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MADHUBAN MEADOWS

Diagnosis and Amelioration of Alkali Soils in Golf Course at The Haryana Armed Police Madhuban, Karnal- Haryana

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FOREWORD

Several bald and barren patches had appeared in the green turf of Golf Course at the Haryana Armed Police, Madhuban, Karnal. We approached the Central Soil Salinity Research Institute, Karnal for appropriate solution to the problem. The CSSRI scientists studied the problem and applied reclamation techniques, which proved highly successful in converting bald patches into green grass. The amelioration of alkali soils in Golf Course has demonstrated vital role of science in the service of society. It is my endeavor that such investigations should be extended to other degraded lands to improve the environmental quality and also increase alternate economic opportunities in sports, recreation and tourism.

I wish to congratulate the authors for their attempt in conserving degraded lands into practically eco-friendly land uses for the larger benefit of the society.

(V.N. Rai)

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CONTENTS

INTRODUCTION

Located on national highway number 1 and at the periphery of NCR Delhi, the Haryana Armed Police, Madhuban enjoys the most strategic location in Haryana. Lying at its doorstep is the first engineering bridge of India, the old Mughal Canal Bridge or *Pucca Pul*. The HAP was established at Madhuban, Karnal, in the seventies. Large part of the complex was covered with highly degraded barren alkali land. Subsequently, a meadow landscape was developed to create a beautiful 9-hole golf course.

Plate.1. Alkali patches in the golf course at HAP Madhuban

But, appearance of several bald and barren patches measuring 5 to 80 square meters marred the beauty of the green turf (Plate 1). Similarly some raised beds and sunken channels also suffered with poor and stunted plant growth. A detailed investigation of soil, land and water occurring in the golf course was undertaken to diagnose the problem and apply appropriate ameliorative techniques for better management of the golf course.

The golf course was traversed and representative patches were selected for study. The soils were sampled upto 4 feet depth for laboratory analysis. The soil layers in barren patches were found very dry, hard, and dense, devoid of soil pores (Plate 2). Plentiful lime nodules were also present in the soil, which is a common feature found in alkali soils of Haryana. Layer wise morphology of a typical soil profile representing alkali soils existing in northern India is described in the later part of the bulletin. Ground water sample from installed tube well was also collected and analysed to ascertain the quality of irrigation water.

Plate.2. Hard and compact alkali soil profile at HAP Madhuban

ALKALI HAZARD IN THE SOILS OF GOLF COURSE

Data in Table 1 show that soil in bald patches were strong alkali with pH 9.8 in the surface and 10.0 and above in the sub surface soil layers.Higher pH values render the soils infertile due to poor availability of essential plant nutrients. Dominance of carbonate and bicarbonate of sodium in the soil solution caused dispersion of clay particles, which settled down in horizontal plane to form platy and angular soil structures. Such structures restrict free movement of air and water and therefore, greatly reduce the infiltration rates of soil.

Higher salt concentrations in the upper soil layers indicated a definite salt accumulation pattern associated with golf course landscapes where it is not easy for the shallow rooted grasses to push down the salts as was the case in the cultivated fields where regular irrigation, cultural practices and deep probing crop roots manage to push salts in deeper soil layers. This tendency of surface salt accumulation in golf course landscapes needs to be properly addressed in any successful amelioration programme.

Data in Table 2 show physico-chemical characteristics of alkali soil profile. The contents of both clay and $CaCO_3$ concretions have significantly increased in the middle and lower soil layers. Under alkali domain higher contents of clay and $CaCO_3$ concretions exert harmful influences on soil properties. The dispersed clay particles after drying act as cementing agents and create impermeable bands in soil while the beneficial role of calcium as an essential plant nutrient and a flocculating agents are not fully realized once it is transformed into concretionary form by soil alkalization. For reclamation of these soils, application of gypsum at the rate of 17-19 tons per hectare is necessary.

The soil separates viz, clay, silt and sand combine in different proportions to form sandy loam and sandy clay loam soil textures in the surface and subsurface respectively. Such textures have moderately slow infiltration rates, therefore, need light and frequent irrigation. Use of sprinklers for irrigation is recommended. It is cautioned that during heavy rain storms the soils may induce heavy run-off. Therefore, to avoid flooding of the turf and other structures drainage provision of some appropriately placed open channels and water pools are necessary. The golf course already has one such pool, second pool could, ideally be located in the southwestern part. The water pools can be designed to enhance ground water recharge in the meadowland.

Table 1. Characteristics of a typical alkali soil profile from golf course at HAP, Madhuban

Depth (cm)	pHs	ECe (dS/m)	Na	Ca + Mg	CO_3 + HCO_3	Cl	SO_4
			me/1				
0 -7	9.8	4.3	48.5	2.2	29.0	14.2	6.0
7 - 19	10.2	6.5	77.5	2.0	58.5	13.0	4.6
19 - 35	10.2	4.7	54.5	1.7	50.0	6.0	2.0
35 - 74	10.0	3.0	36.5	1.0	29.5	6.0	0.5
74 - 118	9.3	2.1	22.0	1.5	13.0	7.5	1.0

Table 2. Physico-chemical characteristics of a soil profile from golf course at HAP, Madhuban

Depth (cm)	Clay	Silt	Sand	$CaCO_3$ >2mm	$CaCO_3$ <2mm	G.R. (t/ha)
	%					
0 -7	14.7	28.8	56.5	2.5	1.6	17.0
7 - 19	15.3	27.7	57.0	1.0	1.1	19.5
19 - 35	22.5	25.5	52.0	2.0	1.5	--
35 - 74	25.0	23.5	51.5	4.5	2.1	--
74 - 118	18.0	22.0	60.0	15.5	5.0	--

ALKALI HAZARD IN THE CRICKET GROUND AND ROSE GARDEN

Besides the golf course, some other sites like the cricket ground, rose garden and areas around the stadium are also affected by severe alkali hazard. A large area of the cricket ground is covered under strong alkali soils, while the rose garden occupies strong alkali in patches (Plate 3). Characterized by extremely hard and infertile surfaces the strong alkali soils have either turned into barren lands or grown some coarse grasses or stunted trees. Soil characteristics (Table 3) indicate the severity of alkalinity in the cricket ground. These soils are amenable and can be treated with gypsum to bring substantial improvements in the playground. Moreover, some of the alkali characteristics can be beneficially utilized in preparing fast and bouncy cricket pitches, which are rare in Indian conditions. The preparation of lively and fast pitches is briefly described in the

Plate 3. Strong alkali soils in cricket ground

Table 3. Selected characteristics of the surface 15 cm layer and gypsum requirement of alkali soil from cricket ground at HAP, Madhuban

Soil depth (cm)	pHs	ECe (dS/m)	Na	Ca+ Mg	CO_3+ HCO_3	Cl	G.R. (t/ha)
			me/1				
0-15	10.3	15.7	197.5	1.6	157.0	32.0	23.0

proceeding pages. Another notable feature is the running of augmentation canal through the HAP Madhuban (Plate 4). About 1.5 km long canal embankments offer good scope for soil and water conservation measures. It can be developed into a beautiful waterfront-park by carving the slopes into small steps and terraces and planting with flowerbeds and herbs to serve as a recreation spot both for the children and the elders. Installation of fancy lights and water fountains would further enhance the quality and beauty of the park.

Plate 4. Canal embankments could be developed as water- front parks

UNDER GROUND WATER QUALITY

A water sample was collected from the tube-well located about 25 m on the eastern side of the water pool. The tube-well was installed at a depth of 80 m in the year 2002. The laboratory analysis of water (Table 4) indicates very good quality for irrigation.

Table 4. Water quality from tube well at the site of golf course at HAP, Madhuban

pHs	ECe (dS/m)	Na	Ca+ Mg	CO_3+ HCO_3	Cl	SAR	RSC
		me/1					
7.9	0.61	1.3	5.3	4.6	2.0	0.8	Nil

RECLAMATION OF ALKALI SOILS OF THE GOLF COURSE

The golf course is interspersed with several patches of moderate to strong alkali soils. The methods and practices adopted to reclaim these patches are briefly described below and progressive reclamation is shown in plate 5.

After proper leveling, strong bunds around each alkali patch were made and irrigated heavily. After the soil attained workable soil moisture condition, gypsum @ 17-20 t/ha was uniformly sprinkled and mixed with a spade upto a depth of 12-14 cm. Recommended dose of Dermit insecticide was applied to free the soil of commonly occurring insects. The patches were again irrigated and broadcasted with *dhaincha* seed @ 75 kg/ha and a soft dose of urea @ 50 kg N/ha was applied. Addition of Zinc Sulphate @ 20kg /ha hastened the reclamation process. The soil was kept wet with frequent irrigations. *Dhaincha* plants were cut after attaining a height of 30-35 cm, buried in the soil and allowed to decompose. The soil was flooded with water till *dhaincha* was largely decomposed. The grass was planted and irrigated regularly to maintain sufficient wetness in the soil. After grass had been established, recommended doses of fertilizers and irrigation were

applied. As golf courses do not enjoy the benefit of deep probing crop roots, occasional piercing of soil surface of the treated patches by deep coring machine is recommended.

Plate 5. Steps in alkali soils reclamation
1. Diagnosis of alkali soils . 2. Leveling, bunding , gypsum application, irrigation and sowing of *dhaincha* in alkali soils
3.& 4. Burrying *dhaincha* in soil. 5. Original alkali soil. 6.Reclaimed alkali soil

REQUIREMENTS AND MANAGEMENT OF GOLF COURSE

Drainage System: The HAP Madhuban golf course fulfills most of its drainage needs. The laying of meadows, roads, channels, passages and other structures provides sufficient slope gradient to induce gentle run-off flow to the outlets available in the form of water pools and channels. Construction of a second pool in the southwestern part is recommended. The meadow soils have good internal drainage conditions to absorb and percolate water from low to medium intensity rainstorms.

Erosion Control: The barren and thinly vegetated areas are susceptible to water erosion. Reclamation of barren alkali patches and putting them under grasses or vegetation shall check soil erosion by water. Wind erosion is negligible.

Fertilizers, Herbicides and Fungicides: Regular fertilization with N,P, K is recommended for establishing and maintaining lush green growth of grasses and vegetation. The grass and herbs etc, need periodic check for use of fungicides and herbicides.

Irrigation System and Equipment: Captive irrigation through tube well meets the requirement of the meadows. However, another tube well is necessary to meet irrigation requirement of the entire meadows. Installation of micro irrigation equipment like the sprinkler and the drip in the entire meadows would substantially save on irrigation water.

Pool Lining: Lining of a water pool is important to prevent the erosion of the banks and slopes. The existing pool has been suitably lined with stones to prevent damage by erosion.

Sediment Control: Alkali and barren patches are potential areas producing sediments. Reclamation and vegetating these patches would prevent sediment yield. However, putting bio-filters at the water entry points, in and around the pool would ensure clean and clear water in the pool. Periodic cleaning and desilting of the pool is recommended.

Soil Conditioners and Amendments: Except amendments to reclaim alkali patches, the meadows do not require any other soil conditioner.

Soil Testing: Periodic soil testing for soil fertility and occurrence of alkalization is recommended to apply required fertilizers, farmyard manure and amendments to maintain lush green meadows.

Water Conservation: A water pool of sizeable capacity is already available to harvest rainwater. Very gentle slopes and soft undulations induce better conditions for water percolation in the meadows. However, some more channels and bunds are needed to guide the flow of water into water harvesting structures.

PREPARATION OF A FAST AND BOUNCY CRICKET PITCH

Preparation of fast and bouncy pitches are rare in India and more so when the available soil is alkali. In most of the cases, pitches are laid by using clayey material from a nearby source comprising a lake or a pond. Such materials, due to higher stickiness and plasticity, low porosity and fertility produce very hard pitches that are liable to crack easily. "The simple concept of producing a fast and bouncy pitch is to fill up one of the two surfaces with ample air." In this case, one cannot do much with a cricket ball so the only option left is to design, lay and engineer the pitch in a manner that it can trap a lot more air.

In order, therefore, to lay a fast, bouncy pitch, bulk of the material used would be clay from a local source but its properties of stickiness, plasticity, low porosity, fertility, workability etc need to be altered to a soil mixture which is firm, cohesive, porous and fertile. This requires selection of appropriate clayey soils and mixing in right proportions with some binding and porous materials,

organic matter, resins, fertilizers etc. A pitch prepared from a combination of such soil mixtures would acquire inherent spongy nature to hold more air and water. Proper curing and rolling of the pitch can further enhance the sponginess. The improvised porosity would induce bounce in the pitch and also allow steady supply of water to grass roots over a longer duration that in turn, will bind the soil firmly in place and also provide pace to the pitch.

MORPHOLOGICAL DESCRIPTION OF ALKALI SOIL PROFILE

Location of Soil Profile: The pit was studied in a 12x8 m barren patch located about 8 m east of old tube well.

Parent Material and Landform: The golf course is laid on very gently sloping old plain of the Gangetic Plain. The terrain is represented by old Yamuna plain. The soil map developed by CSSRI Karnal in 1975 showed that most of the soils in and around HAP Madhuban were suffering from alkalinity. The augmentation canal running adjacent to the golf course has been aligned on the very first Mughal era canal constructed by Emperor Shahjahan to irrigate *sikaargah* and meadowlands around Delhi. Historically, the old brick-made bridge on the Mughal canal at G.T. Road, Madhuban was the first engineering bridge structure in India.

Natural Vegetation: *Dub, Dab, Motha and Karnal* grass and *Palash* tree are the five commonly occurring natural vegetation found in the alkali patches.

Drainage: The alkali patches are well drained on the surface but very poorly drained in the subsurface.

Depth	Morphological Description of Soil
0-7 cm	Yellowish brown (10YR5/6) when moist and pale brown (10YR6/3) when dry; sandy loam; moderate, fine and medium platy and sub angular blocky soil structure; few fine roots, very few fine pores; 2-3% lime nodules; strong effervescence with dilute HCl.
7-19 cm	Grayish brown (10YR5/2) when moist and brown (10YR5/3) when dry; sandy loam; strong coarse angular blocky soil structure; very few fine roots; very few fine pores; <1% lime nodules; weak effervescence with dilute HCl.
19-35 cm	Brown (10YR5/3) when moist and pale brown (10YR6/3) when dry; sandy clay loam; strong, medium angular blocky soil structure; very few fine pores, few fine iron-manganese concretions present; 1-2% lime nodules; strong effervescence with dilute HCl.
35-74 cm	Brown (10YR5/3) when moist and yellowish brown (10YR5/4) when dry; sandy clay loam; strong, medium sub angular blocky soil structure; very few medium pores, few fine iron-manganese concretions present; 2-4% lime nodules; strong effervescence with dilute HCl.
74-118 cm	Yellowish brown (10YR5/4) moist and dry; sandy loam; moderate medium sub angular blocky soil structure; 12-15 % lime nodules; violent effervescence with dilute HCl.

CONSULTANCIES AND OUTREACH PROGRAMMES

- Comparative performance of DP-3491 *vis-a-vis* gypsum as an amendment for reclamation of alkali soils(R. Chhabra)
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