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Use of lignite and poultry manure based humin for maize (*Zea mays* L.) cultivation in acid soil of eastern dry zone of Karnataka

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ABSTRACT
A field experiment was conducted at Krishi Vigyan Kendra, Hadonahalli, Doddaballapura Bangalore rural district, to study the influence of lignite humin (LH) and poultry manure humin (PMH) on maize growth, yield and uptake of major nutrients in acid soil of eastern dry zone of Karnataka. The results revealed that application of 100% RDF + FYM @ 10 t ha^{-1} (T_2:POP) recorded higher growth and yield parameters *viz*., plant height (217.70 cm), number of leaves plant^{-1} (13.93), cob length (17.29 cm), number of kernel rows cob^{-1} (16.90), number of kernels row^{-1} (36.60) and test weight 100 seed^{-1} (32.86 g). Similarly, significantly higher maize kernel (8070 kg ha^{-1}) and stover yield (9948 kg ha^{-1}) were recorded in the same treatment and which was found on par with treatment T_7 (PMH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}) and T_3 (LH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}) and T_8 (PMH @ 5 t ha^{-1} + FYM @ 5 t ha^{-1}). In all these treatments NPK nutrients were applied as per recommended dose of fertilizers. Significantly higher total nitrogen content in maize kernel (1.65%) and stover (0.89%) was observed in T_2 followed by T_7, T_3 and T_8 treatments and found on par with each other. Whereas, there was no significant differences observed among the treatments for total phosphorus and potassium content in maize crop. Significantly higher total uptake of major NPK nutrients (192.65, 41.75 and 134.37 NPK kg ha^{-1}, respectively) was observed in T_2 and found on par with T_7, T_3 and T_8 treatments. These results clearly indicate that the humin residue of poultry manure and lignite after extraction of humic acid can be used for maize cultivation to the tune of 5 t ha^{-1} and 2.5 t ha^{-1}, respectively along with 100% NPK + FYM (@ 5 t ha^{-1} with PMH or @7.5 t ha^{-1} with LH) without any detrimental effect on maize productivity.

Keywords: *FYM,* lignite based humin and poultry manure based humin and maize productivity

Introduction
Organic matter is considered as the "Life of soil" due to its importance in maintaining fertility of the soil, the depletion of the same will become a major threat to food security in the years to come. Hence, there is a need to improve the soil fertility in a sustainable manner by utilizing the locally available organic wastes because these wastes contains substantial amount of nutrients which are necessary for the plant growth in addition to maintaining of soil health. It helps in improving soil physical, chemical and biological properties of soil. However, to improve the organic matter content of soils many management techniques have been adopted such as crop rotation, plough techniques, green manuring and application of animal residues, humic acids and humates (Doran, 2003) [5]. The most active fraction of humus is the humic substances. Hayes *et al.* (1989) [9] described them as a group of naturally occurring, biogenic, heterogeneous organic substances that can generally be characterized as yellow to black coloured high molecular weight material. This group of organic substances can be fractionated in terms of their solubility in acid and alkali into (i) yellowish fulvic acid that is soluble in acid and alkali; (ii) blackish humic acid that is insoluble in acid but soluble in alkali, and (iii) humin that is insoluble both in acid and alkali (Stevenson & Cole, 1999) [17]. Now a days use of humic acid and/ fulvic acid is very common in crop production especially horticulture crops as it influences many soil properties (soil application) and helps in mobility and absorptio of nutrients in the plant (foliar application). Thus humic acid derived from organic wastes like farm yard manure (FYM), cocopeat, press mud, coffee pulp, sewage sludge, poultry manure (PM), urban compost etc. which have substantial quantities of humic materials are of great importance in maintaining soil organic matter levels especially in semi-arid tropics of India. However, among the fractions of humic substances, humin fraction which accounts 60-90 per

Material and Methods

Extraction of humic substances

In the present study two sources of manures such as lignite and Poultry Manure (PM) were used for extraction of humin. Lignite was procured from Neyveli Lignite Corporation of India, located at Neyveli, Tamil Nadu and poultry manure from Poultry Farm, Doddaballapura, and Bengaluru rural district. Laboratory scale extraction of humic substances from selected organic manures was carried out by taking 10 gram of air dried sample into a 250 ml conical flask to which 100 ml 0.1 *N* NaOH was added, stoppered and shaken for 24 hours using end to end shaker. The dark coloured supernatant containing Humic Acid (HA) and Fulvic Acid (FA) were separated by centrifugation and collected. The extraction was repeated thrice with 50 ml of extractant for complete extraction of the humic substances. The residues left after extraction is humin (Schnitzer and Skinner, 1968) [15]. The humic substances (HA, FA and Humin) recovered from poultry manure and lignite were weighed and expressed in per cent and further subjected for characterization. Similarly for field experiment bulk extraction of humin was carried by treating required quantity of poultry manure and lignite with 0.1 *N* NaOH in 100L drum capacity followed by filtering with muslin cloth.

Characterization of manures and Humin

The FYM, PM, lignite and humin residues from PM and lignite were characterized for chemical properties *viz*., pH, EC and OC by (Jackson, 1973) [10], and nutrient composition *viz.*, total major nutrients (N, P and K), secondary nutrients (Ca, Mg and S), sodium by (Piper, 1966), [13] and micronutrients (Zn, Cu, Fe, Mn and B) content following procedures as outlined by Lindsay and Norvell, (1978) [11]. They also subjected for water holding capacity (WHC) and bulk density (BD) analysis following standard procedures (Piper, 1966) [13].

Field experiment

A field experiment was conducted during *kharif* 2018 at Krishi Vigyana Kendra, Hadonahalli, Bengaluru rural district, Karnataka to study the influence of lignite and poultry manure based humin on growth, yield and uptake of major nutrients by maize (*Zea mays* L.) crop in acid soil of eastern dry zone of Karnataka. The soil of experimental site was acidic (pH 4.48), with low salt content (0.10 dS m^{-1}) and low in organic carbon content (4.08 g kg^{-1}). The available nitrogen (145.60 kg ha^{-1}) was low, available phosphorus (29.73 kg ha^{-1}) was high and available potassium content (267.60 kg ha^{-1}) was medium (Table 1). The experiment was laid out in a randomized complete block design with ten treatments, replicated thrice. The Lignite Humin (LH) and Poultry Manure Humin (PH) were applied at different doses (0, 2.5, 7.5 & 10 t ha^{-1}) in combination with FYM (Farm Yard Manure) applied in suchway that the total quantity of humin and FYM is equivalent to 10 t ha^{-1}. The treatment combinations include, T_1: Absolute control, T_2: FYM @ 10 t ha^{-1} (POP),T_3: LH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}, T_4: LH @ 5 t ha^{-1} + FYM @ 5 t ha^{-1}, T_5: LH @ 7.5 t ha^{-1} + FYM @ 2.5 t ha^{-1}, T_6: LH @ 10 t ha^{-1}, T_7: PH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}, T_8: PH @ 5 t ha^{-1} + FYM @ 5 t ha^{-1}, T_9: PH @ 7.5 t ha^{-1} + FYM @ 2.5 t ha^{-1} and $T_{10:}$ PH @ 10 t ha^{-1}. For all the treatments except absolute control, Recommended Dose of Fertilizer (RDF) were applied commonly @ 150:75:40 kg ha^{-1} NPK. The FYM and various combinations of FYM with lignite and poultry manure based humin were applied as per the treatments 15 days before sowing and mixed with the soil properly. Entire dose of P and K were applied at the time of sowing whereas, N was applied in three equal splits at basal, 30 and 50 days after sowing (DAS). The observations on growth parameters *viz*., plant height and number of leaves per plant were recorded at 30, 60 DAS and at harvest. The observations on yield parameters *viz*., cob length, number of rows per cob, number kernels per row and test weight were recorded at harvest. The kernel and stover yield of maize were recorded and expressed in quintal per hectare. All these data's were statistically analysed by adopting standard procedure outlined by Gomez and Gomez (1984) [8]. The initial soil samples before treatment imposition was collected and subjected for analysis physico-chemical properties such as soil texture, pH and EC by Jackson (1973) [10], OC (Walkley and Black, 1934) [20], available micro (Lindsay and Norvell, 1978) [11] and macro nutrients as outlined by Jackson (1973) [10]. At harvest, representative plant samples were collected treatment wise and analysed for total NPK nutrients in kernel and stover samples as described by Tandon (1998) [18]. The uptake of these nutrients by maize crop was computed.

Table 1: Properties of initial soil sample of the experimental site

Sl. No.	Soil properties	Value
1	Mechnical Analysis	
	Sand (%)	77.16
	Silt (%)	9.64
	Clay (%)	13.19
	Textural Class	Sandy loam
2	pH (1:2.5 soil:water suspension)	4.48
3	Electrical conductivity (dS m^{-1})	0.10
4	Organic carbon (g kg^{-1})	4.08
5	Available nitrogen (kg ha^{-1})	145.60
6	Available phosphorus (kg P_2O_5 ha^{-1})	29.73
7	Available potassium (kg K_2O ha^{-1})	267.60
8	Exhangeable Sodium (cmol (p^+) kg^{-1})	0.06
9	Exchangeable calcium (cmol (p^+) kg^{-1})	2.90
10	Exchangeable magnesium (cmol (p^+) kg^{-1})	0.80
11	Available Sulphur (mg kg^{-1})	13.76
12	DTPA Extractable iron (mg kg^{-1})	12.00
13	DTPA Extractable manganese (mg kg^{-1})	14.76
14	DTPA Extractable copper (mg kg^{-1})	1.04
15	DTPA Extractable zinc (mg kg^{-1})	1.07

Results and Discussion

Percent recovery of humic substances from lignite and poultry manure

The recovery percentage of HA, FA and Humin from Lignite and Poultry Manure are presented in Table 2. Higher recovery of 25.63% HA and 9.85% of FA was recorded for lignite compared to poultry manure (8.38% HA and 4.92% FA). Whereas, higher recovery of humin was recorded in poultry manure (86.7%) compared to lignite (64.52%). The variation in recovery of humic substances might be due to elemental composition of organic sources (Gayathri, 2016) [7].

Table 2: Recovery of humic substances extracted from different Sources (%**)**

Sources	Humic Acid	Fulvic Acid	Humin
Poultry Manure	8.38	4.92	86.70
Lignite	25.63	9.85	64.52

Characterization of organic manures and Humin

The data on the chemical composition and characteristics of organic materials like FYM, poultry manure and lignite before and after alkali extraction are presented in the Table 3.

The analysis of the samples revealed that the FYM was slightly acidic (pH 6.04), with 0.77 dS m^{-1} electrical conductivity, 0.47 g m^{-3}, Bulk density, 43.86 per cent water holding capacity and 17.42 per cent organic carbon content. Lignite and poultry manure recorded acidic (4.60) and slightly alkaline (7.83) pH, respectively which after alkali extraction raised to 6.20 and 9.89, respectively. Similarly due to alkali treatments the electrical conductivity was raised from 0.52 and 0.94 to 0.82 and 1.15 dS m^{-1}, respectively in lignite and poultry manure. However, the electrical conductivity is well within the permissible limit (<4.0 dS m^{-1}). Among the sources, poultry manure humin was rich in nutrients compared to lignite based humin which could be supported by the results of Avinash *et al*. (2017) [2]. Total macro nutrients (N, P, K, Ca, Mg and sulphur) and micronurients content were recorded higher in both poultry manure and its humin compared to lignite and its humin. However, the organic carbon content was higher in lignite compared to poultry manure. All these nutrients content were found slightly lower after alkali extraction (Humin) compared to before extration.

With respect to Carbon to Nitrogen ratio, poulty manure recorded very low (11.84 & 15.45, respectively before and after alkali extraction) whereas lignite recorded very high (125.26 and 117.61, respectively before and after alkali extraction). The higher C:N in lignite is due to higher carbon and lower nitrogen content. FYM was having medium in C:N ratio (37.06).

Table 3: Chemical composition and characteristics of organic manures

Parameters	FYM	Lignite		Poultry manure	
		Before alkali extraction	After alkali extraction (humin)	Before alkali extraction	After alkali extraction (humin)
pH (1:5)	6.04	4.60	6.20	7.83	9.89
EC (ds m^{-1})	0.77	0.52	0.82	0.94	1.15
OC (%)	17.42	56.34	49.41	33.05	31.38
Total N (%)	0.47	0.45	0.42	2.79	2.03
Total P (%)	0.32	0.30	0.25	1.58	1.04
Total K (%)	0.43	0.43	0.39	1.97	1.36
Total Na (%)	0.23	0.07	0.26	0.53	0.82
Total Ca (%)	1.48	1.60	1.30	3.90	2.90
Total Mg (%)	0.73	0.70	0.50	1.80	1.40
Total S (%)	0.21	0.24	0.22	0.52	0.44
Total Fe (mg kg^{-1})	1356.30	985.26	650.06	3750.00	1389.71
Total Mn (mg kg^{-1})	167.24	174.00	73.45	533.80	217.95
Total Cu (mg kg^{-1})	35.45	43.62	23.75	73.60	52.87
Total Zn (mg kg^{-1})	72.32	42.25	41.13	468.00	183.41
Total B (mg kg^{-1})	44.92	38.74	32.68	75.12	49.86
BD (Mg m^{-3})	0.47	0.43	0.61	0.49	0.59
MWHC (%)	43.86	41.66	38.64	46.05	39.82
C:N ratio	37.06	125.26	117.61	11.84	15.45

Effect on growth parameters at different stages

Significant differences were observed in maize plant height and number of leaves per plant due to application of different sources of humin (Table 4). Higher plant height (75.89, 217.70 and 231.20 cm, respectively at 30 DAS, 60 DAS and at harvest) and number of leaves per plant (8.07, 13.93 and 15.13, respectively at 30 DAS, 60 DAS and at harvest) recorded in treatment T_2 (100% RDF + FYM @ 10 t ha^{-1}) throughout the crop growth period compared to other treatments except treatments T_7 (PMH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}), T_3 (LH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}) and T_8 (PMH @ 5 t ha^{-1} + FYM @ 5 t ha^{-1}) which were found on par. Further increased application of PM humin (>5 t ha^{-1}) and lignite based humin (>2.5 t ha^{-1}) significantly decreased the growth and yield parameters. Among the two sources of humin, poultry manure based humin recorded higher growth and yield parameters compared to the lignite based humin which might be attributed to lower nutrient content and wider C:N ratio in lignite based humin compared to poultry manure humin. These parameters were recorded lowest in absolute control plot. Higher in growth and yield parameters in T_2 followed by humin treated plots (T_7, T_3 and T_8) might be attributed to balanced application nutrients through organic manures viz., FYM, lignite and poultry manures as well as inorganic fertilizers which resulted in increased physiological processes in crop plants leading to higher growth and increased photosynthate (Arun Kumar *et al*., 2007) [1]. This might be due to better utilization of NPK supply and improved physicochemical properties of soil in the experiment.

Table 4: Effect of lignite and PM based humin on growth parameter of maize at different growth stage of maize

Treatments	Plant height (cm)			Number of leaves $plant^{-1}$		
	30 DAS	60 DAS	At harvest	30 DAS	60 DAS	At harvest
T_1: Absolute control	61.27	170.13	186.07	6.27	11.80	12.60
T_2: FYM @ 10 t ha^{-1} (POP)	75.89	217.70	231.20	8.07	13.93	15.13
T_3: 25% Lignite humin (2.5 t ha^{-1}) + FYM @ 7.5 t ha^{-1}	73.62	196.33	226.00	7.93	13.43	14.63
T_4: 50% Lignite humin (5 t ha^{-1}) + FYM @ 5 t ha^{-1}	69.22	193.80	218.87	7.60	13.20	14.17
T_5: 75% Lignite humin (7.5 t ha^{-1}) + FYM @ 2.5 t ha^{-1}	66.04	191.43	212.47	7.47	13.03	13.77
T_6: 100% Lignite humin (10 t ha^{-1})	64.71	188.60	205.60	7.40	12.60	13.23
T_7: 25% PM humin (2.5 t ha^{-1}) + FYM @ 7.5 t ha^{-1}	74.04	196.87	227.53	8.00	13.53	14.87
T_8: 50% PM humin (5 t ha^{-1}) + FYM @ 5 t ha^{-1}	70.33	194.70	222.53	7.67	13.32	14.43
T_9: 75% PM humin (7.5 t ha^{-1}) + FYM @ 2.5 t ha^{-1}	69.24	191.67	215.13	7.53	13.07	13.9

T_{10}: 100% PM humin (10 t ha^{-1})	67.31	188.80	209.00	7.47	12.80	13.53
S. Em. ±	2.14	7.97	3.42	0.14	0.21	0.27
C.D. at 5%	6.36	23.67	10.17	0.42	0.63	0.81

Effect on yield and yield parameters

Significantly, higher cob length (17.29 cm), number of seed rows per cob (16.90), number of kernels per row (36.60) and test weight (32.86 gm per 100 seeds) were recorded due to application of 100% RDF + FYM @ 10 t ha^{-1} (T_2) which was found on par with treatment T_7 (PMH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}), T_3 (LH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}) and T_8 (PMH @ 5 t ha^{-1} + FYM @ 5 t ha^{-1}). Further increased application of PM humin (>5 t ha^{-1}) and lignite based humin (>2.5 t ha^{-1}) significantly decreased yield parameters (Table 5). Similarly, application of FYM @ 10 t ha^{-1} along with 100% RDF (POP) resulted in higher maize kernel (8070 kg ha^{-1}) and stover yield (9948 kg ha^{-1}) which was found on par with treatment T_7 (PMH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}), T_3 (LH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}) and T_8 (PMH @ 5 t ha^{-1} + FYM @ 5 t ha^{-1}). Further increased application of PM humin (>5 t ha^{-1}) and lignite based humin (>2.5 t ha^{-1}) significantly decreased in kernel and stover yield of maize (Table 5). Among the sources of humin treatments, the higher kernel and stover yield of maize was recorded due to application of PMH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}, followed by LH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1} and PMH @ 5 t ha^{-1} + FYM @ 5 t ha^{-1}. All these three treatments were found on par each other. This increase in yield might be attributed to increased growth and yield parameters *viz*., plant height, number of leaves per plant, cob length, number of rows per cob, number of kernels per row and test weight. Among two sources of humin, application of poultry manure based humin resulted in higher kernel and stover yield compared to corresponding doses of lignite humin. This higher yield might be attributed to higher nutrient content in poultry manure compared to lignite based humin (Avinash *et al.*, 2017) [3].

Table 5: Effect of lignite and PM based humin on yield and yield parameters of maize

Treatments	Cob length	Rows cob^{-1}	Kernels row^{-1}	Test weight	Yield (kg ha^{-1})	
	cm			g	Kernel	Stover
T_1: Absolute control	11.43	12.90	23.53	23.76	3885	3907
T_2: FYM @ 10 t ha^{-1} (POP)	17.29	16.90	36.60	32.86	8070	9948
T_3: 25% Lignite humin (2.5 t ha^{-1}) + FYM @ 7.5 t ha^{-1}	16.98	16.52	33.73	31.78	7662	8877
T_4: 50% Lignite humin (5 t ha^{-1}) + FYM @ 5 t ha^{-1}	16.57	16.36	32.20	30.69	7366	8788
T_5: 75% Lignite humin (7.5 t ha^{-1}) + FYM @ 2.5 t ha^{-1}	16.08	16.40	30.47	29.58	7048	8100
T_6: 100% Lignite humin (10 t ha^{-1})	15.46	15.60	29.60	28.26	6825	7906
T_7: 25% PM humin (2.5 t ha^{-1}) + FYM @ 7.5 t ha^{-1}	17.14	16.72	35.40	32.42	7711	9255
T_8: 50% PM humin (5 t ha^{-1}) + FYM @ 5 t ha^{-1}	16.90	16.40	33.67	30.97	7470	8844
T_9: 75% PM humin (7.5 t ha^{-1}) + FYM @ 2.5 t ha^{-1}	16.18	16.20	31.40	30.12	7251	8588
T_{10}: 100% PM humin (10 t ha^{-1})	15.80	15.60	29.87	29.14	7111	8077
S.Em. ±	0.22	0.18	1.03	0.71	231.95	386.30
C.D. at 5%	0.66	0.50	3.05	2.10	689.17	1147.77

Effect of humin on nutrient content and uptake of major nutrients in maize crop

Significantly, higher total nitrogen content in maize kernel (1.65%) and stover (0.89%) was observed in T_2 (100% RDF + FYM @ 10 t ha^{-1}) followed by T_7, T_3 and T_8 and which were found on par with each other. Higher nitrogen content in these plots were possibly due to the enhanced absorption of nutrients (Sistani *et al.*, 1999) [16]. Whereas, there is no significant differences observed for total phosphorus and potassium content in maize kernels and stover. However, T_2 recorded higher phosphorus (0.40 and 0.14%, respectively in maize kernel and stover) and total potassium content (0.55 and 1.33%, respectively in maize kernel and stover) compared to other treatments (Table 6). Higher total uptake of NPK (192.65, 41.75 and 134.37 kg N ha^{-1}) was recorded in treatment T_2 receiving 100% NPK + FYM @ 10 t ha^{-1} which was found on par with treatment T_7 (PMH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}), T_3 (LH @ 2.5 t ha^{-1} + FYM @ 7.5 t ha^{-1}) and T_8 (PMH @ 5 t ha^{-1} + FYM @ 5 t ha^{-1}). Further increased application of PMH (>5 t ha^{-1}) and lignite based humin (>2.5 t ha^{-1}) significantly decreased the nutrient uptake by maize crop (Table 7). This increased uptake of total NPK might be due to higher kernel and stover yield in these treatments. The increase in NPK uptake under application of organic manures like FYM and Humin could be attributed to improvement in the nutrient availability through improved soil physicochemical properties of the soil (Suryanarayana *et al.*, 2002) [14]. Decreased uptake in poultry and lignite based humin compared to 100% FYM might be due to its devoid from humic acid. Similar results were noticed by Verlindena *et al.* (2011) who found that without application of humic substances at the growing season resulted in lower uptake of nitrogen, phosphorus and potassium by plants.

Table 6: Nutrient content of NPK in kernel and stover of maize crop as influenced by lignite and poultry manure based humin

Treatments	N (%)		P (%)		K (%)	
	Kernel	Stover	Kernel	Stover	Kernel	Stover
T_1: Absolute control	1.43	0.62	0.35	0.11	0.41	1.08
T_2: FYM @ 10 t ha^{-1} (POP)	1.65	0.89	0.40	0.14	0.55	1.33
T_3: 25% Lignite humin (2.5 t ha^{-1}) + FYM @ 7.5 t ha^{-1}	1.61	0.87	0.39	0.13	0.53	1.29
T_4: 50% Lignite humin (5 t ha^{-1}) + FYM @ 5 t ha^{-1}	1.55	0.81	0.37	0.13	0.52	1.27
T_5: 75% Lignite humin (7.5 t ha^{-1}) + FYM @ 2.5 t ha^{-1}	1.51	0.78	0.36	0.12	0.51	1.22
T_6: 100% Lignite humin (10 t ha^{-1})	1.46	0.76	0.36	0.12	0.48	1.18
T_7: 25% PM humin (2.5 t ha^{-1}) + FYM @ 7.5 t ha^{-1}	1.62	0.88	0.39	0.14	0.55	1.31

T_8: 50% PM humin (5 t ha^{-1}) + FYM @ 5 t ha^{-1}	1.56	0.86	0.37	0.13	0.53	1.28
T_9: 75% PM humin (7.5 t ha^{-1}) + FYM @ 2.5 t ha^{-1}	1.53	0.82	0.37	0.13	0.52	1.24
T_{10}: 100% PM humin (10 t ha^{-1})	1.48	0.77	0.36	0.12	0.49	1.21
S. Em. ±	0.03	0.03	0.02	0.01	0.02	0.10
C.D. at 5%	0.08	0.10	NS	NS	NS	NS

Table 7: Uptake of major nutrients by kernel and stover of maize crop as influenced by lignite and poultry manure based humin

Treatments	N (kg ha^{-1})			P (kg ha^{-1})			K (kg ha^{-1})		
	Kernel	Stover	Total	Kernel	Stover	Total	Kernel	Stover	Total
T_1: Absolute control	55.64	14.90	70.53	13.72	2.79	16.51	16.15	26.20	42.35
T_2: FYM @ 10 t ha^{-1} (POP)	132.84	59.81	192.65	32.07	9.68	41.75	44.98	89.39	134.37
T_3: 25% Lignite humin (2.5 t ha^{-1}) + FYM @ 7.5 t ha^{-1}	123.28	49.49	172.78	29.62	7.80	37.42	40.55	74.12	114.67
T_4: 50% Lignite humin (5 t ha^{-1}) + FYM @ 5 t ha^{-1}	114.16	45.05	159.20	27.24	7.09	34.34	37.81	71.16	108.97
T_5: 75% Lignite humin (7.5 t ha^{-1}) + FYM @ 2.5 t ha^{-1}	106.47	41.94	148.40	25.54	6.52	32.06	36.32	63.48	99.80
T_6: 100% Lignite humin (10 t ha^{-1})	99.47	37.03	136.50	24.28	5.88	30.16	33.05	57.09	90.14
T_7: 25% PM humin (2.5 t ha^{-1}) + FYM @ 7.5 t ha^{-1}	124.65	51.38	176.03	29.98	8.24	38.22	42.12	76.87	118.98
T_8: 50% PM humin (5 t ha^{-1}) + FYM @ 5 t ha^{-1}	116.62	49.03	165.65	27.87	7.40	35.27	39.15	72.66	111.81
T_9: 75% PM humin (7.5 t ha^{-1}) + FYM @ 2.5 t ha^{-1}	111.37	44.92	156.28	26.66	6.86	33.53	37.42	68.22	105.64
T_{10}: 100% PM humin (10 t ha^{-1})	105.28	39.48	144.76	25.87	6.21	32.08	35.04	61.95	96.99
S. Em. ±	5.99	3.68	9.24	1.44	0.78	2.20	2.41	6.13	8.01
C.D. at 5%	17.79	10.94	27.45	4.28	2.31	6.54	7.15	18.22	23.81

Conclusion

From the present study, it can be concluded that application of humin residue of poultry manure and lignite after alkali extraction of humic and fulvic acids can be used for maize production to the tune of 5 t ha^{-1}Poulty manure humin and 2.5 t ha^{-1} lignite humin along with 100% RDF and FYM (@ 5 t ha^{-1} with PMH or @ 7.5 t ha^{-1} with LH) without compromising on yield and nutrient uptake.

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