REFERENCES

AYYATHURAI, A. (1969). **Sulphur Forms and Availability and Effect of Sulphur in Major Soil Groups of Tamil Nadu.** M.Sc. Thesis submitted to and approved by University of Madras.

BALASUBRAMANIAM, A.S. (1974). **Studies on Soil Sulphur in Major Soil Series of Coimbatore District.** Thesis submitted to Tamil Nadu Agric. University. Coimbatore.

CHAUDRY, I.A. and CORNFIELD, A.H. (1966). The determination of total sulphur in soil and plant material. **Analyst 91** : 528-530.

EVANS, C.A. and ROST, C.O. (1945). Total organic sulphur and humus sulphur of Minnesota soils. **Soils Sci., 59**: 125-137.

GANESHAMURTHY, A.N. (1989). Forms of S in soil profiles of A & N Islands. **J. Indian Soc. Soil Sci., 37**: 825-829.

LEON CHESNIN and YIEN (1950). Turbedimetric determination of available sulphates. **Soil Sci. Soc. Amer. Proc.,** 15: 149-151.

SAHOO, D. and PANDA, N. (1985). Long term effect of intensive cropping and fertilizers use of S availability to rice in an inceptisol. In: **National Seminar on Sulphur in Agriculture** held at TNAU, CBE. 1985. 12pp.

TAKKAR, P.N. (1988). Sulphur status of Indian Soils. **TSI-FAI Symp. Sulphur in Indian Agriculture.** New Delhi. S/1/2/1-31.

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DIRECT AND RESIDUAL EFFECT OF ADDED LEVELS OF BASIC SLAG WITH GREEN LEAF MANURE ON THE AVAILABILITY AND UPTAKE OF NUTRIENTS BY RICE

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ABSTRACT

Field experiments were conducted during the year 1992-93 with different levels of basic slag and green leaf manure, using ADT-36 rice as test crop. The results revealed that the application of basic slag at various levels significantly increased the available P, Ca, Mg and Fe content of soil at all the stages of crop growth. Moreover, the efficiency of basic slag in building the soil nutrients status was more, when it was applied along with green leaf manure. Similarly, the uptake of P, Ca, Mg and Fe by rice was also enhanced by the combined addition of basic slag along with green leaf manure. The basic slag addition along with green leaf manure at higher levels proved its efficiency even after the residual crops.

KEY WORDS : Basic slag, green leaf manure, rice, effect

Basic slag (BS), a calcium silicophosphate obtained as a by product of steel industry is produced to the tune of 1.5 million tonnes annually in India. Many attempts have been made to use the BS as ameliorative amendments in acid soils, since it contains higher proportion of base forming cations, like Ca and Mg. Besides, it is soil ameliorative properties, it also contains appreciable amounts of P and other micronutrients and this can be well utilised for the improvement of crop yields. BS has been in use as a phosphate fertilizer in European countries. The use of BS is limited in India due to difficulties faced in crushing the BS to a required fineness, besides it's low P_2O_5 content which varies from 2-6% as against a minimum of 12% in European basic slag. Superiority of basic slag over super phosphate in acid soils have been reported by several workers and the reported results are not always in agreement. The fertilizer value of basic slag depends much on the composition of the material, soil characteristics, crop species and crop successions. It's active Ca content was as effective as the Ca content of $CaCO_3$ (Dev and Sharma, 1970). The present study was undertaken to study the effect of basic slag as a nutrient carrier to rice in combination with green leaf manure in neutral soils.

MATERIALS AND METHODS

Field experiments were conducted on sandy clay loam soils (*Udic Haplustalf*) at the Central Farm of Agricultural College and Research Institute, Madurai during the year 1992-93. The soil has a pH of 7.1 and EC 0.31 dSm^{-1}. The

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

Details of Properties	Unit	Soil	Basic Slag	Green leaf manure
Reaction (pH) (1:2)		7.1	10.0	
Electrical conductivity (EC)	ds/m	0.31	-	
Cation exchange capacity	(C mol p^+) per kg	-	-	
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 Iron	per cent	0.73	16.12	-
Total Zinc	ppm	5.6	6.91	-
Available Nitrogen	kg/ha	231	1.01	-
Available Phosphorus	kg/ha	11.20	2% citric acid soluble	
Available Potassium	kg/ha	249	-	-
Available Calcium	ppm	2180	-	-
Available Magnesium	ppm	1041	-	-
Available Iron	ppm	15.63	-	-
Available Zinc	ppm	4.31	-	-

available nutrient status of soil was N (231 kg/ha), P (11.2 kg/ha), K (249 kg/ha), Ca (2180 ppm) and Mg (1041 ppm). There were four levels of basic slag (0, 500, 750 and 1000 kg/ha) and four levels of green leaf manure (0, 6.25, 12.50 and 18.75 t/ha) comprising totally sixteen treatment combinations under factorial randomised block design in three replications. ADT-36 rice was choosen as test crop for both main as well as residual crop (Table 1 and 2).

Table 2. Direct and residual effect of basic slag with green leaf manure on rice yield (kg/ha).

Treatments	Direct		Residual	
	Grain	Straw	Grain	Straw
Control	4517	5300	3678	4593
GLM at 6.25 t/ha	4998	5818	3771	4731
GLM at 12.5 t/ha	5584	6581	4400	5460
GLM at 18.75 t/ha	5792	6730	4846	5795
BS at 500 kg/ha	4641	5569	3701	4811
BS at 500 kg/ha + GLM at 6.25 t/ha	5318	6708	3801	4941
BS at 500 kg/ha + GLM at 12.50 t/ha	5781	6930	4434	5581
BS at 500 kg/ha + GLM at 18.75 t/ha	5812	7256	4874	6035
BS at 750 kg/ha	4718	6263	3931	4980
BS at 750 kg/ha + GLM at 6.25 t/ha	5500	6920	4035	5115
BS at 750 kg/ha + GLM at 12.50 t/ha	5971	7285	4667	5781
BS at 750 kg/ha + GLM at 18.75 t/ha	6021	7545	5108	6431
BS at 1000 kg/ha	4861	6517	4148	5238
BS at 1000 kg/ha + GLM at 6.25 t/ha	5691	7493	4330	5024
BS at 1000 kg/ha + GLM at 12.50 t/ha	6170	7684	4755	6211
BS at 1000 kg/ha + GLM at 18.75 t/ha	6509	7789	5156	6933
CD at 5%	171	261	134	197
BS	171	261	134	197
GLM	171	261	134	197
BS X GLM	342	521	267	393

BS - Basic Slag
GLM - Geen Leaf Manure

Table 3. **Effect of treatments on soil available P, Ca, Mg and Fe status during main rice crop growth**

Treatments	P (kg/hr)			Ca (ppm)			Mg (ppm)			Fe (ppm)		
	Max till	Panicle initiation	Post harvest	Max till	Panicle initiation	Post harvest	Max till	Panicle initiation	Post harvest	Max till	Panicle initiation	Post harvest
Control	13.8	11.9	10.5	2210	2160	1906	1057	I	831	18.3	11.81	9.01
GLM at 6.25 t/ha	14.6	13.0	11.6	2401	2298	1973	1121	948	856	22.81	12.81	10.31
GLM at 12.50 t/ha	17.1	14.8	13.1	2490	2401	2181	1167	978	876	25.34	13.89	12.01
GLM at 18.75 t/ha	19.8	16.1	13.8	2641	2518	2261	1168	987	879	22.14	18.12	13.72
BS at 500 kg/ha	14.6	12.6	11.1	2291	2219	1951	1071	942	836	19.29	12.86	9.81
BS at 500 kg/ha with GLM at 6.25 t/ha	16.9	15.5	13.8	24.86	23.91	2028	1143	959	864	23.96	14.86	12.86
BS at 500 kg/ha with GLM at 12.50 t/ha	19.4	16.6	15.9	2663	2497	2231	1176	981	389	28.12	15.87	15.51
BS at 500 kg/ha with GLM at 18.75 t/ha	22.1	17.2	16.9	2731	2597	2311	1188	996	898	30.21	18.93	16.93
BS at 750 kg/ha	15.8	13.9	11.8	2339	2291	2915	1090	951	849	21.52	13.12	10.16
BS at 750 kg/ha with GLM at 6.25 t/ha	18.1	18.0	13.9	2696	2596	2281	1148	986	884	25.86	16.01	14.87
BS at 750 kg/ha with GLM at 12.50 t/ha	23.1	18.1	16.7	2704	2598	2421	1188	996	904	29.01	19.63	16.81
BS at 750 kg/ha with GLM at 18.75 t/ha	24.4	20.9	26.9	2942	1712	2596	1199	1011	914	32.04	21.86	18.12
BS at 1000 kg/ha	16.3	14.8	13.8	2550	2410	2096	1106	960	860	23.46	13.85	11.50
BS at 1000 kg/ha with GLM at 6.25 t/ha	22.8	20.6	17.1	2701	2663	2402	2276	991	920	29.85	19.56	19.44
BS at 1000 kg/ha with GLM at 12.50 t/ha	26.0	24.8	19.1	2917	2788	2655	1193	1029	923	34.37	23.01	19.95
BS at 1000 kg/ha with GLM at 18.75 t/ha	28.5	25.3	19.6	2992	2997	2744	1243	1034	929	35.13	27.41	21.71
Basic slag	0.4	0.3	0.9	71	67	61	28	21	16	1.13	0.81	0.62
Green leaf manure	0.4	0.3	0.9	71	67	61	28	21	16	1.13	0.81	0.62
Basic slag x Green leaf manure	1.4	1.1	2.0	141	135	120	NS	NS	NS	2.25	1.62	1.50

The main crop was transplanted during July 1992 and subsequently the residual crop was raised in December 1992 without disturbing the original layout. A common dose of 100 g N, 50 kg P_2O_5 and 50 kg K_2O/ha were applied basally. The remaining half of N was applied in equal splits, one at maximum tillering stage and the another at panicle initiation stage and recommended cultural practices were adopted. The soil and plant samples were collected at maximum tillering, panicle initiation and post harvest stages of crop growth of main crop and post harvest stage of residual crop. The crops were harvested at maturity and yield of grain and straw of each plots were recorded. The soil and plant samples were analysed for P, Ca, Mg and Fe following standard procedures.

RESULTS AND DISCUSSION

Direct effect on availability and uptake of P, Ca, Mg and Fe in soil (Table 3, 4 and 5)

The highest soil available P, Ca, Mg and Fe in all the stages of crop growth *viz.*, maximum tillering, panicle initiation and post harvest stages of rice was recorded by the combined application of 1000 kg of basic slag with 18.75 t/ha of green leaf manure which was on par with 1000 kg of basic slag with 12.50 t/ha of green leaf manure. This might be due to synergistic effect between

Table 4. Effect of treatments on uptake of P, Ca, Mg and Fe by rice during main rice crop growth

Treatments	P (kg/ha)			Ca (kg/ha)			Mg (kg/ha)			Fe (g/ha)		
	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total	Grain	Straw	Total
Control	12.9	4.8	17.7	5.6	14.6	20.4	4.2	8.0	12.2	505	1489	20504
GLM at 6.25 t/ha	17.1	7.9	25.0	6.8	17.8	24.6	4.8	9.3	14.1	090	1722	2412
GLM at 12.50 t/ha	20.3	10.3	30.6	8.7	23.6	32.3	5.6	10.6	16.2	866	2066	2932
GLM at 18.75 t/ha	22.4	10.8	33.2	13.6	24.6	38.2	5.9	11.1	17.0	950	2281	3231
BS at 500 kg/ha	14.5	5.5	20.0	6.4	16.5	22.1	4.5	8.5	13.0	607	1581	2188
BS at 500 kg/ha with GLM at 6.25 t/ha	18.9	9.9	28.8	8.1	22.1	30.1	5.2	10.8	16.0	1020	2220	3240
BS at 500 kg/ha with GLM at 12.50 t/ha	22.1	11.22	33.4	9.9	25.0	34.9	5.8	11.4	17.2	1161	2567	3628
BS at 500 kg/ha with GLM at 18.75 t/ha	23.8	12.2	36.0	12.2	27.6	39.8	6.2	12.0	18.2	1226	2735	3961
BS at 750 kg/ha	16.1	6.8	22.9	7.2	19.6	26.8	4.8	9.9	14.7	713	1822	2534
BS at 750 kg/ha with GLM at 6.25 t/ha	21.3	11.7	33.0	9.3	24.6	33.9	5.8	11.3	17.1	1108	2505	3606
BS at 750 kg/ha with GLM at 12.50 t/ha	24.0	12.3	36.3	11.8	27.4	39.7	6.5	12.3	18.6	1299	2782	4081
BS at 750 kg/ha with GLM at 18.75 t/ha	25.5	13.2	38.7	13.6	28.1	42.7	6.3	12.9	19.44	1352	3093	4445
BS at 1000 kg/ha	17.8	7.6	25.4	8.0	21.5	29.5	5.2	10.6	15.8	846	1954	2800
BS at 1000 kg/ha with GLM at 6.25 t/ha	22.9	12.7	35.6	11.6	28.8	40.4	6.2	12.6	18.8	1466	3042	45.08
BS at 1000 kg/ha with GLM at 12.50 t/ha	25.3	13.6	38.9	13.4	29.9	43.4	6.8	13.0	20.0	1611	3196	4807
BS at 1000 kg/ha with GLM at 18.75 t/ha	27.9	14.8	42.7	15.8	31.1	46.9	7.3	13.4	20.7	1791	3344	5140
CD at 5%												
Basic slag	1.5	1.2	2.3	0.7	2.1	2.7	0.4	0.8	1.0	118	167	171
Green leaf manure	1.5	1.2	2.3	0.7	2.1	2.7	0.4	0.8	1.0	118	168	171
Basic slag x Green leaf manure	3.0	3.4	4.7	1.4	4.2	5.5	0.8	1.6	2.1	235	334	341

basic slag and green leaf manure in increasing soil available P, Ca, Mg and Fe status found to exist in all the stages of crop growth. The results brought the necessity for the conjunctive use of insoluble basic slag with green leaf manure to get the maximum benefit of basic slag. The higher available nutrients status due to combined use of basic slag, a calcium silicophosphate which is more easily hydrolysed by weak acids produced on decomposition of green leaf manure made easier for the solubilization of P, Ca, Mg and Fe from insoluble basic slag and resulted in increased nutrient availability of soil. Similar view was earlier reported by Debnath and Basak (1986).

The same treatment also recorded the higher uptake of P, Ca, Mg and Fe by rice in all the stages of crop growth. The reason is obvious that the increased nutrient status observed in the above treatment would have facilitated more absorption by enhanced biomass and ultimately resulted on the uptake by rice (Swarup, 1987).

Residual effect on P, Ca, Mg and Fe availability and uptake of nutrients

The residual effect of basic slag was recorded only at higher doses (750 and 1000 kg/ha). This was probably due to slow and prolonged release of P, Ca, Mg and Fe from insoluble basic slag on decomposition of green leaf manure. The uptake of

Table 5. Effect of treatments on the uptake and availability of P, Ca, Mg and Fe

Treatments	Availability				Uprake											
	P kg/ha	Ca (ppm)	Mg (ppm)	Fe (ppm)	P (kg/ha)			Ca (kg/ha)			Mg (kg/ha)			Fe (kg/ha)		
					G	S	T	G	S	T	G	S	T	G	S	T
Control	8.7	1701	766	9.01	10.4	3.9	14.3	3.6	10.3	13.9	3.2	5.9	9.1	432	884	1316
GLM at 6.25 t/ha	9.1	1791	778	10.78	11.0	4.8	15.8	4.1	11.3	15.4	3.4	6.3	9.7	480	973	1453
GLM at 12.50 t/ha	10.8	1861	788	11.86	15.4	6.6	21.5	5.1	13.9	19.0	4.0	7.5	11.5	610	1217	1827
GLM at 18.75 t/ha	12.4	1911	798	13.71	15.8	7.9	22.9	8.4	15.1	21.1	4.5	8.3	12.8	72	1346	2061
BS at 500 kg/ha	8.9	1793	778	9.76	10.8	5.0	15.8	4.1	12.3	16.4	3.3	6.8	10.1	438	111	1499
BS at 500 kg/ha with GLM at 6.25 t/ha	9.5	1843	787	12.82	11.8	5.5	17.6	4.41	13.2	17.6	3.5	7.3	10.8	562	1274	1836
BS at 500 kg/ha with GLM at 12.50 t/ha	11.3	1911	797	12.98	15.1	6.3	21.4	5.7	16.3	22.0	4.3	8.3	12.6	700	1462	2162
BS at 500 kg/ha with GLM at 18.75 t/ha	13.9	1968	819	15.37	17.6	9.3	26.9	9.2	17.6	26.8	4.8	9.6	14.4	809	1677	2486
BS at 750 kg/ha	9.1	1830	791	10.28	11.5	5.4	16.9	4.3	13.0	17.3	3.5	7.1	10.6	500	1260	1830
BS at 750 kg/ha with GLM at 6.25 t/ha	9.7	1889	791	13.26	12.4	6.1	18.5	4.8	14.8	19.6	3.8	7.6	11.4	653	1370	2223
BS at 750 kg/ha with GLM at 12.50 t/ha	11.8	1934	806	14.12	16.8	7.4	24.0	26.1	18.6	24.7	4.4	8.8	13.2	771	1560	2331
BS at 750 kg/ha with GLM at 18.75 t/ha	14.1	2001	831	16.70	18.5	9.9	28.4	9.9	20.6	30.5	3.1	10.2	15.3	891	1853	2744
BS at 1000 kg/ha	9.8	1844	809	10.67	13.6	6.4	20.0	5.3	14.6	19.9	3.9	7.6	11.5	726	1427	2153
BS at 1000 kg/ha with GLM at 6.25 t/ha	10.4	2001	809	14.42	15.6	7.0	22.6	6.0	17.9	23.9	4.3	8.5	12.8	855	1524	2379
BS at 1000 kg/ha with GLM at 12.50 t/ha	12.6	2002	817	15.36	19.46	6.5	25.8	7.2	21.4	28.6	4.8	9.7	14.5	966	1714	2680
BS at 1000 kg/ha with GLM at 18.75 t/ha	14.8	2020	844	16.78	21.1	11.3	32.4	11.6	24.2	35.8	5.4	10.8	16.2	1093	2151	3244
CD at 5%																
BS (Basic slag)	0.6	48	12	0.71	1.21	0.86	1.12	1.1	2.1	2.3	0.46	0.76	0.98	93	191	261
Green leaf manure	0.6	48	12	0.71	1.21	0.86	1.72	1.1	2.1	2.3	0.46	0.76	0.98	93	191	261
Basic slag x Green leaf manure	NS	96	NS	1.42	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

G - Grain S - Straw T - Total

nutrients were also significantly increased over NPK treated control. The residual effect of basic slag on the availability and uptake of nutrients was in confirmity with findings of Debnath and Basak (1987).

REFERENCES

DEBNATH, N.C. and BASAK, R.K. (1986). Effect of rock phosphate and basic slag on available phosphorus in acid soils in relation to soil characteristics, seasons, moisture regimes. **J. Indian Soc. Soil Sci.**, 464-470.

DEBNATH, N.C. and BASAK, R.K. (1987). Residual effect o rock phosphate and basic slag on the yield of crops. **Indiar J. Agric. Sci., 57** : 52-54.

DEV, G. and SHARMA, P.K. (1970). Basic slag as liming material. **Indian J. Agric. Sci., 40** : 853-863.

SWARUP. (1987). Effect of presubmergence and green leaf manuring (*Sesbania aculeata* on nutrition and yield of wet land rice (*Oryza sativa.* L) on a sodic soil. **Biol. Fertil. Soils 5** : 203-208.

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RESEARCH NOTES

CHARACTER ASSOCIATION AND PATH ANALYSIS IN RICE

A knowledge of association between yield and yield components is useful to make simultaneous selection for more characters. Path analysis partitions correlation co-efficients into direct and indirect effects, indicates the relative significance for each component character to yield. In the present study, character association and direct and indirect effects of yield components on grain yield of rice were analysed in 11 parents comprising 4 early maturing (105-115 days) parents (ADT36, ASD16, CO37, IR50) and 7 extra-early maturing (85-95 days) parents (ASD8, Heera, Kalyani II, Sattari, AS18696, AS89011, CO41). Elevan parental lines were raised in randomised block design with three replications during wet season (October, 1993 to March, 1994) at the Rice Research Station, Ambasamudram. Observations were recorded on five random plants in each replication for 12 characters. Phenotypic correlation co- efficients were computed and were partitioned into direct and indirect effects of component traits on grain yield.

In general, all the characters showed positive correlation with grain yield (GY) but only four characters *viz.*, plant height (PHT) panicle length (PL), grains per panicle (GP), and dry matter production (DMP) showed significant positive correlation with GY indicating that these characters might be relied upon for efficient selection. The association of PHT with DMP; PL with GP, 100 grain weight and DMP; GP with DMP; 100 grain

Table 1. Phenotypic correlation co-efficient for yield components in rice.

Character	DPE	PHT	PP	PL	GP	HGW	DMP	HI	KL	KB	KS	GYP
Days to panicle emergence (DPE)		-0.20	0.41	0.41	0.18	-0.03	0.28	-0.44	0.26	0.20	0.25	0.18
Plant height (PHT)			0.27	0.59	0.56	0.11	0.72*	-0.04	-0.16	0.24	-0.05	0.69*
Panicle per plant (PP)				0.34	0.02	-0.33	0.46	-0.50	0.06	-0.31	0.46	0.38
Panicle length (PL)					0.68*	0.71*	0.86**	0.14	0.27	0.29	0.31	0.87**
Grains per panicle (GP)						-0.01	0.79**	0.15	-0.18	0.45	-0.22	0.80**
100 grain weight (HGW)							0.11	0.26	0.43	0.72*	-0.09	0.17
Dry matter production (DMP)								-0.01	0.03	0.29	0.11	0.97**
Harvest index (HI)									0.47	0.05	0.31	0.23
Kernel length (KL)										0.13	0.80**	0.15
Kernel breadth (KB)											-0.39	0.29
Kernel shape (KS)												0.19

* Significant at P - 0.05 ; ** Significant at P - 0.01