

Studies on the Effects of Fly Ash Treated Soil on the Increased Protein Contents in the Seeds of *Glycine max* (Soya Bean)

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The soil of Chhattisgarh State has been found to be of acidic nature, which is not conducive to plant growth and better crop yield. In the pot experiments, various proportions of fly ash and soil were used for soya bean plant growth observations. Soil and the fly ash were from Hasdeo-Bango Command Area and NTPC Korba, respectively. Various plant parameters, especially amino acid contents, showed improvement in the modified soil samples.

Key words: Effect, fly ash, soil, protein, *Glycine max*.

INTRODUCTION

Seed of *Glycine max* is well-known for its high protein content¹. Its protein hydrolysate provides most of the essential amino acids required by the body system². Mo and Zn requirements in legumes are relatively high³. Soils of Chhattisgarh State are red-yellow (lateritic) and acidic in nature⁴. Most soils in rainfall areas (as Chhattisgarh State), exceeding about 500 mm (20 inches) yearly, develop acidic nature⁵. Acidic soils restrict plant growth. Aluminium toxicity is perhaps the most important cause of reduced plant growth. Fly ash is basic in nature and a good source of nitrogen, phosphorus and potassium. It is also a good source of Cu, Zn, Mn, Mo and Fe⁶. Chhattisgarh soil is deficient in available nitrogen, phosphorus, zinc, sulphur, molybdenum and boron⁷.

For better trace element uptake, the soil of Hasdeo-Bango irrigation project area is undertaken for amelioration of soil acidity by fly ash.

EXPERIMENTAL

Fly ash from NTPC, Korba, Chhattisgarh State was used to ameliorate the acidic soil of the Hasdeo-Bango irrigation project area. Plot experiments were carried out.

Soil and fly ash were analysed for their physico-chemical properties. Soil and fly ash were mixed in different proportions and homogenised by grinding and sieving. Samples of different combinations were analysed by the methods suggested by Hesse⁷.

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Approximately 5 kg of sample of each combination were taken for our study. The details of various combinations have been shown in Table-1.

TABLE-1
SYMBOLS OF DIFFERENT COMBINATIONS

S.No.	Details of combinations	Symbols
1.	Control-contained plain soil only	A
2.	Control + NPK (300 : 400 : 200 mg)	B
3.	Control 90%+ Fly ash 10% + NPK (300 : 400 : 200 mg)	C
4.	Control 80%+ Fly ash 20% + NPK (300 : 400 : 200 mg)	D
5.	Control 70%+ Fly ash 30% + NPK (300 : 400 : 200 mg)	E
6.	Control 60%+ Fly ash 40% + NPK (300 : 400 : 200 mg)	F
7.	Control 50%+ Fly ash 50% + NPK (300 : 400 : 200 mg)	G

Determination of pH and conductivity and estimation of SiO_2 , Al_2O_3 , P_2O_5 etc. of fly ash and of different combinations of soil and fly ash were done by methods suggested by Hesse⁷. Physico-chemical properties of fly ash are shown in Table-2.

TABLE-2
PROPERTIES OF FLY ASH

pH	8.890
Electrical conductivity (in mmhos/cm)	0.215
SiO_2 (%)	64.230
Al_2O_3 (%)	19.980
Fe_2O_3 (%)	7.700
P_2O_5 (%)	0.170
SO_3 (%)	0.220
CaO (%)	1.510

TABLE-3
PHYSICO- CHEMICAL PROPERTIES OF DIFFERENT COMBINATIONS

S.No.	Symbol	pH	Conductivity in mmhos/cm	Compounds conc. (%)						Trace elements (ppm)			
				SiO_2	Al_2O_3	P_2O_5	SO_3	CaO	N	Mn	Zn	Mo	B
1.	A	6.45	0.081	77.10	16.42	0.16	0.26	1.19	0.007	47.91	54.21	4.53	0.31
2.	B	6.47	0.088	77.01	16.41	0.19	0.25	1.59	0.008	48.23	60.00	5.80	0.33
3.	C	6.62	0.095	76.44	16.82	0.18	0.24	1.18	0.006	50.30	55.11	8.41	0.46
4.	D	6.82	0.105	73.13	17.35	0.17	0.24	1.22	0.006	51.15	57.20	13.60	0.49
5.	E	7.11	0.113	71.75	17.88	0.17	0.24	1.26	0.005	51.95	57.99	14.46	0.53
6.	F	7.32	0.121	70.98	18.47	0.17	0.24	1.27	0.005	52.44	58.30	19.65	0.58
7.	G	7.41	0.149	69.52	18.93	0.17	0.24	1.31	0.004	53.65	61.53	24.58	0.60

Analysis

For protein analysis, oil was removed from the seeds by using Soxhlet extractor using normal hexane as a solvent⁹. Proteins were isolated by repeated exhaustive extraction of the defatted and decarbohydrated seeds, with cold, alkaline 10% brine solution containing up to 0.25% of NaOH solution for several hours and filtered. The proteins were precipitated from the filtrate at pH 3.5–4.5, by addition of 10% CH₃COOH and heating the solution at 80°C for 1 h.

Various soya bean plants were grown and developed in these various combinations of soil samples. Leaves, seeds etc. were subjected to chemical analysis. The results are given in Table-4.

Preparation of Protein Hydrolysates

0.5 g isolated protein was refluxed with a mixture of 100 mL 6 N-HCl and 80% HCOOH for 14 h. Excess of acid was removed by evaporation; volume was reduced to 5 mL and then again diluted with 25 mL distilled water and filtered. Filtrate was vacuum dried and stored in a brown bottle under nitrogen atmosphere and was sent for HPLC analysis¹⁰. Results have been presented in Table-4.

TABLE-4
PLANT GROWTH PARAMETERS OF PLANT *GLYCINE MAX*

S.No.	Symbol	Plant height (cm)	Leaf area (cm ²)	Chlorophyll content per leaf (µg)	Grain yield (quintal/ha)	Seed wt/ 1000 seeds (g)	Protein contents (%)
1.	A	25.0	27	65	28	130	35.50
2.	B	25.5	28	68	29	135	38.20
3.	C	26.0	29	69	30	136	38.25
4.	D	26.0	31	70	31	138	39.55
5.	E	26.0	32	80	31	139	41.24
6.	F	29.0	40	110	34	145	45.50
7.	G	24.5	31	80	32	140	40.25

The treatment 'F' gave better results.

For comparison the protein hydrolysates of the two seeds obtained from the plants grown in plain soil and in fly ash treated soil were analysed for their amino acid contents using HPLC method. The HPLC results have been shown in Table-5, which compares the amounts of amino acid contents obtained from the plain soil and 40% fly ash + 60% soil.

TABLE- 5
AMOUNTS OF AMINO ACIDS (IN AU UNITS)
DETERMINED BY HPLC METHOD

S.No. Essential amino acids	Amount of amino acids in plant developed in plain soil	Amount of amino acids in plant developed in 40% fly ash + 60% soil
1. Lysine	122.20	1998.62
2. Phenyl alanine	40.12	1575.01
3. Cysteine	21.41	110.25
4. Isoleucine	98.73	246.37
5. Leucine	203.91	552.79
6. Valine	46.09	1582.68
7. Methionine	125.28	364.13
8. Threonine	507.17	2593.96

Conclusion

As is evident from Table-5, the concentration of amino acids from the hydrolysate of protein from *Glycine max* seeds obtained from 40% fly ash and 60% soil is very much higher as compared to that of seeds obtained from plain soil.

Essential amino acids like phenyl alanine, leucine, methionine and lysine which are very important for the body system, have been found to be in higher yield in *Glycine max* seeds obtained from 40% fly ash and 6.0% soil treatment.

Thus improvement in the various plant parameters (Table-4) have been observed in the *Glycine max* plants which were grown in 60% soil and 40% fly ash combination.

All these are possible due to amelioration of acidic soil by fly ash. This condition is optimum for maximum nutrient uptake. Trace elements like Mo and Zn are optimally available to the plants under these conditions. N, P, K are present in the fly ash. Resultant effect is: increased yield of protein and amino acid contents.

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