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Physiochemical characteristics of the Soil and their Correlation with Leaf Fodder Quality Parameters of *Grewia optiva* Drummond of the Himachal Pradesh

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ABSTRACT: This study was conducted during May and November, 2019 and 2020 to determine the Pearson correlation coefficient between fodder characteristics of *Grewia optiva* and physicochemical characteristics of the soil collected underneath selected populations of *Grewia optiva* Drummond. A significant difference in pH, OC, EC, N, P, K and bulk density was observed. The nine populations *viz.*, Kothi kanwal (Solan), Uncha gaon (Solan), Neri kalan (Solan), Machair (Sirmaur), Jajjer (Sirmaur), Balla (Kangra), Jhinjkari (Hamirpur), Bhaleth (Hamirpur) and Barthi (Bilaspur) showed >24% crude protein. A significant positive correlation was recorded between soil pH and Leaf dry matter and crude protein. The electrical conductivity, Organic carbon and Nitrogen showed a positive correlation with crude protein and ether extract. A negative correlation observed between bulk density and fodder characteristics. Phosphorus showed a positive and significant impact on the leaf dry matter and ether extract. An insignificant correlation obtained between the potassium and fodder characteristics. The correlation developed between fodder and soil characteristics will help in identification and selection of best nutritive strains of *Grewia optiva* to get improved genetic gain and production of quality planting material.

Keywords: *Grewia optiva*, crude protein, soil nutrients, population, forage, correlation coefficient.

INTRODUCTION

Grewia optiva Known locally as Bhimal/Beul/Bihul, it is found in the subtropical western Himalayas. This species shows its existence at the edges/elevations of agricultural terraces rather than in a forest area (Thakur *et al*., 2004; Thakur *et al.*, 2005). It is well distributed from 500 to 2500 m in India, Pakistan and Nepal (Semwal *et al*., 2002). In north-western India, this species is common in the foothills of Jammu and Kashmir, Himachal Pradesh and Uttarakhand for its attributes such as palatability, ease of propagation, faster growth and forage yield (Mukherjee *et al*., 2018). Leaves of *Grewia optiva*are excellent forage for livestock, especially in winter (the lean season), when there is no alternative to green forage (Katoch *et al.*, 2017). It has more than 70% potential digestibility of DM and effective degradability (56.7%) reported by Singh *et al.* (1989). The bark fibres are used to make sturdy ropes, Kurna (backpacks) and Kandi (baskets), purses, handbags, chappals, mats, carpets, etc. and these products founded to be appropriate, sustainable and beneficial for farmers in the central and western highlands of Nepal (Pandey *et al.*, 2017). The bark extract also has medicinal properties as it is used to treat indigestion, gastric problems (Radha *et al.*, 2021). Wood is used for making handles, shoulder pads, bed frames, pallets, tools and axe handles. Its young branches are used to make baskets (Gill *et al.*, 2016).

Soil is comprised of certain kind of chemical, physical, mineralogical and biological properties (Thakre *et al.*, 2012). The knowledge of physiochemical properties *viz.*, organic carbon, available Nitrogen (N), Phosphorus (P_2O_5), Potassium (K_2O), pH, electrical conductivity, soil texture and bulk density of soil is necessary to find the available nutrient status in soil and to develop specific fertilizer directions (Sumithra *et al.*, 2013). The soil organic matter contents, electrical conductivity, and pH regulates not only macronutrients (N, P, and K) but also micronutrients (Zn, Fe, B, and

Cu) for better uptake in plants (Havlin 2020). High soil pH usually results in the precipitation of nutrients. On the other hand, an increase in soil electrical conductivity due to higher water-soluble salts changes the osmotic potential of the soil solution. This change in the osmotic potential of soil solution resulted in lower nutrient levels in the plants. Furthermore, limited organic matter in soil decreases microbial proliferation and causes alteration in C: N ratio, disturbing the available nutrients pool in the soil (Weil and Brady 2017). Also, the distribution of soil particles according to their size *i.e.*, soil texture plays an imperative role in managing soil fertility status for cultivation of all crops (Chaudhari *et al.*, 2013).

The soil Nitrogen (N) is one of the most important biological elements for plants, agricultural crops and forest trees as it has an irreplaceable role in organ construction, material metabolism, fruit yield and the quality of fruit tree formation (Bai *et al.*, 2016). Phosphorus (P) present in soil is essential for various tree growth functions (Jonard *et al.*, 2015). Potassium (K) is used for photosynthesis, fruit quality, flowering, protein formation and disease reduction (Valente *et al.*, 2012). It has a high mobility in plants and plays an important role in the regulation of cellular osmotic pressure and in the balance of cations and anions in the cytoplasm (Hu *et al.*, 2016a). Therefore, considering the importance of the physicochemical properties of the soil mentioned above, the present study was conducted to establish a correlation between the physicochemical characteristics of the soil and important fodder quality parameters (proximate principles) of *Grewia optiva* Drummond in Himachal Pradesh. This study will help to determine the optimal soil nutrient conditions for obtaining good yield and high-quality nutritious strains of *Grewia optiva* Drummond.

MATERIALS AND METHODS

Study area: The present study on physiochemical characteristics of soil and leaf fodder characteristics of different populations of *Grewia optiva* Drummond was carried out during the month of May and November, 2019 and 2020. Total thirty-five population of 20 cm–30 cm diameter class (five population in each district) (Fig. 1) were selected from seven districts of Himachal Pradesh *i.e*., Kangra, Mandi, Bilaspur, Solan, Sirmaur, Una and Hamirpur, taking into account the rich genetic diversity and phenotypically superior plant populations of *Grewia optiva*. The soil samples were collected from 15 cm–30 cm depth underneath the selected populations of *Grewia optiva* Drummond and leaf samples were taken from upper, middle and lower portion of the crown. The soil and leaf samples were collected in two consecutive years 2019 and 2020, twice in year *i.e*., in the month of May and November. In 2019, first soil and leaf samples were collected during the Month of May, when this species was in leafing and flowering stage and second samples were taken at six months interval in the month of November, when the species was in the seed ripening and fodder lopping stage. Similarly, in the year 2020, two consecutive samples were collected in month of May and November from the same selected sites and depth (15 cm–30 cm) respectively, from all thirty-five populations. The pooled data from two years presented for statistical analysis and evaluation in the year 2021 under the present investigation. The fodder quality traits *viz*., leaf dry matter content (%), Crude protein (%), Crude fibre (%), Ether extract (%), NFE(%), Total ash (%) of these selected populations were recorded simultaneously with soil characteristics. Further the Pearson correlation coefficient was established between physiochemical characteristics of soil and fodder quality traits of selected populations.

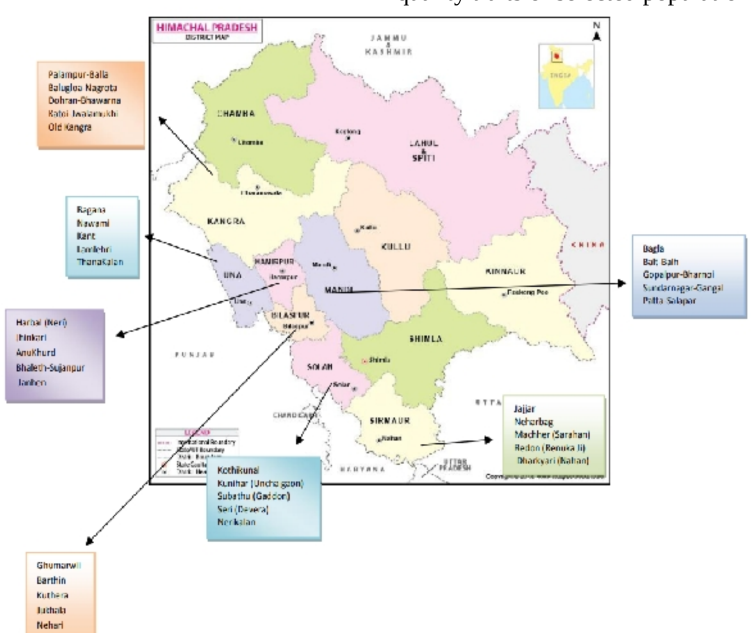


Fig. 1. Pictorial representation of thirty-five selected populations from seven districts of Himachal Pradesh.

Sample collection: For determination of soil physiochemical characteristics; soil samples were collected from (15 cm–30 cm depth underneath the selected populations of *Grewia optiva* Drummond. The samples were analysed using standard methods (Table 1) under the laboratory conditions of Soil- science, University of Horticulture and Forestry, Nauni, Solan (HP).

Table 1: Standard methods used for Soil analysis.

Sr. No.	Soil Parameters	Analysis Method Used
1.	Soil texture	Robinson's pipette method
2.	pH	Digital pH meter (Jakson, 1973).
3.	Organic carbon (%)	Chromic acid titration method (Walkley and Black 1934)
4.	Available Nitrogen (kg ha^{-1})	Micro Kjeldhal Method (Subbiah and Asija, 1956)
5.	Available Phosphorus (kg ha^{-1})	0.5 M sodium bicarbonate ($NaHCO_3$) at 8.5 pH (Olsen *et al*., 1954)
6.	Available K (kg ha^{-1})	Flame photometric method (1N NH_4OAC extractable) (Merwin and Peech 1951)
7.	EC (dSm^{-1})	Digital EC meter (Jakson, 1973)

For determination of fodder characteristics *viz*., leaf dry matter (LDM), crude protein (CP), crude fibre (CF), ether extract (EE), total ash (TA) and nitrogen free extract (NFE) the leaf samples were collected from lower, middle and upper portion of the crown. The collected leaf samples were analysed under laboratory condition of Tree Improvement and Genetic Resources, University of Horticulture and Forestry, Nauni, Solan (HP) using following standard methods:

Leaf dry matter content (%) : $\frac{\text{Weight of dried sample}}{\text{Weight of fresh sample}} \times 100$

Crude protein (%): It was estimated by Microkjeldhal method (Sankaram, 1966). For the crude protein estimation, nitrogen content of leaves estimated and estimated Nitrogen content was multiplied by standard factor of 6.25.

Crude protein (%) = N (%) × 6.25

Ether extract (%): It was extracted by using petroleum ether (AOAC, 1995).

$$\text{Ether extract} = \frac{\text{Wt of fat}}{\text{original weight of Sample}} \times 100$$

Where; Weight of fat = (wt. of thimble + sample) –(weight of thimble + sample after extraction)

Crude fibre (%): It was estimated by acid alkali digestion (ashing) method described by AOAC (1995).

$$\text{Crude fibre (\%)} = \frac{\text{weight of crude fiber}}{\text{original weight of sample}} \times 100$$

Total ash (%): It was estimated by using the procedure given by AOAC (1995).

$$\text{Total ash (\%)} = \frac{\text{weight of ash}}{\text{original weight of sample}} \times 100$$

Nitrogen free extract (%): It was determined by subtracting the sum of crude protein, crude fiber, ether extract and total ash content from 100 (AOAC, 1995).

RESULTS AND DISCUSSION

A. Physiochemical characteristics of soil samples collected underneath the selected populations of Grewia optiva Drummond

There was significant difference was observed in pH, OC, EC, bulk density and in macronutrients (N, P, K) within selected population of each district (Table 2). These results on soil physiochemical characteristics have been reported by Sankhyan *et al*. (2021). The soil of district Solan, Sirmaur, Kangra, Hamirpur and Bilaspur district noted rich in soil nutrients. Mandi and Una district delineated with poor soil nutrients. Soil of different texture were founded underneath populations of different districts (Table 2) *viz.* 50% of soil texture observed as sandy loamy and sandy clay loamy followed by clay loamy (20%), gravelly loamy (10%), loamy (10%) and remaining silty clay loamy (5%) and silty loam (5%). The tree has a capacity to grow in almost any type of soil but sandy loam with proper moisture is most suitable for its proper growth (Singh *et al.*, 2018).

Table 2: Physicochemical characteristics of soil samples collected underneath different thirty-five populations of *Grewia optiva* Drummond.

District	Population	Population Name	pH	EC (dSm^{-1})	Organic Carbon (g kg^{-1})	N (kg ha^{-1})	P (kg ha^{-1})	K (kg ha^{-1})	Soil Texture	Bulk Density
SOLAN	1	Kothi kanwal	7.32	0.25	7.40	295.83	14.93	240.05	Sandy Loam	1.14
	2	Unchagaon	7.54	0.19	10.70	343.92	30.61	282.67	Clay loam	1.13
	3	Nerikalan	7.66	0.17	7.30	327.19	33.60	489.81	Clay loam	0.99
	4	Gaddo	6.70	0.33	6.60	278.06	23.89	360.88	Sandy Loam	1.17
	5	Devera	7.02	0.30	3.50	270.79	17.92	212.80	Clay loam	1.16
Mean			7.24	0.24	7.1	303.15.	24.19	337.24		1.11
SIRMAUR	6	Machair	6.76	0.36	14.65	378.45	57.12	439.28	Silt Clay Loam	1.70
	7	Jajjar	7.09	0.48	16.85	357.43	33.06	376.81	Silt Loam	1.24
	8	Neharbag	7.52	0.54	19.05	379.51	49.40	512.46	Loam	1.39
	9	Badon	6.98	0.47	12.6	343.79	63.96	378.60	Sandy Clay Loam	1.08

	10	Dharkyari	6.91	0.26	15.75	368.22	35.68	285.96	Sandy Clay Loam	1.15
Mean			7.05	0.42	15.78	365.48	47.84	398.62		1.31
UNA	11	Kant	6.60	0.14	10.02	280.36	25.60	285.38	Gravelly Loam	1.21
	12	Navami	7.80	0.17	11.20	290.60	29.33	349.30	Sandy Clay Loam	1.04
	13	Kharunibangana	6.89	0.14	16.09	360.60	33.78	290.49	Loam	1.08
	14	Thanakalan	7.20	0.19	14.16	320.80	56.89	349.88	Sandy Clay Loam	1.18
	15	Lamlehri	7.22	0.22	10.08	280.18	46.70	477.21	Gravelly Loam	1.16
Mean			7.14	0.11	12.31	307.60	38.47	350.45		1.13
KANGRA	16	Katoi	6.65	0.15	9.90	282.24	24.64	283.36	Sandy, Clay, Loam	1.21
	17	Balugloa	7.65	0.16	11.25	291.64	29.12	348.32	Loam	1.08
	18	Purana kangra	6.71	0.10	10.05	363.77	33.60	284.48	Loam	1.15
	19	Dohan	6.01	0.11	14.10	319.87	53.76	349.44	Gravelly Loam	1.13
	20	Balla	7.21	0.19	7.05	272.83	44.80	577.92	Sandy Loam	1.22
Mean			6.84	0.14	10.47	306.07	37.18	368.70		1.15
HAMIRPUR	21	Janhen	7.30	0.47	17.21	370.50	43.60	240.43	Sandy Clay Loam	1.46
	22	Jhinkari	7.11	0.60	20.82	380.31	40.42	260.30	Sandy Loam	1.13
	23	Harbalneri	7.10	1.15	27.25	372.13	35.46	272.10	Sandy Loam	1.11
	24	Anu khurd	7.20	0.82	25.06	344.91	37.90	212.66	Gravelly Loam	1.19
	25	Bhaleth	7.13	1.32	26.08	380.33	34.70	161.30	Clay loam	1.14
Mean			7.16	0.85	23.28	369.63	38.35	229.35		1.14
MANDI	26	Patta	5.7	0.18	2.70	231	37.5	316	Clay Loam	1.15
	27	Gangal	5.4	0.21	1.01	132	35.5	480	Loam	1.17
	28	Bagla	6.3	0.12	1.48	115	18.8	182	Sandy Loam	1.38
	29	Balt	5.1	0.15	1.10	134	35.8	258	Sandy clay Loam	1.01
	30	Bharnoi	6.3	0.18	2.63	136	18.8	414	Sandy clay Loam	1.30
Mean			5.76	0.16	1.78	149.5	29.28	330		1.20
BILASPUR	31	Ghumarwin	7.38	0.33	22.10	362.70	42	246.70	Clay Loam	1.33
	32	Barthi	7.68	0.25	27.50	419.20	45.62	328.80	Loam	1.20
	33	Kuthera	5.92	0.12	15.20	378.32	45.20	213.40	Sandy Loam	1.18
	34	Jukhala	7.26	0.81	17.21	364.40	37.20	297.80	Clay Loam	1.08
	35	Nehari	7.40	0.46	27.12	386.30	38.10	279.84	Sandy Loam	1.22
Mean			7.12	0.39	21.82	382.18	41.62	267.30		1.18
SEM			0.09	0.08	0.76	11.84	2.31	7.72		0.02

Significant at 1% level of significance, where; EC- electrical conductivity, OC-organic carbon, BD-bulk density, N-nitrogen, P-phosphorus, K-pottasium

B. Fodder quality characteristics of selected populations of Grewia optiva Drummond

Crude protein (CP) content is most important criterion for judging feed and fodder quality. The earlier studies indicated that some tree leaves are nutritionally desirable for their crude protein contents, since it is the most important nutrient (Prajapati *et al*., 2019). The Kothi kanwal population exhibited average 24.43 % crude protein (CP), Uncha goan population with average 24.96 % crude protein (CP), Neri Kalan with average 25.12 % crude protein, Machair population reported with average 25.02 % crude protein, Jajjer with average 24.56 % crude protein, Balla population with average 25.05 % crude protein, Jhinjkari population with average 24.98 % crude protein, Bhaleth population with average 25.11 percent crude protein and Barthi population showed average 25.15 % crude protein (Table 3). These nine populations showed crude protein percentage greater than 24 percent. This observed percentage of crude protein was more than highest as per range (17.35 -20.99 % crude protein) reported by Sankhyan and Bhagta (2016) in their study on *Grewia optiva*. Crude fibre was observed in range of 19.12 to 21.51 % for selected populations. The low to moderate fibre contents of browse foliage positively influenced their voluntary intake and digestibility in small ruminants (Bakshi and Wadhwa 2004) and as the percentage of crude fibre increased digestibility decreased because crude fibre is resistant to decomposition and it often envelops digestive nutrients rendering them unavailable (Maynard, 1937). The ash content was observed in range of 11.43 to 19.87 percent (Table 3). The ash content of the leaf is the inorganic residue, which provide a measure of the total amount of minerals within a leaf fodder which supplement the mineral requirement of livestock (Prajapati *et al.*, 2019). The ether extract recorded between 4.12 to 5.67 percent and nitrogen free extract founded between 39.39 to 43.31 percent. Dry matter content was observed between range of 20.61 % (for Navami population of Una district) to 60.22 % in Jajjer population of Sirmaur District. Dry matter content is directly related to the concentration of the nutrients in it. These results are in line with the findings obtained earlier by Prajapati *et al*. (2020); Bhat *et al*. (2012); Bhagta *et al*. (2019) in *Grewia optiva.*

Table 3: Average value for fodder quality characteristics of different thirty-five population of *Grewia optiva* Drummond.

District	Population	Population Name	LDM(%)	CP(%)	CF(%)	TA(%)	EE(%)	NFE(%)
SOLAN	1	Kothi kanwal	42.46	24.43	19.54	12.76	4.35	39.59
	2	Unchagaon	46.25	24.96	21.05	12.02	4.12	40.23
	3	Nerikalan	31.59	25.12	20.19	13.02	4.38	41.98
	4	Gaddo	43.79	21.98	19.98	12.13	5.03	39.98
	5	Devera	33.25	20.12	21.5	13.68	4.34	40.14
Mean			39.47	23.32	20.45	12.72	4.44	40.38
SIRMAUR	6	Machair	50.91	25.02	19.66	12.94	4.62	42.54
	7	Jajjar	47.35	24.56	20.32	12.68	5.12	41.98
	8	Neharbag	41.94	20.43	21.51	11.87	4.69	42.05
	9	Badon	34.85	21.22	20.49	11.64	5.33	43.31
	10	Dharkyari	40.48	20.19	21.03	12.06	4.35	40.67
Mean			43.11	22.28	20.60	12.23	4.82	42.11
UNA	11	Kant	29.56	19.23	20.05	12.42	4.28	42.7
	12	Navami	32.25	19.11	20.45	12.03	4.98	39.89
	13	Kharunibangana	35.98	20.17	20.51	11.93	5.21	42.85
	14	Thanakalan	37.19	19.89	20.33	12.54	4.86	40.88
	15	Lamlehri	36.99	20.33	20.76	12.31	4.53	41.14
Mean			34.39	19.74	20.42	12.24	4.77	41.49
KANGRA	16	Katoi	40.165	20.15	21.21	12.11	4.21	43.25
	17	Balugloa	40.05	22.34	21.43	19.87	4.38	42.34
	18	Purana kangra	33.86	23.43	20.54	12.64	5.22	41.33
	19	Dohan	37.59	22.65	21.15	13.81	5.11	42.24
	20	Balla	49.01	25.05	19.87	12.08	4.98	40.98
Mean			40.13	22.72	20.84	14.10	4.78	42.02
HAMIRPUR	21	Janhen	42.23	23.92	21.02	11.55	5.18	42.39
	22	Jhinkari	46.16	24.98	20.43	11.76	5.24	39.68
	23	Harbalneri	33.65	23.69	20.52	12.12	5.21	42.17
	24	Anu khurd	40.46	20.94	19.56	12.04	5.27	40.21
	25	Bhaleth	42.76	25.11	20.03	12.23	5.22	42.43
Mean			41.05	23.72	20.31	11.94	5.22	41.37
MANDI	26	Patta	35.52	19.34	21.22	12.61	5.36	42.17
	27	Gangal	34.96	19.73	20.27	11.98	4.98	40.19
	28	Bagla	35.90	20.22	19.12	11.87	5.44	42.23
	29	Balt	32.47	20.52	20.12	12.24	5.43	40.56
	30	Bharnoi	31.89	19.68	20.32	12.64	4.98	43.22
Mean			34.15	19.89	20.21	12.26	5.23	41.67
BILASPUR	31	Ghumarwin	36.67	23.93	19.21	11.43	4.78	41.45
	32	Barthi	42.12	25.15	19.97	13.12	5.33	44.21
	33	Kuthera	39.28	20.98	21.34	12.97	5.67	39.87
	34	Jukhala	32.36	23.42	20.17	11.98	4.98	39.67
	35	Nehari	37.65	22.72	20.12	12.45	5.61	40.34
Mean			37.62	23.24	20.16	12.39	5.27	41.10
SEM			0.843*	0.464*	0.414*	0.264*	0.104*	0.913*

Significant at 1% level of significance. Where, LDM-leaf dry matter, CP-crude protein, CF-crude fibre, TA-total ash, EE-ether extract, NFE-nitrogen free extract

C. Correlation between Physiochemical characteristics of soil and fodder characteristics of different populations of Grewia optiva Drummond

There was a positive correlation observed between leaf dry matter (LDM) and soil pH (Table 4). These results supported by findings of Gentili *et al.* (2018). Crude protein also showed strong correlation with the soil pH, similar results shown by Lee *et al.* (2010). Soil reaction (pH), in particular, can be considered a key variable due to its influence on many other soil proprieties and processes affecting plant growth. Indeed, microorganism activity as well as nutrients solubility and availability are some of the most important processes that depend on pH.

Electrical conductivity showed positive correlation with crude protein (Table 4) similar as reported in the study of Ding *et al.,* (2018). The electrical conductivity (EC) is an index of salt concentration and an indicator of electrolyte concentration of the solution. EC of the nutrient solution is related to the amount of ions available to plants in the root zone. There was positive correlation determined between Electrical conductivity of the soil and ether extract of fodder leaf. These results were contradictory to study of Boga *et al.* (2014) who reported that salinity and plants had no significant effect on ash and ether extract.

Organic carbon showed positive correlation with the crude protein (Table 4). As the soil organic carbon promotes soil structure or tilth meaning there is greater physical stability. This improves soil aeration (oxygen in the soil) and water drainage and retention, and reduces the risk of erosion and nutrient leaching. The chemical and nutritional benefits of organic matter are related to the cycling of plant nutrients and the ability of the soil to supply nutrients for plant growth. Organic matter retains plant nutrients and prevents their leaching to deeper soil layers. There was negative correlation recorded between Bulk density and leaf dry matter. The similar results given by Kobata *et al.* (2000). The bulk density effects soil compaction which is an important environmental problem and it causes physical degradation by adversely influencing hydraulic properties of soil and productivity parameters. It can affect root development and nutrient uptake. Increase in bulk density caused in all plants a significant decrease ($p \leq 0.05$) in dry weights of root and shoot (Parlak and Ozaslan 2011).

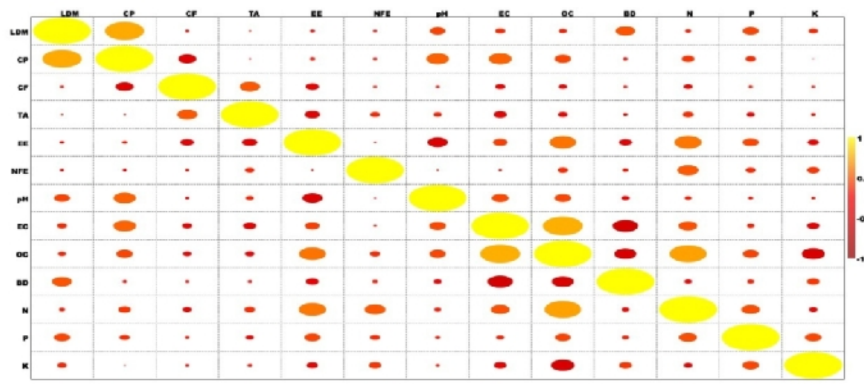
Nitrogen showed significant positive correlation with crude protein (Table 4). Similarly, Gonçalves *et al.*

(2011); McDonald *et al.* (2011) reported in their study that increase in soil nitrogen effect positively crude protein and leaf biomass in *Moringa oleifera*. Phosphorus gave positive correlation with the leaf dry matter similar findings of increase in dry matter with phosphorus have been reported by Sokobela *et al.* (2022) in *Moringa oleifera.* As Phosphorus is important in cell division and development of new tissue, associated with complex energy transformations in the plant. It is a vital component of ATP, the "energy unit" of plants and essential for the general health and vigour of all plants. Potassium showed insignificant correlation with leaf fodder quality parameters.

Table 4: Correlation between physicochemical characteristics of soil samples collected underneath selected populations of *Grewia optiva* Drummond and leaf fodder quality parameters of selected populations of *Grewia optiva* Drummond.

	LDM	CP	CF	TA	EE	NFE	pH	EC	OC	BD	N	P	K
LDM	**1**												
CP	0.644^{**}	1											
CF	-0.047^{NS}	-0.255^{**}	1										
TA	0.011^{NS}	0.013^{NS}	0.291^{**}	1									
EE	-0.060^{NS}	0.062^{NS}	-0.166^{NS}	-0.230^{*}	1								
NFE	-0.063^{NS}	-0.062^{NS}	-0.014^{NS}	0.109^{NS}	0.005^{NS}	1							
pH	0.247^{*}	0.359^{**}	-0.019^{NS}	0.102^{NS}	-0.323^{**}	0.027^{NS}	1						
EC	0.150^{NS}	0.376^{**}	-0.128^{NS}	-0.205^{*}	0.230^{*}	-0.027^{NS}	0.270^{**}	1					
OC	0.120^{NS}	0.261^{**}	-0.107^{NS}	-0.141^{NS}	0.435^{**}	0.124^{NS}	0.261^{**}	0.685^{**}	1				
BD	-0.322^{**}	-0.059^{NS}	-0.049^{NS}	-0.058^{NS}	-0.198^{*}	0.059^{NS}	-0.116^{NS}	-0.422^{**}	-0.362^{**}	1			
N	0.088^{NS}	0.193^{*}	-0.104^{NS}	0.173^{NS}	0.443^{**}	0.265^{**}	0.099^{NS}	0.306^{**}	0.612^{**}	-0.114^{NS}	1		
P	0.261^{**}	0.157^{NS}	0.046^{NS}	-0.125^{NS}	0.257^{**}	0.119^{NS}	0.063^{NS}	0.113^{NS}	0.255^{**}	0.107^{NS}	0.297^{**}	1	
K	0.148^{NS}	0.009^{NS}	-0.039^{NS}	0.060^{NS}	-0.167^{NS}	0.154^{NS}	0.050^{NS}	-0.199^{*}	-0.387^{**}	0.200^{*}	-0.130^{NS}	0.267^{**}	1

Correlation Significant at $p<0.05$;Where, LDM-leaf dry matter, CP-crude protein, CF-crude fibre, TA-total ash, EE-ether extract, NFE-nitrogen free extract, EC-electrical conductivity, OC-organic carbon, BD-bulk density, N-nitrogen, P-phosphorus, K-potassium



Where, LDM-leaf dry matter, CP-crude protein, CF-crude fibre, TA-total ash, EE-ether extract, NFE-nitrogen free extract, EC-electrical conductivity, OC-organic carbon, BD-bulk density, N-nitrogen, P-phosphorus, K-potassium

Fig. 2. Graphical representation of Correlation between soil physicochemical characteristics and leaf fodder quality parameters of selected populations of *Grewia optiva* Drummond.

CONCLUSION

The soil of district Solan, Sirmaur, Kangra, Hamirpur and Bilaspur district noted rich in soil nutrients. Mandi and Una district delineated with poor soil and leaf nutrient characteristics. The analysis on fodder characteristics of selected populations of *Grewia optiva* Drummond in Himachal Pradesh, India unveiled that nine Populations *viz.*, Kothi kanwal (Solan), Uncha gaon (Solan), Neri kalan (Solan), Machair (Sirmaur), Jajjer (Sirmaur), Balla (Kangra), Jhinjkari (Hamirpur), Bhaleth (Hamirpur) and Barthi population of Bilaspur district reported with highest percentage (>24 per cent) for crude protein, as crude protein (CP) content is most important criterion for judging feed and fodder quality. The correlation developed between fodder characteristics and soil characteristics will help in quantify the impact of different soil characteristics on fodder characteristics and help in selection of best nutritive populations, further improvement and fertilizers recommendation dose.

FUTURE SCOPE

The correlation established between soil physiochemical characteristics and *Grewia optiva* leaf fodder characteristics will help in identification and selection of Superior nutritive strains of *Grewia optiva* for further propagation to get improved genetic gain and for production of quality planting material.

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