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Forage Yield and Quality of Egyptian Clover (*Trifolium alexandrinum* L.) Fertilized with Biowastes under Calcareous Soil Conditions

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Abstract: Field trials were conducted in the winter seasons of 2017/18 and 2018/19 in calcareous soil to study the effect of composted sludge and farmyard manure alone or integrated with reduced N level on forage yield, nutrient content and berseem phytotoxicity with heavy metal and soil properties. Additional target of the trials was to provide more detailed information on the fertilizer value of composted sludge, as the availability of nutrients tends to be restricted under calcareous soils. The results showed that the chemical analysis of the composted sludge complied with the Egyptian code of practice for sludge reuse. Heavy metals addition were too small and could not pose any threat according to the alkaline nature of the soil and high pH values. In general, composted sludge significantly increased berseem yield by almost 20% compared with FYM on a volumetric addition basis. The application of inorganic N increased crop yields on average with both manure types by approximately 10 %. Indeed, the results showed that mineral N significantly increased crop yield when integrated with 5 and 10 m^3 fd^{-1} rates of composted sludge and manure application, but there was no significant effect of fertilizer at the highest rate of manure input. Forage production was also significantly raised with increasing rate of manure application. Fertilizer replacement value of N showed that the composted sludge had N equivalency value of approximately 40% of the mineral fertilizer. Overall, crop concentrations of N, P, K and Mn were below their normal ranges and Zn and Cu were at less than half the concentrations that regarded as necessary for optimum production. No significant effects due to the treatments after cumulative applications of 40 m^3 fd^{-1} of composted sludge and FYM on soil properties and there were no apparent trends in the data and heavy metal concentrations were very small. Tissue concentrations of zinc and copper were below recommended levels in berseem. It could be concluded from this study that heavy metal concentrations were very small and are of no concern to crop quality, phytotoxicity or animal and human dietary intake and no detectable effects of composted sludge on soil quality.

Key words: Biowastes · Clover · Yield · Phytotoxicity · Heavy metals · N replacement value

INTRODUCTION

The calcareous soils area in Egypt about 8% of the total area [1] and most of them are concentrated in the North Western Coastal region of Egypt. Increasing availability of these nutrients is one of the important objectives in plant nutrition [2]. Soil fertility stress under calcareous soils was found to be an important factor for the lower berseem yield in Bangladesh. Supplying optimal quantities of mineral nutrients of macro and micronutrients to growing crops is one way to improve crop yields [3]. According to several authors the improvement of fertility and quality of soil requires the input of organic materials [4-6]. Low soil fertility is one of the obstacles to mention and sustain agricultural management [7, 8]. However, the use of appropriate and conjunctive use of application of suitable nutrients through organic and inorganic solely or in combination

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can provide the solution to the problems of inorganic fertilizers and deterioration effect of soil fertility and productivity [9]. Abd El Lateef *et al*. [10] reported that due to the difficulty of expansion in the old lands and the competition with different strategic crops or irrigation system adopted in such soils (flood) which increase water consumption, it is necessary to find additional areas for horizontal expansion to grow berseem under rationalized use of water. One of the soil types candidates for this purpose is the calcareous soils where pH is high and $CaCO_3$ is dominated, plants suffer from low availability of P and K and would cause problems more serious than their deficiencies. The same authors reported that the adverse effects and fertility stress of calcareous soils on cotton could be mitigated through integrated use of macronutrients and organic substances which reflected on crop yield and improving nutrient status especially micronutrients. The use of appropriate and conjunctive use of application of suitable nutrients through organic and inorganic solely or in combination can provide the solution to the problems of deterioration effect of soil fertility and productivity [11].

Egyptian clover or berseem (*Trifolium alexandrinum* L.) is an annual cultivated mostly in irrigated sub-tropical regions as leguminous crop. It is an important winter crop in Egypt, where it may have been cultivated since ancient times, [12, 13] and was introduced to many countries like India in the early nineteenth century and in the United States and Europe. Berseem is capable of producing up to 8 tons of forage in a single growing season [11].

Using biowastes like composted sludge is proven to be beneficial to field crops [14]. Under calcareous soil conditions, it was found that composted sludge supplied cotton with significant N, P and K and micronutrient quantities through composted sludge while heavy metal metals Ni, Cd, Pb, Cr and Co additions were too small and could not pose any threat to crops [10]. Bughdady [15] concluded that, the mixture of forage crops and using organic manure at 20 m^3 fd^{-1}, with three cuts are recommended annually for high forage fresh, dry weights, straw yield and protein% under semi-arid conditions at the New Valley, Egypt.

Therefore, the objective of this study was to study the effect of composted sludge and farmyard manure levels alone or combined with reduced N level on forage yield, nutrient and heavy metal content in berseem and soil in order to provide more detailed information on phytotoxicity with heavy metals and the N replacement value of composted sludge under such calcareous soils.

MATERIALS AND METHODS

Two field trials were conducted in the winter seasons of 2017/18 and 2018/19 to study the effect of integrated application of composted sludge and farmyard manure with reduced N level on forage yield, nutrient and phytotoxicity of heavy metal in berseem under calcareous soils. The experiments were conducted in on a private farm in Bagdad village Nubaria, Alexandria governorate (28 km Alex-Cairo desert road). The soil under the present investigation was characterized by high calcium carbonate and low fertility status that could influence crop growth. The chemical analysis of the soils are presented in Table (1).

The experiment included 16 treatments which were the combinations of two organic manures types (composted sludge (CS) and farm yard manure (FYM) at three rates *i.e.*; 5, 10 and 20 m^3 fd^{-1} with or without reduced N level (45 kg N fd^{-1}) as well as 4 additional nitrogen fertilizer rates 0, 30, 45 and 60 kg N fd^{-1} were used to estimate fertilizer replacement value relationship. The experimental design was Split-Split plot design with 4 replicates. The organic manure types occupied the main plots while application rates and N levels were in the sub plots and N fertilizer levels applied to the sub–sub plots. The composted sludge and farmyard manure analyses used in the trial are presented in Table (2).

The experimental area was ploughed twice, ridged and divided to experimental unites each of 21 m^2. Organic manures rates were applied after manually calibration on a volumetric basis to the assigned plots. In order to secure homogenous incorporation with the soil surface layer, a rotary cultivator was used. Multicutting berseem, Meskawy (*Trifolium alexandrinum* L.) variety (Sakha 4) seeds were sown in the experimental plots on 22th and 30th November in 2017/2018 and 2018/2019 seasons, respectively. Sowing was done by hand and Seed rate was 35 kg fd^{-1}, phosphatic fertilizer was applied as superphosphate 15.5% P_2O_5 at 31.5 kg fd^{-1} during seed bed preparation while nitrogen fertilizer levels were applied in two equal doses at 21 and before the 2nd cut as well as a common application of potassic fertilizer was applied at 24 kg K_2O fd^{-1} before the 1st cut. Irrigation was carried out as followed in the district twice a week by sprinkler irrigation. Weeds were controlled by hand pulling after 20 and 34 days from sowing. The 1st and the 2nd cuts of berseem were taken on 31 January and 12 March 2018 and 2 February and 16 March 2019, respectively. Berseem plants were left for seed yield in the

Table 1: Chemical analysis of the experimental soil

				Total concentration (mg kg^{-1})											
pH	EC (dS m^{-1})	OM (%)	$CaCO_3$ (%)	N	P	K	Fe	Mn	Zn	Cu	Cr	Co	Cd	Pb	Ni
8.2	0.38	1.09	31.5	1540	33	3132	20131	219.2	30.4	9.8	7.3	44.5	1.3	4.2	16.5

subsequent period and harvested at the end of May in both seasons. Fresh and dry weights of the 1st and 2nd cuts were determined from two central rows of each plot by quadrat. Berseem leaf samples were taken from the 2nd cut in both seasons and analysed for macro, micronutrients and heavy metals.

The chemical analyses of soil, manure and leaves were carried out according to the methods described by [16, 17]. The data were statistically processed using software package (MSTAT-C) [18]. After testing the homogeneity of the error according to Bartlett's test, combined analysis for both seasons were done. Duncan' s Multiple Range Test was adopted for means comparison.

RESULTS AND DISCUSSION

Manure Chartrestics: The chemical analysis of the composted sludge is given in Table (2) and comply with the Egyptian code of practice for sludge reuse (Mistrial Decree 222/2005). The data show that 14.7, 4.2 and 3.5 kg m^{-3} of N, P and K were applied through composted sludge application to berseem, respectively while the corresponding values for FYM were 12.6, 2.8 and 7.7 kg m^{-3} of N, P and K, respectively. Micronutrient addition were 7.0 kg of Fe as well as 140, 119 and 98 g m^{-3} of Mn, Zn and Cu, while the corresponding values for FYM were 5.6 kg of Fe as well as 7.0 kg of Fe as well as 112, 91 and 58.1 g m^{-3} of Mn, Zn and Cu, respectively. Heavy metals addition were too small and could not pose any threat according to the alkaline nature of the soil and high pH values. These results are in accordance with the results of Abd El Lateef *et al*. [10] who reported that sludge has improved the nutrient content of cotton, including that of the trace elements, which are often deficient in crops and the human diet in Egypt. Increases in the heavy metal content of plants were negligible due to the calcareous soil conditions of Egypt.

Yield: The yield data for berseem in were statistically scrutinised and significant main effects were detected. Significant interactions between mineral fertilizer and rate of manure addition and among the rate of manure application and type were also apparent. The mean yield data were statistically compared in Table (3). The interaction means are presented in Table (4). The main effect means show that, in general, composted sludge significantly increased berseem yield by almost 20 % compared with FYM on a volumetric addition basis. The application of inorganic N increased crop yields on average with both manure types by approximately 10 %. However, the significant interaction detected between fertilizer use and rate of manure addition (Table 4) indicated that the response to fertilizer varied depending on the rate of manure application. Indeed, the results show that mineral N significantly increased crop yield at the 5 and 10 m^3 fd^{-1} rates of composted sludge and manure application, but there was no significant effect of fertilizer at the highest rate of manure input. Forage production was also significantly raised with increasing rate of manure application. However, more detailed scrutiny of the data (Table 4) and the interaction between manure type and application rate, showed that this was principally attributable to composted sludge since no significant relationship was apparent between crop yield and the rate of FYM. Protein yield varied according to manure level alone or combined with mineral N at 45 kg fd^{-1} (Table 4 and Fig. 1). Similar results were obtained by Bughdady [15] and Abd El-Lateef *et al*. [19], they obtained an increase of 25% in overall crop performance due to compost application from an average of yield where the compost applied at 24 m^3 ha^{-1}.

Fertilizer Replacement Value: Simple linear regression models of the form y = a + bx were fitted to the yield data for plots receiving mineral N fertilizer and sludge compost (without mineral N), (Fig. 2). A comparison of the regression coefficients of the yield response to the rate of N addition in fertilizer and compost showed that the composted product had N equivalency value of approximately 40 % (Table 5). This value is entirely consistent with the fertilizer value determined for compost in the other field trials reported by [20] who showed that the clearest picture of N availability for the different manures was obtained for the first crop of the rotation (wheat, winter season). This gave an N equivalency for digested sludge of 50 %. The results also show that the apparent N equivalency of sludge increased as the trial

Table 2: The chemical analysis of the composted sludge (CS) and farmyard manure (FYM) (Means data of 2017/18 - 2018/19 seasons)

						Total content (% ds)				Total content (mg kg^{-1} ds)							
Manure	Ds (%)	Vs (% ds)	OM (% ds)	pH	EC (ds m^{-1})	N	P	K	Fe	Mn	Zn	Cu	Ni	Cd	Pb	Cr	Co
CS	84.3	50.1	33.2	6.7	2.2	2.1	0.6	0.5	1.0	200	170	140	45	4.5	34	30	7
FYM	83.3	45.4	26.1	6.8	3.3	1.8	0.4	1.1	0.8	160	130	83	25	4.2	26	16	8
Mistrial Decree 222/2005*									-	-	>2800	>1500	>420	>39	>300	>1200	

(Ds: Dry solids; Vs: Volatile solids; OM: Organic matter), organic manures density 0.7

*Source: The Egyptian Code for Wastewater and Sludge Reuse in Agriculture (222/2005)

Table 3: Main effect means of fertilizer treatments on berseem fresh and dry yields (t fd^{-1}), (Combined data of 2017/18 - 2018/19 seasons)

Treatment*	1st cut FW (t fd^{-1})	2nd cut FW (t fd^{-1})	1st cut DW (t fd^{-1})	2nd cut DW (t fd^{-1})	Total FW (t fd^{-1})	Total DW (t fd^{-1})
Effect of N fertilizer						
Without fertilizer	4.45 a	5.76 b	0.45 b	1.11 b	10.2 b	1.55 b
With fertilizer	4.82 a	6.52 a	0.49 a	1.31 a	11.3 a	1.81 b
Effect of rate						
5 m^3 fd^{-1}	3.90 c	5.58 b	0.42 b	1.12 b	9.48 c	1.54 b
10 m^3 fd^{-1}	4.62 b	6.38 a	0.46 ab	1.24 ab	11.0 b	1.70 a
20 m^3 fd^{-1}	5.38 a	6.47 a	0.52 a	1.28 a	11.9 a	1.80 a
Effect of manure type						
Composted sludge	5.30 a	6.42 a	0.51 a	1.26 a	11.7 a	1.77 a
FYM	3.97 b	5.87 b	0.42 b	1.17 b	9.83 b	1.59 b

Values for each mean category within a column, followed by the same letter, are not significantly different at P = 0.05

* The additional N Fertilizer levels (30, 45 and 60 kg) are not included

Table 4: Effect of fertilizer treatments on fresh, dry forage and protein yields (t fd^{-1}) of berseem (Combined data of 2017/18 - 2018/19 seasons)

Treatment	1st cut FW (t fd^{-1})	2nd cut FW (t fd^{-1})	1st cut DW (t fd^{-1})	2nd cut DW (t fd^{-1})	Total FW (t fd^{-1})	Total DW (t fd^{-1})	Protein yield kg fd^{-1}
Control	2.25h	4.37d	0.23e	0.88cd	6.61f	1.11e	169.94e
30 kg N fd^{-1}	2.39gh	4.54cd	0.44b-d	1.22a-c	6.93f	1.66a-d	241.70a-d
45 kg N fd^{-1}	3.35d-h	5.85a-d	0.37c-e	1.17a-d	9.21c-f	1.54b-e	197.27b-e
60 kg N fd^{-1}	4.34c-f	6.40abc	0.55a-c	1.26a-c	10.7b-e	1.81a-c	330.33a-c
CS 5 m^3 fd^{-1}	3.14f-h	4.99b-d	0.31de	0.99b-d	8.13ef	1.30de	174.72e
CS 5 m^3 fd^{-1} + F	5.13bc	6.59ab	0.51a-d	1.31ab	11.7a-c	1.82ab	332.15ab
CS 10 m^3 fd^{-1}	4.90b-e	5.94a-d	0.57ab	1.28a-c	10.8b-d	1.85ab	307.66ab
CS 10 m^3 fd^{-1} + F	5.09b-d	7.57a	0.43b-e	1.39ab	12.7ab	1.82ab	382.20ab
CS 20 m^3 fd^{-1}	7.14a	6.87ab	0.57ab	1.24a-c	14.0a	1.82ab	392.39ab
CS 20 m^3 fd^{-1} + F	6.41ab	6.54ab	0.69a	1.34ab	13.0ab	2.03a	408.64a
FYM 5 m^3 fd^{-1}	3.15e-h	5.22b-d	0.37b-e	0.99b-d	8.37d-f	1.36c-e	206.58b-e
FYM 5 m^3 fd^{-1} + F	4.20c-f	5.50b-d	0.49b-d	1.20a-d	9.70c-e	1.69a-d	288.31bc
FYM 10 m^3 fd^{-1}	4.53c-f	5.41b-d	0.34de	0.81d	9.94c-e	1.15e	235.84d
FYM 10 m^3 fd^{-1} + F	3.95c-h	6.59ab	0.49ab-d	1.48a	10.5b-e	1.97ab	353.42ab
FYM 20 m^3 fd^{-1}	3.85c-h	6.12ab-d	0.48b-d	1.37ab	9.97c-e	1.85ab	285.64ab
FYM 20 m^3 fd^{-1} + F	4.13c-g	6.34a-c	0.36c-e	1.16a-d	10.5b-e	1.52b-e	272.69bc

Means within a column, followed by the same letter, are not significantly different at P=0.05

F= 45 kg inorganic N

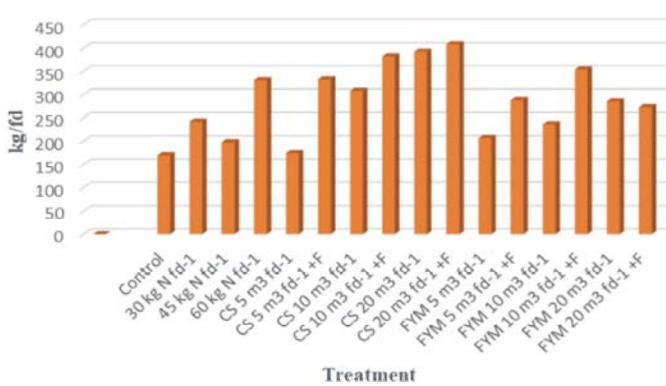

Fig. 1: Effect of fertilizer treatments on protein yield kg fd^{-1}

progressed associated with the effects of cumulative additions of sludge on soil fertility and crop yields. The N equivalencies estimated for FYM were less consistent than for composted sludges, however, the N equivalency value calculated for FYM was apparently much larger than for sludge with some crops. Similar results were confirmed by [21].

The efficiency of integrated application of organic and inorganic fertilizers is documented and justified. There are scientific evidences supporting the idea that the application rate of chemical fertilizers could be reduced (to achieve optimum yield levels) if they were applied along with organic fertilizers [22, 23].

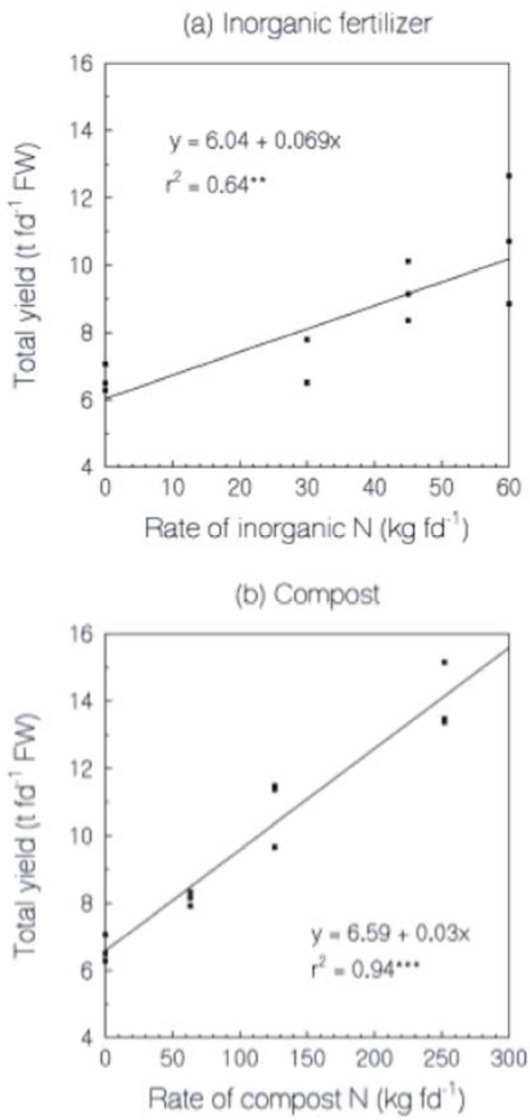

Fig. 2: Berseem yield (total for two cuts) in relation to the rate of N application in (a) inorganic fertilizer and (b) sludge compost

Table 5: Nitrogen equivalency of composted sludge for berseem production on calcareous desert soil after two dressings of compost (Combined data of 2017/18 - 2018/19 seasons).

Regression coefficient for compost N (a)	0.030
Regression coefficient for inorganic N (b)	0.069
% N efficiency (a/b*100)	43

Phytotoxicity of Heavy Metals to Berseem: The chemical composition of berseem, sampled at the second cut, is summarised in Table (6). No statistically significant differences were detected by ANOVA. Overall, crop concentrations of N, P, K and Mn were below their normal ranges and Zn and Cu were at less than half the concentrations that regarded as necessary for optimum production (Table 6 and Figs. 4, 5) as well as protein % (Fig. 3). In this respect [10] reported that there was some evidence of beneficial increases in the N, P and K content of the crop and the amounts of Fe, Mn, Zn and Cu in the plants were also usefully elevated by compost application compared to the untreated control, which received only a base dressing of inorganic fertilizers. Thus, in terms of plant and animal nutrition, compost improved herbage quality since these elements are often deficient in such calcareous soils. Even so, the concentrations of Zn and Cu in the berseem from the compost-treated plot only reached the adequacy levels for the ruminant nutrition. The long effects of the combined application of organic and inorganic fertilizers in improving soil fertility and crop yield have been demonstrated by [24-28].

In order to scrutinise the phytotoxicity of heavy metals to berseem, two contrasted heavy metals behaviour were chosen (Fig. 6). The first is Cadmium (Cd) which represents the human dietary poison of principal concern in relation to the utilization of sewage sludge on agricultural land. This is because Cd is highly bioavailable for plant uptake and can accumulate in edible portions of crops to levels which could potentially be deleterious to humans, if consumed for long periods of time and in large quantities lead. The second element is lead (Pb) which considered as immobile element the impact of sludge Pb is unlikely to be a significant issue under Egyptian conditions because the sludges which will be used in agriculture in the future will be air-dried and will therefore be incorporated into the soil before crops are planted. Furthermore, dried sludge does not adhere to forage avoiding its likely intake by grazing livestock. The results in (Fig. 6) indicate that the concentration of both elements in berseem leaves were too far from pytotoxic levels [24] which indicates and reflect in general, the application of compost improved the nutritional quality of fodder as an animal feed on calcareous soil.

Table 6: Chemical composition of berseem (2nd cut), (Units: nutrients as %; other elements as mg kg^{-1}) (Combined data of 2017/18 - 2018/19 seasons)

Treatment	N	P	K	Fe	Mn	Zn	Cu	Cd	Pb	Protein%
Control	2.45	0.17	1.76	111.1	28.3	13.9	3.23	0.09	0.12	15.31
30 kg N fd^{-1}	2.33	0.18	1.75	223.0	31.7	10.6	3.38	0.10	0.13	14.56
45 kg N fd^{-1}	2.05	0.18	1.68	124.1	27.8	12.2	2.30	0.11	0.21	12.81
60 kg N fd^{-1}	2.92	0.24	1.73	103.3	32.0	17.8	6.32	0.11	1.23	18.25
CS 5 m^3 fd^{-1}	2.15	0.16	1.64	149.3	32.1	10.0	3.68	0.09	0.32	13.44
CS 5 m^3 fd^{-1} + F	2.92	0.25	1.83	161.8	35.3	15.3	2.34	0.14	0.45	18.25
CS 10 m^3 fd^{-1}	2.66	0.15	1.71	100.2	26.9	18.4	3.10	0.08	0.50	16.63
CS 10 m^3 fd^{-1} + F	3.36	0.23	1.88	167.3	26.4	13.4	3.50	0.09	0.11	21.00
CS 20 m^3 fd^{-1}	3.45	0.22	1.76	309.2	41.1	16.2	4.73	0.12	0.17	21.56
CS 20 m^3 fd^{-1} + F	3.22	0.19	1.87	178.6	39.6	21.3	1.79	0.12	0.78	20.13
FYM 5 m^3 fd^{-1}	2.43	0.18	1.79	70.1	29.7	15.1	3.22	0.10	0.39	15.19
FYM 5 m^3 fd^{-1} + F	2.73	0.23	1.83	121.0	30.9	16.9	6.49	0.11	1.05	17.06
FYM 10 m^3 fd^{-1}	3.43	0.22	1.76	218.1	35.4	23.9	3.88	0.12	0.27	21.44
FYM 10 m^3 fd^{-1} + F	2.87	0.22	2.07	136.6	34.6	15.3	3.81	0.09	0.19	17.94
FYM 20 m^3 fd^{-1}	2.47	0.21	1.87	180.9	30.7	15.6	2.30	0.14	0.11	15.44
FYM 20 m^3 fd^{-1} + F	2.87	0.23	1.82	271.4	33.1	18.4	4.35	0.08	0.16	17.94
Mean	2.77	0.20	1.80	164.1	32.2	15.9	3.65	0.11	0.39	17.31
Probability	0.099	0.549	0.653	0.787	0.905	0.674	0.264	0.922	0.635	0.096
Significance	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

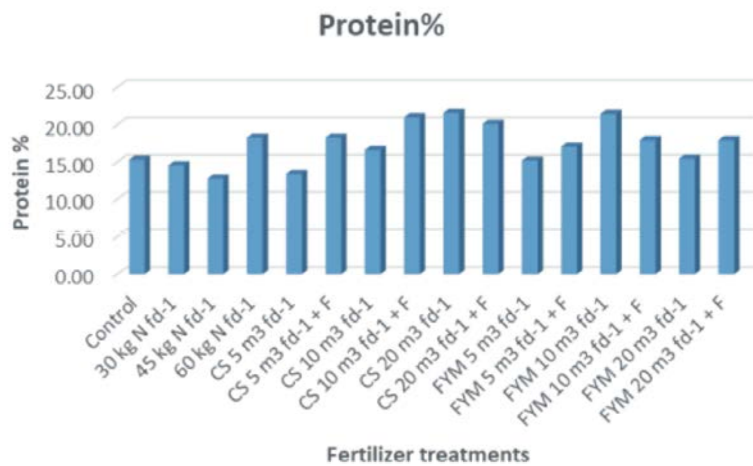

Fig. 3: Effect of fertilizer treatments on berseem protein %

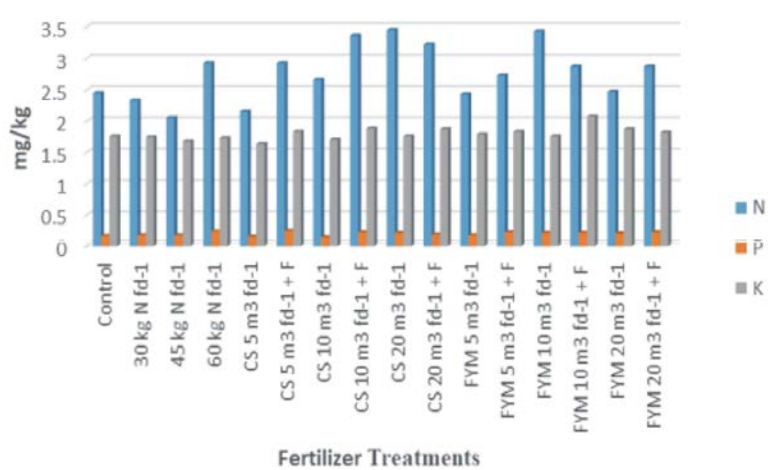

Fig. 4: Effect of fertilizer treatments on N, P and K concentration in berseem leaves

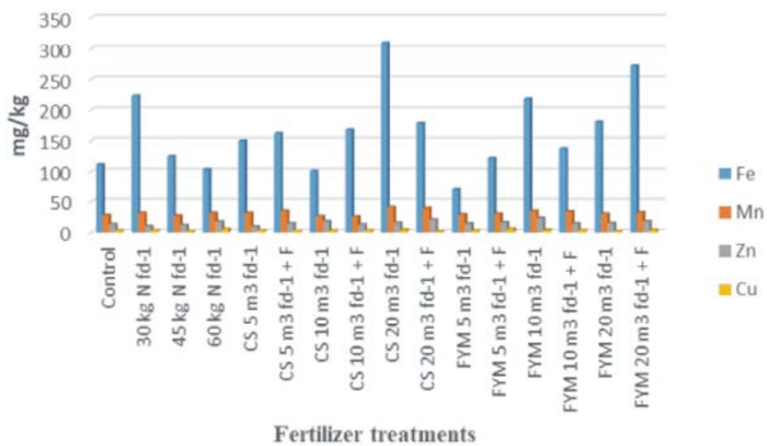

Fig. 5: Effect of fertilizer treatments on micronutrient concentration in berseem leaves

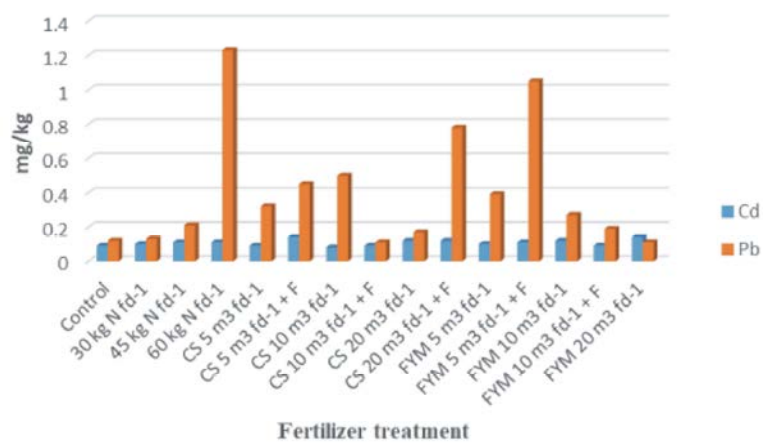

Fig. 6: Effect of fertilizer treatments on heavy metals concentration in berseem leaves
(Pb: Sufficient or normal 5-10, Excessive or toxic 30-300, Tolerable in agricultural crops 10 ppm)
(Cd: Sufficient or normal 0.05 -0.2, Excessive or toxic 5-30, Tolerable in agricultural crops 3 ppm)

Table 7: Chemical analysis of soil sampled after berseem, (Units: EC as dS m^{-1}; OM and nutrients as %; other elements as mg kg^{-1}) (Combined data of 2017/18 - 2018/19 seasons)

Treatment	pH	EC	OM	N	P	K	Fe	Mn	Zn	Cu	Ni	Cd	Pb	Cr	Co
Control	8.37	0.50	1.16	1563	32.0	3466	22282	233.7	27.9	9.39	16.2	1.25	4.90	9.25	41.7
60 kg N fd^{-1}	8.22	0.44	1.29	1528	24.0	3132	22967	244.8	28.4	8.92	16.0	0.83	4.24	9.67	41.0
CS 20 m^3 fd^{-1}	8.21	0.48	1.53	1668	33.3	3219	23175	233.5	32.0	10.49	17.6	0.98	4.90	10.58	41.0
FYM 20 m^3 fd^{-1}	8.19	0.40	1.29	1633	27.0	3321	22057	226.8	29.7	9.71	17.9	1.00	3.38	11.25	41.8
Probability	0.34	0.74	0.19	0.66	0.91	0.49	0.63	0.54	0.19	0.54	0.09	0.79	0.29	0.83	0.95
Significance	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Values for each mean within a column, followed by the same letter, are not significantly different at P=0.05

The soil from selected treatments (control and highest rates of fertilizer compost and FYM) was sampled and analysed for a range of chemical parameters, the results of which are summarised in Table (7). ANOVA detected no significant effects due to the treatments after cumulative applications of 40 m^3 fd^{-1} of compost and FYM and there were no apparent trends in the data. Heavy metal concentrations were very small.

The long-term effects of the combined application of organic and inorganic fertilizers in improving soil fertility and crop yield have been demonstrated by [25-29]. It has been demonstrated that soil's physicochemical properties can be modified by organic fertilizer as a result of its comprehensive nutrients [30, 31]. Moreover, the fertilizer efficiency of organic factors is more lasting when compared with inorganic fertilizers [32-34]. Therefore, the application of organic fertilizers is better for the nutrient recycling of soil and the reduction of environmental pollution.

It may be concluded from this preliminary study that compost application to newly reclaimed calcareous soil is effective in improving crop productivity. It is unlikely that a single factor in composted sludge was responsible for this but is more likely to be due to the mixture of nutrients, micronutrients and organic matter that compost supplies. The recycle and use of nutrients from organic manure has been given more consideration for insuring sustainable land use and agricultural production development. In general, the application of compost improved the nutritional quality of fodder as an animal feed on calcareous soil.

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