Journal of Pharmacognosy and Phytochemistry

Available online at www.phytojournal.com

**E-ISSN:** 2278-4136
**P-ISSN:** 2349-8234
JPP 2018; 7(3): 2752-2755
Received: 13-03-2018
Accepted: 17-04-2018

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# Physical and chemical properties of soils under prevalent cropping systems in Kinnaur district of Himachal Pradesh

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**Abstract**
A total of 90 Global positioning (GPS) surface (0-15cm) and subsurface (15-30 cm) soil samples were collected from 45 important sites covering wheat, maize, pea, potato and rajmash growing valleys of dry temperate zone to study physical and chemical properties of soil. The soils were neutral to alkaline in reaction and GPS based surface (0-15cm) and subsurface (15-30 cm) soil samples were collected randomly from different prevalent cropping system of Kinnaur district in Himachal Pradesh. These samples were analyzed for physico-chemical properties, available NPK. In surface soils mean available N contents (200.13 kg $ha^{-1}$) were in low category whereas, P (75.1 kg $ha^{-1}$) and K (610.20 kg $ha^{-1}$) were found in medium category under different cropping system. Clay was found below 20 percent and silt near and above 15 per cent. Soils were found sandy loam to silty clay loam in texture. Bulk density was highly variable ranging from 1.07 to 1.30 $Mgm^{-3}$.

**Keywords:** physico-chemical, fertility status, Kinnaur soils

## Introduction
Kinnaur, located on the Indo-Tibetan border, is very scenic; and is surrounded by the Tibet on the east, Garhwal Himalaya on south, Spiti Valley on the north and Kullu on the west. It lies between North latitude 31o 35'40" to 31o 34'42" and East longitude 77o 52'38" to 78o 51'28". The district has a total geographical area of 6,401 sq km, covers 11.5 % area of the State and ranks 3rd in the State. The district is divided into five tehsils and one sub-tehsil. The five tehsils are Nichar, Kapla, Sangla, Pooh and Moorang. The only sub-tehsil in the district is Hangrang. There are 660 villages in the district, of which 234 villages are inhabited and 426 are uninhabited. For development purpose, the district has been subdivided into 3 Community Development Blocks viz. Nichar, Kalpa and Pooh. The major sources of irritation are small water channels or the Kuhls, in the district and an area of 77.86 sq km is brought under irrigation by surface water sources like, major khads and nallahs. A sizeable part of the cultivated area of the district, is not having assured irrigation facilities and the agriculturists have to depend on the vagaries of weather. Under various plans, the construction of kuhls and lift irrigation schemes are being taken up in the district. Kinnaur district presents an intricate mosaic of mountain ranges, hills and deep valleys. It is primarily a hilly district, with altitudes ranging from 1,500 m to more than 6,500 m amsl. There is a general increase in elevation, from west to east and from south to north. The drainage system of the district forms a part of the Indus River basin, except a small part in the northeastern area, which is apart of the Ganga River system. Geomorphologically, the district has been sub divided into the fluvial terrain, fluvio-glacial terrain, Alpines / meadows and Rocky terrain. Taking into consideration, the morphological and physico-chemical characteristics of the soils and general similarity in them, the various types of soils observed in the district can be grouped into three major types viz Type-I, Type-II& Type-III. Type-I soil is coarse loamy, mixed in nature. The soil is developed from granites, highly metamorphosed gneisses, schists and occurs on moderately sloping to steep lands. These soils are well drained, with moderately rapid permeability. Natural vegetation exists in these soils and various crops are cultivated according to the suitability. Type-II soil is fine loamy, mixed, frigid in nature. They have developed on parent material consisting of granite-gneiss and mica schists, on steep to very steep slopes at an altitude of >3000 m amsl. These are grazing lands supporting alpine grasses. Type- III soil includes various series like Sangla, Spilo, Kalpa, Leo, Rocky I, Rcky II and Scree series. The Himalayan regions characterized by varied physiographic and climatic conditions are endowed with a variety of landuse types and agricultural systems. Over 80% area comprises forests and wastelands; the cultivated area was hardly 12%.

The per capita availability of land was only about 0.17 ha. Notwithstanding small arable land resource, the agriculture remains to be main source of livelihood to the people of mountainous regions (Agriculture census reoprt, 2003) [3]. The natural vegetation comprised of grasslands with an area of 31.04%. Forests, excluding orchards and other cultivated trees comprised of 10.24%, and scrublands accounted for the least area (2.95%). More than half (51.91%) of the total area of the district is represented by bare rocks and area under perpetual snow (Chawla *et al*. 2012) [2]. The major food crops of the region are cereals, pulses, oilseeds and potato. The agro-climatic conditions of the region are suitable for the production of temperate to subtropical fruits such as apple, pear, plum, peach, apricot, kiwi, strawberry, grape, cherry, almond and walnut. Most of the Kinnaur has a temperate climate due to its high elevation, with long winters from October to May and short summers from June to September. The lower parts of the Satluj valley and the Baspa valley receive monsoon rains. The upper areas of these valleys and lower reaches of Spiti valley in Kinnaur fall in the rain shadow area. These areas are considered to be arid regions, having climate similar to Tibet. In the lower reaches of Satluj and Bapsa Valleys, the vegetation comprises trees like pine, oak, chestnut, birch, deodar, fir, grasses and shrubs giving a lush look to the area. The rain shadow area, having higher in general, has sparse vegetation comprising hardy grasses, dry alpine scrub, dwarf juniper scrub. The transition area between these two climatic and vegetation zones is home to chilgoza dry fruit. A unique feature of Kinnaur is that the fruit trees like apple, apricot, almonds are cultivated by the farmers across these zones successfully.

## Material and Methods

A preliminary survey of the area was carried out for the collection of basic information regarding vegetation and physiographic locations etc. Surface (0-15 cm) and subsurface (15-30 cm) soil samples were collected randomly from different cropping (cereal and vegetable) marked with the Global Positioning System co-ordinates. All the samples were collected with stainless steel auger, spade and spatula to avoid any contamination. The soil samples were air dried, ground, passed through 2 mm sieve and finally stored in cloth bags. Available nitrogen was determined by alkaline permanganate method (Subbiah and Asija, 1956) [12]. Available phosphorus by 0.5M $NaHCO_3$ (pH 8.5) extraction method (Olsen *et al*. 1954) [7]. Available potassium by neutral normal ammonium acetate extraction method (Jackon (1967) [4]. Texture by international pipette method (Piper 1967). Bulk density by weighing bottle method (Lutz 1947). pH by 1: 2.5 (soil : water) suspension using glass electrode pH meter and electrical conductivity by conductivity bridge method (Jackson 1967) [4]. Organic carbon by Rapid titration method (Walkey 1994). Water holding capacity by Keen's box method (Piper 1950) [8].

## Results and Discussion

### Texture

Data revealed that sand fraction varied from 58.5 to 69.5, 57.1 to 71.0 and 56.0 to 68.0 per cent in surface and 57 to 69.0, 55.4 to 67.1 and 56.0 to 67.0 per cent in subsurface horizons of pea-fallow-wheat, maize-fallow-rajmash and maize-fallow-wheat cropping system. Silt content in surface soils of pea - fallow- wheat, maize-fallow-rajmash and maize fallow-wheat cropping system, varied from 14 to 21, 15.0 to 22.5 and 15 to 26 per cent, respectively whereas, in the sub-surface soils it ranged from 16.3 to 26.0, 16.1 to 24.8 and 18 to 26 per cent in respective cropping systems.

Under pea-fallow-wheat, maize-fallow-rajmash and maize-fallow-wheat cropping systems the clay content ranged from 12.0 to 17.5, 12.5 to 18.5 and 12.0 to 19.2 per cent, respectively in surface soils whereas, in subsurface soils it ranged from 13.2 to 20.2, 14.4 to 21.5 and 10.1 to 20.1 in respective cropping systems. The texture of soils of Kinnaur district was found to be sandy loam to silty clay loam in texture, dominant parent materials of the soils of dry temperate zone were granite, quartzite, gneiss, shale and schist, which might have resulted into coarse texture of the soils (Verma *et al*. 1976). A critical observation of the data with respect to the depth of soils (Table 1 and 2) revealed that in prevalent cropping systems the sand fraction reflected a variable trend with depth i.e. it decreased with soil depth and it tended to accumulate in the surface i.e. it decreased with increase in soil depth. The silt and clay content in all three cropping systems increased with increase in soil depth. The increasing tendency of clay with depth may be due to leaching during snowmelt (Sharma and Kanwar, 2010) [11].

### Bulk density

Bulk density in the surface soils under pea-fallow-wheat, maize-fallow-rajmash and maize-fallow-wheat varied from 1.07 to 1.30, 1.09 to 1.32 and 1.09 to 1.29 $Mgm^{-3}$, whereas, in the subsurface layers, it varied from 1.10 to 1.33, 1.13 to 1.32 and 1.16 to 1.44 $Mgm^{-3}$, respectively.

Bulk density increase with increase in soil depth in all the soil profiles under study (Table 1, 2). This may be attributed to the increase in fraction with depth (Sharma and Kanwar, 2007).

### Water holding capacity (WHC)

The data on WHC under prevalent cropping systems have been given in tables 1, 2. A perusal of data in table 1 revealed that WHC decreased with increase in soil depth. It may be due to decrease in finer fraction (clay) of soils with depth as WHC of soils is influenced greatly with the amount of clay contents. WHC varied from 15.9 to 27.5, 13.9 to 23.8 and 13.8 to 25.3 in surface and 13.4 to 22.5, 12.1 to 21.1 and 12.2to 22.1 per cent in subsurface layers of cultivated lands (annual crop), cultivated lands (apple plantation) and pasture lands pea-fallow-wheat, maize-fallow-rajmash and maize-fallow-wheat cropping systems, respectively (Babhulkar *et al.* 2000 and Selvi *et al.* 2005) [9].

### Soil pH

A perusal of data in the Table 1, 2 indicate that pH of surface soils pea-fallow-wheat, maize-fallow-rajmash and maize-fallow-wheat cropping system varied from 5.3 to 8.2, 5.9 to 7.2 and 5.6 to 6.8 respectively. Whereas, in the subsurface soil it varied from 5.3 to 6.7, 5.7 to 7.0 and 5.6 to 6.6 respectively. The soils of the dry temperate zone of Himachal Pradesh were found neutral to alkaline. The soil reaction was found to decrease with the increase in soil depth. The higher soil pH in this zone might be due to higher accumulation of CaCO3 and other salts due to extremely low rainfall and high evaporation rate in this zone (Sharma and Kanwar, 2007).

### Electrical conductivity (EC)

The electrical conductivity values for the surface soils of district Kinnaur under pea-fallow-cropping, maize-fallow-rajmash and maize-fallow-wheat cropping system (Table 1) ranged 0.14 to 0.49 dS $m^{-1}$, 0.22 to 0.45 dS $m^{-1}$ and 0.25 to 0.44 dS $m^{-1}$ in sub surface layer its value ranged from 0.13 to

0.44 dS $m^{-1}$ (pea-fallow-wheat), 0.2 to 0.44 dS $m^{-1}$ (Maize-fallow-Rajmash) and 0.22 to 0.41(Maize-Fallow-Wheat), respevtively (Table 2). The electrical conductivity was found to be more in the surface 0 – 15 cm soil depth and decreased in the sub surface soil depth. EC values in the study area are in safe limits (<0.8 dS $m^{-1}$) without any salinity/ alkalinity hazards (Selvi *et al*. 2005) [10].

**Organic carbon**

Organic carbon content in surface soils under cropping system pea-fallow-wheat, maize-fallow-rajmash and maize- fallow-wheat varied from 0.97 to 3.06, 1.3 to 3.06 and 1.30 to 2.91 per cent, respectively whereas, in the subsurface layers it varied from 0.90 to 2.90, 0.90 to 2.97 and 1.21to 2.88 per cent in respective system (Tables 1 and 2). The organic carbon content indicates decreasing values with the soil depth, in general. This may be due to the management practices and more addition of the FYM under protective cultivation systems (Liu *et al.* 2010).

**Available Nitrogen**

A look into the data pertaining to available nitrogen content of soils of Kinnaur district under different cropping system (Table 1 and 2) indicated that its content in the surface soils of pea-fallow-wheat, maize-fallow-rajmash and maize-fallow-wheat system ranged from 98 to 347, 201 to 471 and 189 to 404 kg $ha^{-1}$, respectively. However, in the sub-surface layers, its values varied from 96 to 388 for pea-fallow-wheat, 189 to 443 maize-fallow-rajmash and 182 to 388 kg $ha^{-1}$ for maize-fallow-wheat. As such available nitrogen was low to medium under all the three cropping systems. The low to medium levels of N may be due to the cultivation of high nutrient requirement crops. Also, despite high organic carbon, the low to medium N levels may be due to the lower decomposition rates of the organic matter under the influence of the prevailing climate. The available nitrogen decreased with soil depth (Mahajan, 2001 and Chandel, 2013) [6].

**Available phosphorus**

Available phosphorus content ranged from 13.5 to 75.1, 19.4 to 54.8 and 17.4 to 75.9 kg $ha^{-1}$ for the surface soils under pea-fallow-wheat, maize-fallow-rajmash and maize-fallow-wheat, respectively. In subsurface soils the corresponding values were 12.7 to 66.8, 17.1 to 44.8 and 14.9 to 65.2 kg $ha^{-1}$ under respective cropping systems. Soils are rated as medium to high in their available P Status (Table 1 and 2). The high available P in these soils may be due to higher organic matter and more addition of phosphatic fertilisers for vegetable crop production. Also, the availability of P is highly pH dependent with maximum availability near neutral pH which explains its high contents in these soils (Zhohui *et al*. and Quan *et al*. 2011).

**Available potassium**

Data (Table 1) indicated that the values of available potassium in surface horizons under pea-fallow-wheat, maize-fallow-rajmash and maize-fallow-wheat were 471 to 876, 480 to 895 and 504 to 896 kg $ha^{-1}$, respectively whereas, in the sub-surface layers these values (Table 2) varied from 449 to 866, 465 to 775 and 491 to 765 kg $ha^{-1}$ for corresponding cropping systems. As such, the soils under study were high available potassium status. The high available potassium may be due to more application of potassic fertilizers (Zhohui *et al*. 2002) [14].

**Table 1:** Range & mean values of physico-chemical properties in surface soils (0-15 cm) under different cropping system in Kinnaur district

| | Sand (%) | Silt (%) | Clay (%) | BD (Mg $m^{-3}$) | WHC (%) | pH | EC (dS $m^{-1}$) | OC (%) | N (kg $ha^{-1}$) | P (kg $ha^{-1}$) | K (kg $ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pea-Fallow-Wheat** | | | | | | | | | | | |
| Range | 58.5-69.5 | 14-25 | 12.0-17.5 | 1.07-1.30 | 15.9-27.5 | 5.3-6-9 | 0.14-0.49 | 0.97-3.06 | 98-347 | 13.5-75.1 | 471-876 |
| Mean | 65.94 | 18.06 | 15.06 | 1.19 | 19.96 | 6.9 | 0.31 | 2.06 | 200.13 | 75.1 | 610.20 |
| SD± | 3.19 | 2.91 | 1.55 | 0.08 | 3.13 | 0.46 | 0.100 | 0.66 | 86.98 | 39.97 | 125.15 |
| **Maize-Fallow-Rajmash** | | | | | | | | | | | |
| Range | 57.1-71.0 | 15-22.5 | 12.5-18.50 | 1.09-1.32 | 13.9-23.8 | 5.9-7.2 | 0.22-0.45 | 1.23-3.06 | 201-471 | 19.4-54.8 | 480-895 |
| Mean | 63.44 | 19.11 | 15.95 | 1.202 | 18.47 | 6.36 | 0.380 | 2.05 | 345.33 | 34.22 | 635.13 |
| SD± | 3.77 | 2.25 | 1.86 | 0.076 | 2.74 | 0.38 | 0.061 | 0.60 | 74.02 | 9.79 | 122.67 |
| **Maize-Fallow-Wheat** | | | | | | | | | | | |
| Range | 56-68 | 15-26 | 12.0-19.20 | 1.09-1.29 | 13.8-25.3 | 5.6-6.8 | 0.25-0.44 | 1.30-2.91 | 189-404 | 17.4-75.9 | 504-896 |
| Mean | 62.02 | 20.8 | 15.21 | 1.19 | 19.06 | 6.3 | 0.34 | 2.22 | 290.86 | 39.56 | 663 |
| SD± | 4.05 | 3.34 | 2.120 | 0.067 | 3.30 | 0.38 | 0.070 | 0.51 | 57.58 | 18.69 | 118.20 |

**Table 2:** Range & mean values of physico-chemical properties in subsurface soils (15-30 cm) under different cropping system in Kinnaur district

| | Sand (%) | Silt (%) | Clay (%) | BD (Mg $m^{-3}$) | WHC (%) | pH | EC (dS $m^{-1}$) | OC (%) | N (kg $ha^{-1}$) | P (kg $ha^{-1}$) | K (kg $ha^{-1}$) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Pea-Fallow-Wheat** | | | | | | | | | | | |
| Range | 57.5-69.0 | 16.3-26.0 | 13.2-20.2 | 1.07-1.30 | 15.9-27.5 | 5.3-6.7 | 0.13-0.44 | 0.90-2.90 | 96-388 | 12.7-66.8 | 449-866 |
| Mean | 62.64 | 20.29 | 15.88 | 1.19 | 19.96 | 6.15 | 0.28 | 1.84 | 189.2 | 33.77 | 582.73 |
| SD± | 3.97 | 3.03 | 1.93 | 0.08 | 3.13 | 0.42 | 0.093 | 0.55 | 83.34 | 17.80 | 124.56 |
| **Maize-Fallow-Rajmash** | | | | | | | | | | | |
| Range | 55.4-67.1 | 16.1-24.8 | 14.4-21.5 | 1.13-1.32 | 12.1-21.1 | 5.7-7.0 | 0.2-0.44 | 0.90-2.97 | 189-443 | 17.1-44.8 | 465-775 |
| Mean | 60.22 | 20.89 | 18.32 | 1.23 | 15.24 | 6.37 | 0.34 | 1.65 | 318.46 | 29.43 | 588.20 |
| SD± | 3.82 | 3.2 | 2.14 | 0.70 | 2.37 | 0.37 | 0.06 | 0.58 | 66.23 | 8.18 | 97.43 |
| **Maize-Fallow-Wheat** | | | | | | | | | | | |
| Range | 56-67 | 18-26 | 10.1-20.1 | 1.16-1.44 | 12.2-22.1 | 5.6-6.6 | 0.22-0.41 | 1.21-2.88 | 182-388 | 14.9-65.2 | 491-765 |
| Mean | 60.04 | 22.10 | 16.32 | 1.25 | 16.24 | 6.14 | 0.31 | 16.24 | 267.66 | 33.62 | 623.33 |
| SD± | 3.82 | 2.63 | 2.90 | 0.07 | 2.68 | 0.35 | 0.073 | 2.68 | 56.38 | 56.38 | 93.37 |

## Conclusion

The soils were neutral to alkaline in reaction. Available N contents were in low category whereas, P and K were found in medium category under different cropping system. Clay was found below 20 percent and silt near and above 15 per cent. Soils were found sandy loam to silty clay loam in texture. The organic carbon content indicates decreasing values with the soil depth, in general. Available nitrogen was low to medium under all the three cropping systems.

## References


1. Kumar AK. Vascular Plants, Northwestren Himalaya, Himachal Pradesh, India. Journal of Species Lists and Distribution. 2012; (8):321-348.
2. Chawla AO, Parkash, Sharma V, kumar RS, Lal B, Gopichand RD *et al*. Vascular Plants, Northwestren Himalaya, Himachal Pradesh, India. Journal of Species Lists and Distribution. 2012: 8:321-348.
3. Directorate of Agricultural Census, Report on Agricultural Census, Government of Himachal Pradesh, India, 2003, 1-49.
4. Jackson ML. Soil Chemical Analysis, Prentice Hall of India Private Limited., New Delhi, 1967.
5. Lutz JF. Apparatus for collecting disturbed soil samples. Soil Science. 1947: 64:399-401.
6. Mahajan A. Characterization of Balh valley soils of District Mandi. *M.Sc. Thesis*, Department of Soil Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, India. 2001, 133.
7. Olsen SR, Cole CV, Watanave FS, Dean LA. Estimation of available phosphorus by extraction with sodium bicarbonate. US Department of Agriculture, Citric. 1954, 939.
8. Piper CD. Soil and Plant Analysis. Inc. Sci. Pub. INC, New York, 1950.
9. Selvi D, Santhy P, Dhakshinamoorthy M. Effect of inorganics alone and in combination with farmyard manure on physical properties and productivity of Vertic-Haplustepts under long-term fertilization. Journal of Indian Society of Soil Science. 2005: 53(3):302-307.
10. Selvi D, Santhy P, Dhakshinamoorthy M. Effect of inorganics alone and in combination with farmyard manure on physical properties and productivity of Vertic-Haplustepts under long-term fertilization. Journal of the Indian Society of Soil Science. 2005; 53(3):302-307.
11. Sharma V, Kanwar BB. Copper status and its relation with soil properties in pea growing soils of high hills dry temprate zone of Himachal Pradesh. Indian Journal of Agricultural Research. 2010: 44(1):32-37.
12. Subbiah BW, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. Current Science 1956; 25:259-260.
13. Walkely A, Black CA. An estimation of the method for determination of soil organic matter and a proposed modification of the chromic acid titration method. Soil Science. 1934: 37:29-39.
14. Zhohui L, Jiang L, Zhang W, Zheng F, Wang M, Lin H. Evolution of fertilization rate and variation of soil nutrient contents in greenhouse vegetable cultivation in Shandong. Acta Pedologica Sinica. 2002: 23:67-78.