DIHAR

Extension Bulletin No. 24

IMPROVING SOIL HEALTH STATUS OF COLD DESERT LADAKH REGION

Somen Acharya, Narendra Singh, Anand K Katiyar
S B Maurya, R B Srivastava

GOLDEN JUBILEE YEAR 2011-12

Defence Institute of High Altitude Research (DIHAR)
Defence Research & Development Organisation (DRDO)
LEH (Ladakh)-194101 (J&K) India

Introduction

Soil is a living system that represents a finite resource vital to life on the earth. It forms a thin layer of unconsolidated minerals and organic matter on the earth's surface that performs many processes essential to life. It develops slowly from parent materials and is modified by various soil forming factors like time, climate, macro and microorganisms, vegetation and topography. Soils are complex mixtures of minerals, organic compounds and living organisms that interact continuously in response to natural and imposed biological, chemical and physical activities. It serves as a substrate for plant growth, as a nutrient reservoir, and as the site for many biological processes involved in decomposition and recycling of plant and animal residues. People are dependent on soil, and conversely, fertile soils are dependent on people and the use they make of the land. Fertile soils provide starting point for successful agriculture. For determination of soil health status of the cold arid Ladakh region, DIHAR has made survey in several villages of Leh and Kargil district. DIHAR also analyzed various physico-chemical properties of soil and given recommended practices which could improve soil fertility as well as crop productivity in this region.

Soil sample collection and preparation

The soil samples collected for analysis should be representative of the area sampled. The soil sample should be taken in a zig zag pattern to cover the field. A representative composite soil sample can consist of 5-10 sub-samples from a uniform field. For most field crops, a sampling depth of 15-20 cm is desired. For sampling soft and moist soil, the tube auger, spade or khurpi is quite satisfactory. A screw type auger is more convenient on hard/dry soil while post hole auger is useful for sampling excessive wet areas/rice fields.

The collected soil samples should be thoroughly mixed on a clean piece of cloth, polythene sheet or thick paper and the bulk reduced by the quartering method so that about 500 gm of composite sample is retained. It is preferable to air dry soils at 20-250C and 20% to 60% relative humidity. After air drying, the soil samples are crushed gently in pestle and morter and sieved through a 2 mm sieve. For determination of organic carbon the samples should be sieved through a 0.25 mm sieve. Litter, root parts and other plant reisdues should be removed from soil samples before sieving.

For determination of soil health status of this cold arid region, DIHAR has made survey and collected soil samples from several villages of Leh and Kargil region. Depending upon the land holding, 3-6 composite samples have been collected from each village.

Parameters important for soil fertility

Chemical analysis of soil samples is a prime source of information on the relative availability of plant nutrients. In most cases, only a small fraction of the nutrients present in soils are plant available form. The samples have been analyzed for various physico-chemical parameters which are indicator of soil health of a particular region. Major nutrients (nitrogen, phosphorus and potassium) and micro nutrients (zinc, iron, copper and manganese) were measured besides measuring soil pH, presence of soluble salts and organic carbon which are very important parameters for soil fertility. The soil analysis data revealed that the type of soil in the region depends upon weathered rocks in the particular location and soils in this region are mostly sandy to sandy loam in nature which is very susceptible to erosion.

Table 1 : Range of chemical properties of soils of different villages of Leh and Kargil district

Parameters	Leh		Kargil	
	Minimum	Maximum	Minimum	Maximum
pH	5.65	10.12	6.57	9.47
EC (m mos/cm)	0.05	1.56	0.08	1.55
Organic carbon (%)	0.08	1.41	0.21	3.2
Nitrogen (Kg/ha)	185.6	411.4	205.1	452.5
Phosphorus(Kg/ha)	4.0	25.66	2.80	116.1
Potasssium (kg/ha)	12.32	496.15	115.0	861.3
Zinc (ppm)	0.06	6.0	0.14	5.17
Iron (ppm)	0.54	33.79	0.20	38.1
Copper (ppm)	0.43	3.52	0.48	3.41
Manganese (ppm)	0.2	32.17	0.40	4.74

Majority of the soils in Leh and Kargil district are sandy to sandy loam in texture and medium to medium-high (e"0.75%) in organic matter with poor water holding capacity. The pH ranged from 5.65 to 10.12 in Leh and pH of Kargil varied from 6.57-9.47. More than 90% samples from both the districts were having pH in the ranges of 7-9. Therefore, majority of the soils in high altitude cold desert regions are alkaline in nature. Electric conductivity ranged from 0.05-1.56 dS/m in Leh district and 0.08-1.55 dS/m in Kargil respectively. More than 90% soils are low in available phosphorus but high in potassium with availability of the potassium depending upon the other parameters of the soil. In both the districts, micronutrient status (zinc, iron, copper and manganese) are found to be below critical level and majority of soil samples have shown deficiency in its content. However, copper content is found normal in 65% villages.

Irrigation water quality of Ladakh

In agriculture, irrigation water quality is related to its effects on soils, crops and management practices necessary to overcome problems linked to water quality. Chemical constituents of irrigation water can affect plant growth directly through toxicity or deficiency, or indirectly by altering plant availability of nutrients. Therefore, appropriate tests should be conducted prior to apply irrigation water in the field for better growth and yield of the crops. Hence, DIHAR also contributed towards assessment and comparative study of irrigation water quality of different villages of Leh and Nubra valley. Average pH and total dissolved solids (TDS) of irrigation water is found between 7.78 to 8.06 and <180 ppm respectively, which is considered to be good for irrigation. Using EC and sodium adsorption ratio (SAR) values, irrigation water of Leh and Nubra valley exists in C_2S_1 and C_1S_1 class, respectively which is considered to be good for irrigation purposes. Mean soluble sodium percentage (SSP) and residual sodium carbonate (RSC) values are 19.5

and 0.30 and 24.8 and 0.38 for Leh and Nubra valley, respectively. Zn and Mn concentration was also found much lower (Zn: 0.009 and 0.007 ppm; Mn: 0.008 and 0.005 ppm for Leh and Nubra valley respectively) than recommended maximum concentration (Zn: 2 ppm; Mn: 0.2 ppm).

Table 2 : Irrigation water quality of different villages of Leh valley

Name of Villages	pH	EC (μScm^{-1})	TDS (ppm)	SAR	SSP	RSC (mel^{-1})
Chuchot Goma	8.00	334.7	161.0	1.14	24.2	0.07
Chuchot Soma	8.09	340.3	163.3	1.12	23.4	0.07
Chuchot Yogma	8.10	337.3	161.6	1.15	24.3	0.22
Matho	7.92	286.7	138.1	0.28	7.7	0.15
Nimoo	8.00	323.6	154.1	1.14	24.2	0.22
Phey	7.90	232.3	111.4	0.90	22.3	0.34
Phyang	7.82	197.7	94.6	0.69	16.3	0.30
Saboo	7.85	141.7	66.9	1.47	35.1	0.37
Shey	7.93	288.0	136.0	1.04	24.3	0.50
Stoke	7.78	232.0	111.3	0.28	7.9	0.18
Taru	7.83	152.0	73.0	0.28	9.2	0.55
Thiksey	7.98	325.0	156.3	1.15	24.2	0.10
Average	7.93	265.9	127.3	0.89	20.3	0.25

Table 3 : Irrigation water quality of different villages of Nubra valley

Name of Villages	pH	EC (μScm^{-1})	TDS (ppm)	SAR	SSP	RSC (mel^{-1})
Bogdang	7.96	164.43	78.53	0.08	2.5	0.04
Diskit	7.90	365.67	176.10	1.10	22.3	0.08
Hundar	7.87	77.87	36.50	1.28	40.0	0.52
Khalsar	7.79	66.43	31.17	0.95	33.5	0.43
Ombe	7.82	94.80	44.90	0.92	29.0	0.26
Partapur	7.92	121.77	57.40	1.30	30.0	0.22
Skumpook	7.95	86.22	40.07	0.78	26.1	0.29
Skuru	7.85	88.83	41.80	0.19	8.2	0.36
Sumur	8.02	282.20	133.83	1.28	27.6	0.78
Tirche	7.95	217.03	103.57	1.00	22.7	0.48
Average	7.90	156.53	74.39	0.89	24.2	0.35

From the above results, it is concluded that there is no hazard in irrigation water of Ladakh region in terms of salinity, sodium and bicarbonate levels, and Zn and Mn concentration and therefore, can be used safely for growing crops.

Recommendations for improving soil health

- **Soil erosion and degradation control measures**

Since the topography of the area is rugged, undulated with sloppy terrain and being erosion prone, soil erosion is accelerated especially during summer months when snow melts, resulting in heavy discharge in nallahas, washing away the prime agriculture lands, plantations and pasture areas. A number of mechanical and cultural management practices like land leveling, contour bunding, contour trenching, bench terracing, contour farming, intercropping, strip cropping, mixed cropping, mulching, crop geometry and vegetative barriers etc. are recommended for checking soil and water loss from the sloping lands. The runoff water could be harvested and stored in suitable storage structures for supplemental irrigations during moisture stress periods for the crops.

Figure: Soil erosion control measures in different places of Ladakh

- **Improving nutrient content of soil**

✓ Most of the villages of Ladakh have shown alkalinity (high pH) problem in its cultivated fields. This underlines urgent need for soil reclamation in the affected areas. Gypsum/pyrite should be used for improvement of soil pH.

✓ In some of the cultivated fields deficiency of organic carbon has also been noticed. Regular application of farm yard manures, crop residues etc. should be encouraged to improve the organic carbon status of the soil.

✓ Phosphorus is generally below the normal range. Hence, application of phosphorus must be ensured especially in root/tuber crops. Potassium is adequately available but most of the forms are unavailable for the crops in soils of Ladakh. Hence, its proper application should be encouraged.

✓ Micronutrients have been found deficient in most of the villages of Ladakh and there is no practice of application of micronutrients by the farmers of the region. Hence, it becomes necessary to apply all the micronutrients regularly, especially in deficient areas.

- **Adopting integrated nutrient supply system**

✓ The conjunctive use of chemical fertilizers and organic manure (NPK+FYM) enhance organic carbon, soil available nutrients, soil aggregation, water infiltrability, microbial biomass carbon and microbial population as compared to use of chemical fertilizers alone.

✓ The combined use of major and micronutrient fertilizers, bio-fertilizers and FYM will help in obtaining quite higher yields of different vegetables like peas, potato, cauliflower, cabbage etc. in this cold desert region. The integrated nutrient management also improves quality of produce in terms of protein, starch, total soluble sugars and vitamins. DIHAR has developed vermicompost technology for this cold desert region to improve soil fertility as well as productivity. Nutritional composition of this vermicompost is much more superior to farmyard manure.

Table 4 : Nutrient Profile of Vermicompost and Farm Yard Manure

Nutrients	Vermicompost	Farm Yard Manure
N (%)	1.6	0.5
P_2O_5 (%)	0.7	0.2
K_2O (%)	0.8	0.5
Ca (%)	0.5	0.9
Mg (%)	0.2	0.2
Fe (ppm)	175.0	146.5
Mn (ppm)	96.5	69.0
Zn (ppm)	24.5	14.5
Cu (ppm)	5.0	2.8
C:N ratio	15.5	31.3

Table 5 : Common fertilizers containing major nutrients in India

Fertilizer	Nutrient content (%)				
	N	P_2O_5	K_2O	S	Others
Ammonium sulphate (AS)	21			23	
Calcium Ammonium Nitrate (CAN)	25-26				Ca
Anhydrous Ammonia (liquid)	82				
Urea (prilled/granulated)	45-46				
Urea (Zincated)	43				2% Zn
Single Super Phosphate (SSP)		14/16		11	20% Ca
Bone Meal (Raw/steamed)		20/22			Ca
Rock Phosphate		18-20			Ca
Potassium Chloride (MOP)			60		46% Cl
Potassium Sulphate			50	17.5	
Potassium Nitrate	13		45		
Diammonium Phosphate (DAP)	18	46			
Nitrophosphate (ANP)	20/23	20/23			
Gypsum (Agriculture grade)				13	16-19% Ca
Pyrites (Agriculture grade)				18-22	Fe
Magnesium Sulphate				12	16% Mg
Zinc Sulphate				11	22% Zn

Table 6 : Nutrient content of some organic manure

Sources	N (%)	P_2O_5 (%)	K_2O (%)
Cattle dung	0.3-0.4	0.10-0.15	0.15-0.20
Sheep & goat dung	0.65	0.5	0.3
Human excreta	1.2-1.5	0.8	0.5
Farmyard manure	0.5-1.0	0.15-0.20	0.5-0.6
Poultry manure	2.9	2.9	2.4

- ✓ The use of biofertilizers is still minimal in this hilly and mountainous region and requires to be promoted by producing effective strains with enhanced shelf life. A variety of biofertilizers that could be popularized are nitrogen fixers (*Rhizobium, Azotobacter, Azospirillum*), phosphate solubilizing bacteria (PSB), blue-green algae, mycorrhizae and plant growth promoting rhizobacteria (PGPR).

- **Soil testing facilities**

- ✓ Adequate soil testing laboratory facility is not available in both Leh and Kargil districts of Ladakh region. DIHAR has created facility for testing of important components of soil such as ph, EC, OC, N, P and K. Analysis of other component of soil samples are carried out with the help of Indian Agricultural Research Institute, New Delhi.

For Further Details Contact:

DIRECTOR

DEFENCE INSTITUTE OF HIGH ALTITUDE RESEARCH

C\O 56 APO

Phone: 01982-252096 Fax: 01982-252096