acid insoluble-N in terms of mg kg^{-1} were high when spentwash at 5 ml kg^{-1} of soil (1:10 spentwash and water dilution) applied in conjunction with recommended dose of fertilizers over control after harvest of the crop, followed by the combinations of FYM + spentwash and pressmud + spentwash in both at 3:1 ratio for mixing and curing for 25 days.

Reference

Allison, F.E. (1973). Soil organic matter and its role in crop production. Developments in soil science, 3. Elsevier Sci. Publ. Co., Amsterdam.

Appel, T. and Mengel K. (1992). Nitrogen uptake of cereals grown on sandy soils as related to nitrogen fertilizer application and soil nitrogen fractions obtained by electro ultrafiltration (EUF) and $CaCl_2$ extraction. *Europen. J. Aron.*, **1**, 1-9.

Baskar, M., Kayalvizhi C. and Subashchandrabose M. (2003). Eco-friendly utilization of distillery effluent in agriculture. *Agric. Rev*., **24(1)**, 16-30.

Bhat, B.V., Hariprasanna K. and Ratnavathi C.V. (2023). Global and Indian scenario of millets. International Year of Millets, **73(1)**, 16-18.

Bremner, J.M. (1951). A review of recent work on soil organic matter. *Int. J. Soil Sci*., **2**, 67-82.

Bremner, J.M. (1965). Organic nitrogen in soils, *In* W.V. Batholomew and F.E. Clark (ed.) Soil nitrogen. ASA, Madison, WI: 93-149

Campbell, C.A., Schnitzer M., Lafond G.P., Zentner R.P. and Knipfel J.E. (1991). Thirty-year crop rotations and management practices effects on soil and amino nitrogen. *Soil Sci. Soc. Am. J.,* **55**, 739-745.

Carski, T.H. and Sparks D.L. (1987). Differentiation of soil nitrogen fractions using a kinetic approach. *Soil Sci. Soc. Am. J.,* **51**, 314-317.

Currie, W.S., Aber J.D., McDowell W.H., Boone R.D. and Magill A.H. (1996). Vertical transport of dissolved organic C and N under long-term N amendments in pine and hardwood forests. *Biogeochemistry,* **35**, 471-505.

Glaser, B., Turrion M.B. and Alef K. (2004). Amino sugars and muramic acid e biomarkers for soil microbial community structure analysis. *Soil Biol. Biochem*., **36**, 399-407.

Gomez, K.A. and Gomez A.A. (1984). Statistical procedure for agriculture research, 2[nd] edition. A willey inter-science publication, New York (USA), 220-240.

Gupta, U.C. and Reuszer H.W. (1967). Effect of plant species on the amino acid content and nitrification of soil organic matter. *Soil Sci.,* **104**, 395-400.

Handayanto, E., Cadisch G. and Giller K.E. (1995). Manipulation of quality and mineralization of tropical legume tree pruning's by varying nitrogen supply. *Plant Soil,* **176**, 149-160.

Kher and Minhas (1992). Long term effect of liming, manuring and cropping on different hydrolysable N forms in an acid Alfisol. *Journal of the Indian Society of Soil Science,* **40**, 840-842.

Liang, C., Zhang X.D., Rubert K.F. and Balser T.C. (2007). Effect of plant materials on microbial transformation of amino sugars in three soil microcosms. *Biol. Fertl. Soil*., **43**, 631-639.

Lydia, H.Z., Laurel A.K. and David D.M. (2012). The importance of amino sugar turnover to C and N cycling in organic horizons of old-growth Douglas-fir Forest soils colonized by ectomycorrhizal mats. *Biogeochem*., **23**, 123-133.

Manjunath, L. (1999). Nitrogen fraction in soils of different agroclimatic zones of Karnataka. M.Sc. (Agri.) Thesis, University of Agricultural Sciences, Bangalore, Karnataka, India

Pansu, M. and Thuries L. (2003). Kinetics of C and N mineralization, N immobilization and N volatilization of organic inputs in soil. *Soil Biol Biochem,* **35**, 37-48.

Prieto, G.S.J., Jocteur-Monrozier L., Hetier J.M. and Carballas T. (1997). Changes in the soil organic N fractions of tropical Alfisol fertilized with ^{15}N-urea and cropped to maize or pasture. Plant and Soil, **195**, 151-160.

Rajkkannu, K. and Manickam T.S. (1996). Use of distillery and Sugar Industry Wastes in Agriculture. 28th & 29th October, 1996. AC & RI, Trichy. 23-29.

Scheller, E. (2001). Amino acids in dew-origin and seasonal variation. *Atmospheric Environment,* **35(12)**, 2179-2192.

Srivastava, S.C. and Lal J.P. (1998). Nitrogen mineralization in variously treated dry land tropical aerable soil. *Journal of the Indian Society of Soil Science,* **46**, 9-14.

Stevenson, F.J. (1982). *Organic forms of soil nitrogen*. In: Stevenson, F.J. (Ed.), Nitrogen in Agricultural Soils. *ASA-SSSA*. 67-122.

Stevenson, F.J. (1994). *Humus Chemistry: Genesis, Composition and Reactions*. John Wiley and Sons, New York.

Stevenson, F.J. (1994). Nitrogen organic forms. In: Methods of Soil Analysis. Part 3. Chemical methods. Agron. Monogr. No. 9. A.L. Page (Eds.), Book Series, Madison, W.I. 625-642.

Umesh, U.N., Kumar V., Prasad R.K., Singh K.D.N. and Singh A.P. (2014). Effect of integrated use of inorganic and organic materials on the distribution of different forms of nitrogen in soil and their influence on sugarcane yield and nutrient uptake. *Journal of the Indian Society of Soil Science,* **62**, 209-215.

Wang, J.S., Stewart J.R., Khan S.A. and Dawson J.O. (2010). Elevated amino sugar nitrogen concentrations in soils: a potential method for assessing N fertility enhancement by actinorhizal plants. *Symbiosis,* **50**, 71-76.