The porosity (Table 4) viz., capillary, non capillary and total porosity of the soil was also increased due to the addition of organics. The improvement in all the above soil physical properties were quite explainable since the reduced bulk density which caused an increase in the porosity of soil and improvement in hydraulic conductivity might have provided good physical environment for crop growth which in turn reflected in grain yield of sorghum.

In the residue management studies, different tillage treatment did not have any influence on the grain yield of soybean. However, organic manure applied plots recorded significantly higher yield as compared to control. (Table 5). The residual effect of organic manure in terms of physical and chemical fertility maintenance would have resulted in high yield of soybean.

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Direct and residual effect of combined application of basic slag with green leaf manure on soil available nutrients and yield of rice

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Abstract : Field experiments were conducted on sandy clay loam soil (Udic Haplustalf) at Central Farm of Agricultural College and Research Institute, Madurai to study the effect of added levels of basic slag with green leaf manure on ADT 36 rice. Addition of graded levels of basic slag viz., 500, 750 and 1000 kg/ha significantly increased the soil available P, Ca, Mg, Fe, Si and the grain and straw yield of rice. Application of 1000 kg of basic slag with 12.50 or 18.75 t/ha of green leaf manure recorded the highest soil available nutrients as well as grain and straw yield of rice over rest of the treatments. The residual crop yield was also significantly increased over NPK treated control by conjunctive use of basic slag with green leaf manure at higher level (1000 kg of basic slag with 18.75 t/ha of green leaf manure). The superiority of basic slag with green leaf manure in increasing the soil available nutrients was proved only at higher doses. *(**Key Words** : Basic slag, Green leaf manure, Residual effect)*

A safe disposal of several industrial wastes possesses a great problem. These waste materials and by-products of industries contain some amount of plant nutrients besides it's soil ameliorative properties. These properties can be well utilized for better crop production. In India basic slag, a by-product of steel industry containing calcium silicophosphate, is produced to the tune of 1.5 million tonnes annually. Basic slag has been in use as an phosphatic fertilizer in European countries. In India the use of basic slag is no way comparable to the situation prevailing in Europe due to its low P_2O_5 content which varies from 2-6 per cent as against the maximum of 12 per cent P_2O_5 content in European basic slag. Several attempts have been made in India as well as in abroad to study the fertilizer value of basic slag. However, the reported results are not always in agreement. The value of material depends on its composition, soil characteristics, crop species and crop succession. The liming effect of basic slag was demonstrated in many research attempts, however work on neutral and alkaline soils are not adequate. Hence, the present study was undertaken to assess the direct and residual effect of basic slag along with green leaf manure on soil available nutrients, grain and straw yield of rice in neutral soils.

Materials and Methods

Field experiments were conducted on sandy clay loam soil (Udic Haplustalf) at the Central Farm of Agricultural College and Research Institute, Madurai. Analytical values of initial soil and chemical composition of basic slag and green leaf manure used in the studies are presented in Table-1. Four levels of basic slag (0, 500, 750 and

1000 kg ha^{-1}) and four levels of green leaf manure (0, 6.25, 12.50 and 18.75 t ha^{-1}) and totally sixteen treatment combinations were tried in Factorial Randomized block design with three replications. ADT.36 rice was chosen as test crop for both main as well as residual crop.

The main crop was transplanted during July 1993 and residual crop was raised subsequently in December 1993 without disturbing the original lay out. A common dose of 100 kg of N, 50 kg of P_2O_5 and 50 kg of K_2O ha^{-1} were applied. Half the dose of N and full doses of P and K_2O were applied basely. The remaining half of N was applied in two equal splits, one at maximum tillering and another at flowering stage. The recommended package of practices were followed and the crop was harvested at maturity and the grain and straw yield of each treatment of main and residual crops were recorded separately (Table 2). The soil samples were collected at post harvest stage of main and residual crop and were analysed for available Si, P, Ca, Mg and Fe following standard procedures (Table 3).

Results and Discussion

Direct Effect

Application of graded levels (500, 750 and 1000 kg ha^{-1} of basic slag either alone or in combination with green leaf manure at various levels, i.e. 6.25, 12.50 and 18.75 t ha^{-1} significantly increased the soil available Si, P, Ca, Mg and Fe as well as grain and straw yield of rice over NPK treated control. This could be well attributed to the increase in soil available nutrient status intern reflected in increased nutrient absorption and ultimately resulted on the grain yield. The basic slag being a good source of nutrients resulted in increase biomass production leading to higher yield (Khan et al., 1992). The favourable influence of basic slag at higher levels (750 and 1000 kg ha^{-1}) were spectacular only in the presence of higher doses (12.50 or 18.75 t ha^{-1}) of green leaf manure. This interesting observation might be well attributed to the energetic effect of green leaf manure on basic slag. The organic acids liberated during the process of mineralisation of green leaf manure was found to be helpful in relcasing the mineral nutrients from

Table 1. Analytical values of initial soil and chemical composition of basic slag and green leaf manure (Glyricidia maculata. L)

Details of Properties	Unit	Soil	Basic Slag	Green leaf Manure
Reaction (pH) (1:2)	-	7.1	10.0	-
Electrical conductivity (EC)	$_{d}sm^{-1}$	0.31	-	-
Cation exchange capacity	(c mole + p/kg^{-1})	18.24)	-	-
Total nitrogen	Per cent	0.11	-	2.53
Total Phosphorus	Per cent	0.07	2.30	0.42
Total Potassium	Per cent	0.36	-	1.07
Total Calcium	Per cent	0.43	23.00	-
Total Magnesium	Per cent	0.31	1.81	-
Total Silica	Per cent	-	18.21	-
Total Iron Per cent	0.73	16.12	-	
Total Zinc ppm	5.6	6.91	-	
Available nitrogen	kg ha^{-1}	231	-	-
Available Phosphorus	kg ha^{-1}	11.20	-	-
Available Potassium	kg ha^{-1}	249	-	-
Available Calcium	ppm	2180	-	-
Available Magnesium	ppm	1041	-	-
Available Silica	ppm	175	-	-
Available Iron	ppm	15.63	-	-
Available Zinc	ppm	4.31	-	-

Table 2. Direct and Residual effect of basic slag with green leaf manure on yield of rice (kg ha^{-1}).

Treatments	Direct		Residual	
	Grain	Straw	Grain	Straw
Control	4517	5300	3678	4593
GLM at 6.25 t ha^{-1}	4998	5818	3771	4731
GLM at 12.5 t ha^{-1}	5584	6581	4400	5460
GLM at 18.75 t ha^{-1}	5792	6730	4846	5795
BS at 500 kg ha^{-1}	4641	5569	3701	4811
BS at 500 kg ha^{-1} +GLM at 6.25 t ha^{-1}	5318	6708	3801	4911
BS at 500 kg ha^{-1} +GLM at 12.50 t ha^{-1}	5781	6930	4434	5581
BS at 500 kg ha^{-1} +GLM at 18.75 t ha^{-1}	5812	7256	4874	6035
BS at 750 kg ha^{-1}	4718	6263	3931	4980
BS at 750 kg ha^{-1} +GLM at 6.25 t ha^{-1}	5500	6920	4035	5115
BS at 750 kg ha^{-1} +GLM at 12.50 t ha^{-1}	5971	7285	4667	5781
BS at 750 kg ha^{-1} +GLM at 18.75 t ha^{-1}	6021	7545	5108	6431
BS at 1000 kg ha^{-1}	4861	6514	4148	5238
BS at 1000 kg ha^{-1} +GLM at 6.25 t ha^{-1}	5691	7493	4330	5024
BS at 1000 kg/ha +GLM at 12.50 t ha^{-1}	6170	7684	4755	6211
BS at 1000 kg ha^{-1} +GLM at 18.75 t ha^{-1}	6509	7789	5156	6933
CD at 5%				
BS	171	261	134	197
GLM	171	261	134	197
BS x GLM	342	521	267	393

BS - Basic Slag GLM - Green Leaf Manure

insoluble basic slag to better available nutrients which is conducive for increased yield (Majumdar and Chakraborthy, 1974).

As could be observed in the grain yield, the significant increase of straw yield was also observed due to incremental addition of basic slag. It indicates that the potential nutrient supply by the basic slag was also resulted on the straw yield. This was in confirmation with the findings of Debnath and Basak (1987). This conjunctive use of basic slag with green leaf manure recorded the highest straw yield than the application of basic slag alone at various levels, as observed in the grain yield.

Residual Effect

The residual effect of basic slag on soil available Si, P, Ca, Mg, Fe and grain yield was demonstrated only at higher doses of basic slag (750 and 1000 kg ha^{-1}). This may be due to rapid depletion of nutrients at lower dose, and slow and liberal release of nutrients at higher levels to the residual crop. The residual effect of basic slag on soil available nutrients and rice grain yield was earlier reported by Debnath and Basak (1987). The residual effect of basic slag was better realized in straw yield rather than grain yield indicating it's suitability for vegetative yield, was also in conformity with their findings of Debnath and Basak (1987).

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Table 3. Direct and Residual effect of basic slag with green leaf manure on soil available P, Ca, Mg, Fe and Si at post harvest stage of rice.

Treatments	Direct					Residual				
	P(kg ha^{-1})	Ca (ppm)	Mg (ppm)	Fe (ppm)	Si (ppm)	P(kg ha^{-1})	Ca (ppm)	Mg (ppm)	Fe (ppm)	Si (ppm)
Control	10.5	1906	831	9.01	176	8.7	1701	766	9.01	102
GLM at 6.25 t ha^{-1}	11.6	1973	856	10.31	183	9.1	1791	778	10.78	111
GLM at 12.5 t ha^{-1}	13.1	2181	876	12.01	180	10.8	1861	788	11.86	118
GLM at 18.75 t ha^{-1}	13.8	2261	879	13.72	182	12.4	1911	778	13.71	112
BS at 500 kg ha^{-1}	11.1	1951	836	9.81	191	8.9	1793	778	9.76	112
BS at 500 kg ha^{-1} +GLM at 6.25 t ha^{-1}	13.8	2028	864	12.86	198	9.5	1843	787	12.82	121
BS at 500 kg ha^{-1} +GLM at 12.50 t ha^{-1}	15.9	2231	389	15.51	218	11.3	1911	797	12.98	128
BS at 500 kg ha^{-1} +GLM at 18.75 t ha^{-1}	16.9	2311	898	16.93	221	13.9	1968	819	15.37	136
BS at 750 kg ha^{-1}	11.8	2915	849	10.16	211	9.1	1830	791	10.28	128
BS at 750 kg ha^{-1} +GLM at 6.25 t ha^{-1}	13.9	2281	884	14.87	216	9.7	1889	791	13.26	134
BS at 750 kg ha^{-1} +GLM at 12.50 t ha^{-1}	16.7	2421	904	16.81	228	11.8	1934	806	14.12	146
BS at 750 kg ha^{-1} +GLM at 18.75 t ha^{-1}	26.9	2596	914	18.12	231	15.1	2001	831	16.70	151
BS at 1000 kg ha^{-1}	13.8	2096	860	11.50	223	9.8	1844	809	10.67	148
BS at 1000 kg ha^{-1} +GLM at 6.25 t ha^{-1}	17.1	2402	920	19.44	231	10.4	2001	809	14.42	158
BS at 1000 kg ha^{-1} +GLM at 12.50 t ha^{-1}	19.1	2655	923	19.95	242	12.6	2002	817	15.36	175
BS at 1000 kg ha^{-1} +GLM at 18.75 t ha^{-1}	19.6	2744	929	21.71	246	14.8	2020	844	16.78	181
CD at 5%										
Basic Slag	0.9	61	16	0.62	7.8	0.6	48	12	0.71	6.2
Green Leaf Manure	0.9	61	16	0.62	7.8	0.6	48	12	0.71	6.2
Basic Slag x Green Leaf Manure	2.0	120	NS	1.50	15.3	NS	96	NS	1.42	12.4

BS - Basic Slag GLM - Green Leaf Manure