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Reclamation of Saline and Alkali Soils (Field Experiments)

by

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A fairly large variety of legumes and non-legumes constitute the green manuring crops. The majority of them are legumes. An ideal green manuring crop should possess three characteristics - ability to grow well on poor soils, rapid growth, and abundant and succulent tops.

Lander (1935) used *Senji (Trifolium alexandrinum)* as green manure in the alkaline fields. His treatments with *Senji* revealed that the exchangeable calcium of the soil had increased and an average wheat crop was produced. *Janter (Sesbania aculeata)* is an ideal green manure crop. Gadgil (1937) recommended it even under water logged conditions. Basu (1937) reported that *Janter* improved alkaline soils by lowering exchangeable sodium. Rege and Patwardhan (1956) were of the opinion that green manuring with *Janter* not only reduced harmful salt but also opened the soil. In semi-arid and arid zones, the problem of gradual salinization demands immediate attention. It has been estimated that such type of soils comprise about 39 per cent of the world's dry land area. Dhawan and his collaborators (1958; 1958; 1953) have carried out intensive work on the reclamation of alkali soils. From the results of different experiments conducted by them on different green manures they concluded that *Janter* was one of the best reclaiming agents for alkali soils.

Very little work has so far been done on field scale for investigating most effective methods for the reclamation of saline and alkali soils. It was, therefore, considered desirable to conduct field experiments for comparing different treatments.

Experimental : Two typical soil blocks containing predominantly white alkali (sodium chloride and sodium sulphate) and black alkali (sodium carbonate) were selected for carrying out different treatments. The following data in respect of white alkali reveals the nature of the soil and sub-soil observed on the analysis of a typical representative profiles :-

TABLE I.

Results of analysis of white alkali profile.

S. No.	Depth.	Total Soluble Salts.	pH	Dispersion Co-efficient.	Degree of alkalization. Exch. Na + K × 100 / Exch. Na+K+Ca+Mg.
1.	0'-0.5'	2.5	9.90	59.3	90.5
2.	0.5'-1.0'	0.81	9.15	53.8	77.5
3.	1.0'-1.5'	0.56	9.77	66.6	61.2
4.	1.5'-2.0'	0.48	9.20	80.7	68.5
5.	2.0'-2.5'	0.47	9.85	79.1	61.8
6.	2.5'-3.0'	0.41	9.93	83.3	79.7

TABLE II.

Results of analysis of black alkali profile.

S. No.	Depth.	Total Soluble Salts.	pH	Dispersion Co-efficient.	Degree of alkalization. Exch. Na + K × 100 / Exch. Na+K+Ca+Mg.
1.	0-0.5'	3.00	10.25	67.10	81.40
2.	0.5-1.0'	0.85	10.00	63.80	74.40
3.	1.0-1.5'	0.68	9.95	51.00	71.90
4.	1.5-2.0'	0.70	9.97	64.80	74.50
5.	2.0-2.5'	0.70	10.05	74.00	66.67
6.	2.5-3.0'	0.73	10.05	65.70	84.10

Dispersion co-efficient measures the percentage of total clay that can pass into suspension stage by contact with water.

The following treatments were conducted :—

A. **White alkali soils :**

(i) Control :— Leaching (18" delta before rice transplantation).

(ii) Leaching as in (i) *cum* green manuring with *Janter (Sesbania aculeata)* at 26,000 lb. per acre.

(iii) Leaching as in (i). Farm yard manure at 8,500 lb. per acre plus green manure *(Janter)* at 13,000 lb. per acre.

(iv) Leaching as in (i). Press-mud at 4,500 lb. per acre plus green manure *(Janter)* at 13,000 lb. per acre.

Press-mud is a waste from sugar factories and contains 40 to 45% Calcium oxide.

B. **Black alkali soils :**

(i) Control :— Leaching (24″ delta before rice transplantation)

(ii) Leaching as in (i) *cum* green manuring with *Janter (Sesbania aculeata)* at 26,000 lb. per acre.

(iii) Leaching as in (i). Farm yard manure at 8,500 lb. per acre plus green manure *(Janter)* at 13,000 lb. per acre.

(iv) Leaching as in (i). Press-mud at 4,500 lb. per acre plus green manure *(Janter)* at 13,000 lb. per acre

(v) Leaching as in (i). Press-mud at 4,500 lb. per acre plus distillery waste at 65,000 lb. per acre.

Distillery waste is a waste product from alcohol factories. Its pH ranges between 4.5 to 4.9. Due to its acidic nature the calcium carbonate usually present in the semi-arid and arid soils become soluble at this pH value and the reverse reaction of replacing Sodium by Calcium in the exchange complex starts. With the gradual replacement of Sodium by Calcium the ameliorative properties of the soil begin to re-appear.

(vi) Leaching as in (i). Farm yard manure at 8,500 lb. per acre plus Gypsum at 2,500 lb. per acre.

(vii) Leaching as in (i). Farm yard manure at 8,500 lb. per acre plus Distillery waste at 65,000 lb. per acre.

(viii) Leaching as in (i). Green manure at 13,000 lb. per acre plus Gypsum at 2,500 lb. per acre.

The size of the experimental plots was kept at 40 ft. x 20 ft. Four replications were given to each treatment.

Drains from 3 to 3½ ft. deep were dug all around the fields for facilitating the sub-soil drainage.

Discussion of Results : *White alkali plots :* Weekly floodings each with 3″ irrigation were given to each plot for six weeks in May and June. After the fourth irrigation, treatments (ii), (iii), and (iv) were applied. Rice seedlings (349 Punjab Jhona) were transplanted in each plot in the 4th week of June. Each plot received 30″ of irrigation for the maturity of rice. This was aided by a normal monsoon rainfall of 15 inches.

Fig. I presents the results of average yield per acre of rice in each plot, which runs in the following order :—

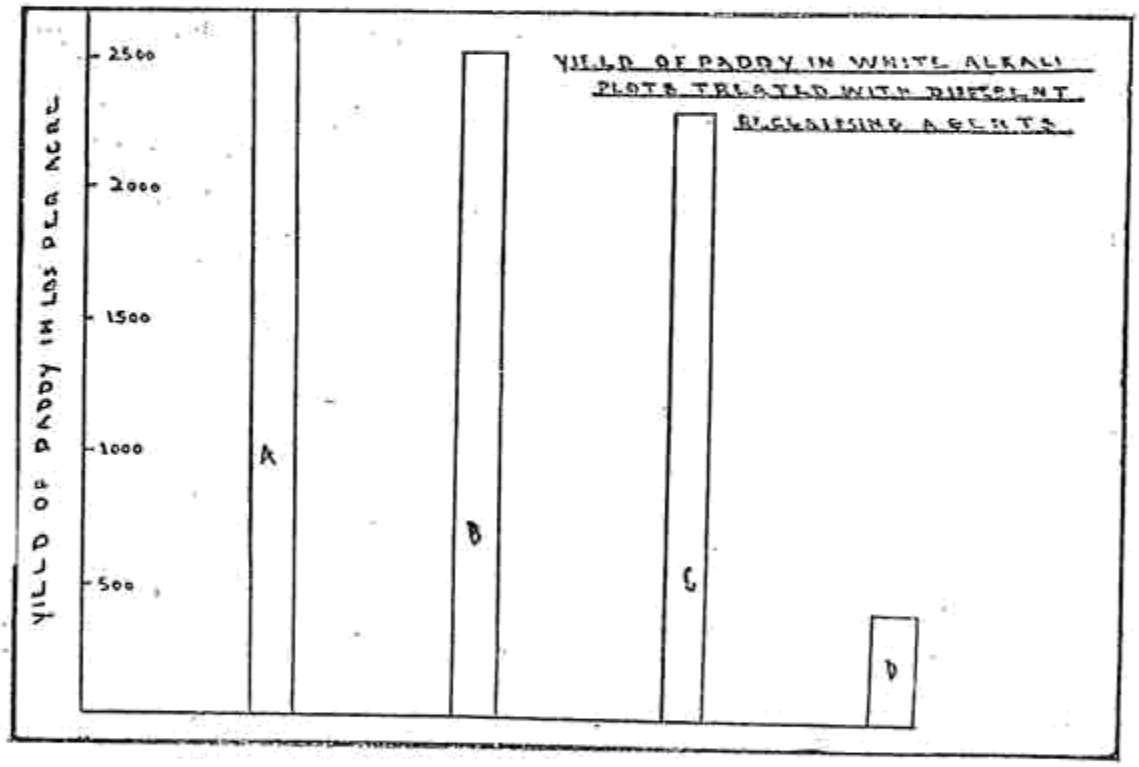
(i) Plots treated with green manure plus Press-mud had the maximum yield.

(ii) Plots green manured with *Janter (Sesbania aculeata)* alone stood second.

(iii) Green manuring plus farm yard manure plots came next to *Janter* treated plots.

(iv) Control plots had very little yield.

Fig. 1.



A — Press-Mud. @ 4500 lb/acre plus green manure @ 13000 lb/acre and leaching.

B — Leaching cum green manuring with 26000 lb/acre.

C — Farm yard manure @ 2300 lb/acre plus green manure @ 13000 lb/acre and leaching.

D — Control (leaching with 18" delta).

It confirms that green manuring plays the dominant role in increasing the yield of paddy in such type of soils.

Dispersion co-efficient decreased maximum in plots treated with Press-mud and green manured with *Janter* in the second year of reclamation.

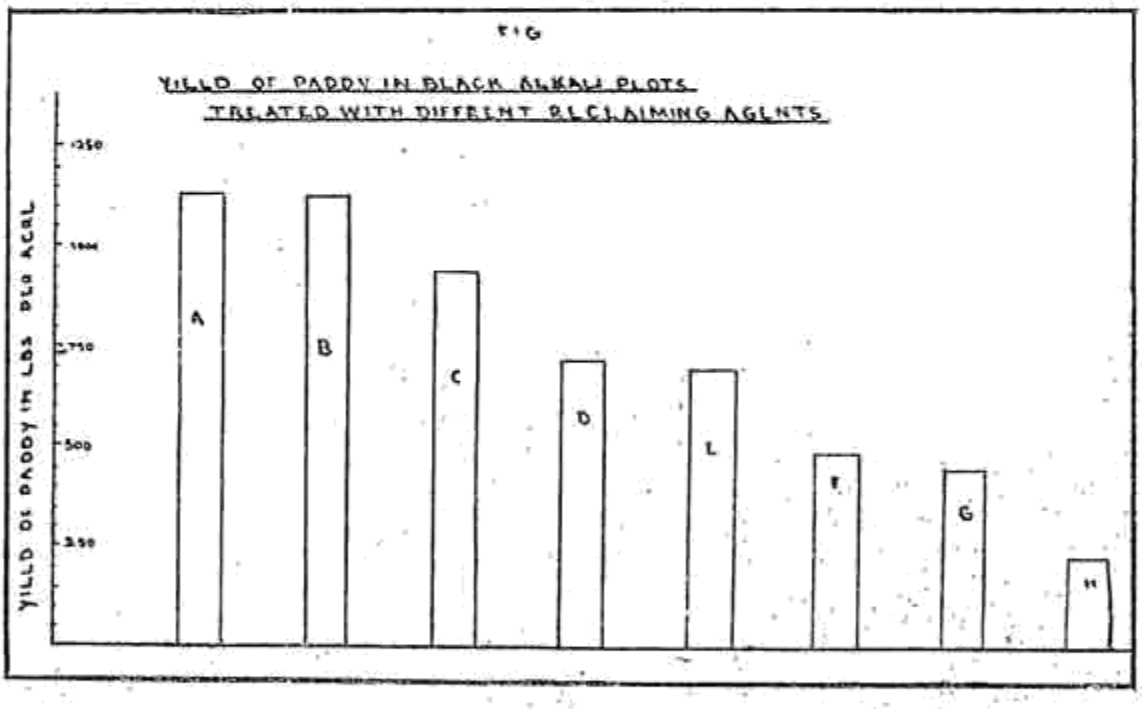
Black alkali soils : The second experiment related to the reclamation of black alkali soils as described in "experimental details".

The layout and size of plot was of the same order i. e. 40' x 20'. The treatments were eight and replications were four. The variety of rice transplanted was the same i. e. 349 Punjab Jhona.

Fig. II shows the yield of paddy in different plots given varying types of treatments. A glance at fig. II reveals the effect of various treatments in the following order :—

(i) Plots green manured with *Janter* and containing farm yard manure or treated with Distillery waste (a waste product from alcohol industry) plus farm yard manure gave the maximum yield of 1,125 lb. per acre.

FIG. 2.



A — Leaching farm yard manure at 8500 lb/acre green manure at 19000 lb/acre

B — Leaching farm yard manure at 3500 lb/acre plus distillary waste at 6500 lb/acre.

C — Leaching green manure at 13000 lb/acre plus gypsum at 4300 lb/acre.

D — Leaching green manure at 13000 lb/acre plus press-mud at 4500 lb/acre.

E — Leaching green manure at 20000 lb/acre.

F — Leaching Press-mud at 4500 lb/acre plus distillary waste at 6500 lb/acre.

G — Leaching farm yard manure at 8500 lb/acre plus gypsom at 2500 lb/acre.

H — Control leaching with 24" Delta

Distillery waste being acidic in character, with pH 4.5 to 4.9 aids in neutralising the excessive alkalinity of the soil more quickly.

(ii) Green manuring plus gypsum had 950 lbs. per acre yield.

(iii) Green manuring plus Press-mud produced 720 lbs. per acre.

(iv) From green manuring alone only 700 lbs. of rice per acre were obtained.

(v) Press-mud plus Distillery waste could produce 500 lbs. per acre.

(vi) Farm yard manure and gypsum behaved parallel to Press-mud plus Distillery Waste.

The results of dispersion co-efficient showed that Distillery waste *cum* green manuring with *Janter (Sesbania aculeata)* produced the maximum reduction. Dhawan (1950) reported that the structure of the soil was mainly governed by the dispersion co-efficient. Therefore the treatment producing the maximum reduction in the dispersion co-efficient was the most effective in reclaiming the alkali soils.

It was further confirmed from the results of these plots that a combination of green manuring with farm yard manure or distillery waste was very effective. But there are inherent difficulties for the transport of distillery waste, while farm yard manure may not be available in sufficient quantities. If these products are available near the site of reclamation, their combination with green manuring is the most effective treatment. In case they are not available, green manuring with *Janter* alone should be adopted as a reclamation agent.

Dhawan and his associates *(loc. cit.)* have also concluded from the laboratory and semi-field experiments that *Janter* is the most effective green manure plant.

Summary : The following methods may be safely adopted for the reclamation of saline *cum* alkali soils :—

(1) Adequate drains depending upon the soil and water table conditions should be constructed all around the field. Field drains should pour into a bigger block-drain.

(2) *Janter (Sesbania aculeata)* for green manure should be sown in early April, and when the plant attains a height of 12″, leaching operations should be started to complete a total of 18″ to 24″ delta in May and June. If *Janter* cannot be grown in the first

year due to excessive alkalinity, it may be grown on a good nei nearby and imported from there in mid June. Green manure mus be incorporated before the 15th June. One or two subsequent irriga tions would decompose the organic matter. If press-mud or distillery waste is not available nearby, only green manuring with *Jantc (Sesbania aculeata)* should be carried out.

(3) Rice should be transplanted preferably in rows with two or more seedlings at each spot.

(4) If irrigation is available during winter, Berseem *(Trifolium alexandrinum)* should be taken as winter crop and sown immediately after paddy harvest; otherwise gram *(Cicer arietinum)* lentil or any cereal may be grown.

(5) Repetition of this method during the subsequent two years would reclaim the soil completely and would tend to increase the paddy yields from 2,400 lb. to 3,000 lb. and subsequent Berseem crop from 50,000 lb. to 80,000 lb. of green fodder, or in the absence of that 1,200 lb. of gram.

(6) The drains will have to be kept deep and clean.

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