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Assessment of Soil Fertility Status in Vegetable Growing Area of Daman-Palung, Nepal

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ABSTRACT
Soil fertility assessment is essential for sustainable planning for a particular area. Considering this, a study was conducted in November 2018, to determine the soil fertility status of the vegetable growing area of Makwanpur district, Nepal. In total, 50 soil samples were collected randomly from a depth of 0-20 cm using a soil sampling auger. A standard analytical method was used to analyze the texture, soil pH, (Organic matter (OM), Nitrogen (N), Phosphorus (P_2O_5), and Potassium (K_2O) status of samples at the National Soil Science Research Centre, Khumaltar. The sand, silt and clay content were 45.67±2.08, 35.6±51.37 and 18.49±0.93 respectively and were indicated as loam and sandy loam in texture. The soil was moderately acidic (pH 5.11±0.5) in nature. Soil organic matter ranged from low to medium but the medium (3.37±1.72 %) was prevalent. Total nitrogen content (0.22±0.01 %) and available phosphorus (230.58 ±85.61 ppm), were found to be high. Furthermore, available potassium (97.4±70.04 ppm) content was medium in the soil. The purpose of this soil fertility assessment is to help researchers and farmers in Daman, Palung know the soil fertility status of their area and to guide sustainable soil fertility practices. This soil fertility assessment aims to help researchers and farmers in Daman, Palung understand soil fertility status and determine the best soil fertility practices for their area.

Keywords: Soil test, soil fertility, Daman, Palung

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INTRODUCTION
Soil is a complex system composed of minerals, soil organic matter (SOM), water and air (Vishal et al 2009). The soil physical parameters include soil texture, structure, colour etc. In the same way, the crucial chemical properties include soil reaction (pH), organic matter, macro, and micronutrients. These properties are vital for soil fertility and determined after soil testing (Brady and Weil 2004). Soil fertility is defined as the inherent ability of a soil to supply plant nutrients in sufficient amounts and required proportions essential for utmost plant growth (Von Uexkuell 1988). The soil fertility of an area degrades sporadically due to varied natural and human factors. Insufficient soil fertility is a major problem for sustained agricultural development in various sites of Nepal. (Khadka et al 2016a, Khadka et al 2016b, Khadka et al 2016c, Khadka et al 2016, Khadka et al 2017).

Soil testing assesses the fertility status and provides data about nutrient availability in the soils which is the basis for the fertilizer recommendations for increasing crop yields and maintains the required fertility in soil for a prolonged period. Soil test-based fertility management is an effective implement for maximizing the productivity of agricultural soils that have spatial variability resulting from a combined effect of physical, chemical, and biological processes (Goovaerts 1998). Global Positioning Systems (GPS) is an essential tool to evaluate soil spatial variability.

Daman and Palung are popularly known as Tistung-Palung lies in Thaha Municipality in Makwanpur district of Bagmati Pradesh in the mid-hills of Nepal. The main occupation of people living in this area is agriculture. They are the major exporter of potato and other vegetables (cauliflower, cabbage, brinjal, radish and different varieties of green chillies and capsicum) to major cities like Kathmandu, Hetauda, Narayangadh, Pokhara, Birjung and to India. Being a vegetable growing area of Nepal, the studies regarding soil fertility status is not yet been documented. Therefore, it is pragmatic and informative to investigate the soil fertility status which helps to provide important information related to vegetable production. Taking this into account, the present study was done to assess the soil fertility status of the vegetable growing area of Nepal, Daman and Palung.

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MATERIALS AND METHODS

Study Area:
The study area lies in the major vegetable growing Thaha Municipality (Daman and Palung) of Makwanpur district. The various vegetables namely, cauliflower, cabbage, radish, carrot, beans, coriander, potato, spinach, okra, cucumber, pumpkin, snake gourd, sponge gourd etc. were grown seasonally in the field. The cool (moderate temperature) summer, and cold winter is common in the study area.

Soil Sampling:
Surface soil samples (0-20 cm depth) were collected from Daman and Palung, Nepal during November 2018. Total of 50 soil samples was collected from the Daman by soil sampling auger. The exact locations of the samples were recorded using a handheld GPS receiver. Moreover, the sample was taken ranged from 1700 to 2240 masl. The random method based on the variability of the land was used to collect soil samples.

Laboratory Analysis:
The collected soil samples were analyzed at the laboratory of the National Soil Science Research Centre, Khumaltar. The different soil parameters tested as well as methods adopted to analyze have been shown in table 1.

Statistical Analysis
Descriptive statistics (mean, range, standard deviation, standard error, coefficient of variation) of soil parameters were computed using the Minitab 17 package. Rating (very low, low, medium, high and very high) of determined values were based on National Soil Science Research Centre, Khumaltar, Lalitpur, Nepal.

Table 1. Analysis method for soil parameters

S.N.	Parameters	Methods
1.	Soil Texture	Hydrometer (Bouyoucos, 1927)
2.	Soil pH	Potentiometric 1:2 (Jackson, 1973)
3.	Total nitrogen	Kjeldahl (Bremner and Mulvaney, 1982)
4.	Available P_2O_5	Modified Olsen's (Olsen et al., 1954)
5.	Extractable K_2O	Ammonium acetate (Jackson, 1967)
6.	Total plant nitrogen	Kjeldahl (Bremner and Mulvaney, 1982)

RESULTS

For evaluation of soil fertility status of the study area texture, pH, OM, Primary nutrients were determined.

Soil Texture

The particle size distribution of the soils showed sand content from 16% to 76% with a mean of 45.67%. Similarly, silt content of the soil was found from range 15% to 53% with a mean of 35.65 while clay content ranged from 7% to 34% with a mean of 18.49. The textural classes loam, sandy loam, silt loam, silty clay loam was determined but much of the growing area was found loam followed by sandy loam.

The variability of sand, silt and clay were 1.22%, 7.04% and 13.46%, respectively. This showed low variability among the studied samples.

Table 2: Soil textural status of vegetable growing area Daman-Palung, Nepal

Descriptive statistics	Soil Texture		
	Sand	Silt	Clay
	%		
Mean	45.67	35.65	18.49
Standard deviation	14.58	9.57	6.48
Standard error	2.08	1.37	0.93
Min	16	15	7
Max	76	53	34
CV%	31.91	26.84	35.05
Class		Loam; Sandy loam	

Soil pH

The soil pH varied from 4.16 to 6.67 with a mean of 5.11 as shown in table 3. This showed that area was very acidic in nature. The soil reaction showed low variability (9.70) among the soil samples.

Soil Organic matter

The Organic matter content ranged from0.68 to 9.38 with a mean of 3.76 which is shown in table 3. The soil organic matter ranges from low to medium but the medium (3.37%) range was prevalent. Organic matter showed moderate (45.63%) variability among sampled soils.

Table 3. Soil fertility status of vegetable growing area Daman-Palung, Nepal

Descriptive Statistics	Soil Fertility Parameters	
	pH	OM
		%
Min	4.16	0.68
Max	6.67	9.38
Mean	5.11	3.76
SD	0.5	1.72
Sem	0.07	0.24
CV%	9.70	45.63

Total Nitrogen
The total nitrogen content ranged from 0.09 to 0.45% with a mean of 0.22% (Table 4). This showed a low to high nitrogen range, but high nitrogen level was prominent. Moderate variability (34.61%) in total nitrogen was found among the sampled soils.

Available Phosphorus
The available phosphorus varied from 26 to 401 ppm with a mean of 230.58 ppm (Table 4). This showed the very high nutrient status of available phosphorus (Table 2). Available phosphorus showed moderate variability (37.13%) among the soils sampled.

Available Potassium
The available potassium content ranged from 11 to 339 ppm (Table 4). This showed medium (97.4 ppm) available potassium content. High variability (71.91 %) in available potassium was observed among the sampled soils.

Table 4. Soil fertility status of vegetable growing area Daman-Palung, Nepal

Descriptive Statistics	Soil Fertility Parameters		
	Nitrogen	Phosphorus	Potassium
	%	ppm	
Min	0.09	26	11
Max	0.45	401	339
Mean	0.22	230.58	97.4
SD	0.08	85.61	70.04
Sem	0.01	12.11	9.91
CV%	34.61	37.13	71.91

DISCUSSION
Soil texture is the summation of proportions of sand, silt, and clay content. It is interrelated with soil fertility and quality in the long term and is a stable feature that influences soil biophysical properties (Uphadhya and Raghubansi 2020). Also, it is a prominent soil character that promotes crop production and field management. The proportion of sand and silt was high. Overall, the observed texture (loam and sandy loam) (table 2) had proper water and water holding capacity. Loam soil means an equal proportion of sand, silt and clay and sandy loam means a little bit more amount of sand in it. Loam soil is medium-textured soil and sandy loam is moderately coarse-textured soil based on USDA particle-size classification. (Panda 2010), reported that medium coarse-textured soils like loam soils are considered suitable among other soil textures for most of the crop.

Soil pH is defined as a measure of the acidity and alkalinity of the soil. Soil pH was moderately acidic (5.17) as shown in table 3, in the area with a range of 4.16 to 6.67. Soil pH is important because it influences the availability of essential nutrients. Most of the horticultural crops grow well in soils with a pH between 6(slightly acidic) and 7.5 (slightly alkaline). From a solubility point of view, this pH range can assure the high bioavailability of most nutrients essential for vegetable growth and development (Ronen 2007). The pH affects microbial activity, which can affect the bioavailability of both macronutrients and micronutrients. Most of the soil microbes thrive in a range of slightly acidic pH (6-7) due to the high bioavailability of most nutrients in that pH range (Sylvia et al 2005). Being a major vegetable growing area, pH might be acidic due to the use of more inorganic fertilizers. The use of agricultural lime is recommended if high acidity occurs.

Organic matter is an important factor that makes soil alive, and improves physical, chemical and biological properties (Hoyle et al 2011). The soil organic matter ranges from low to medium but the medium (3.37%) (table 3) range was prevalent. Organic matter showed moderate (45.63%) variability among sampled soils. The study area lies in the mid-hill region has a year-round low temperature. The low temperature reduces the rapid microbial degradation of organic substances therefore organic matter is optimum in the study area. The higher organic matter in the vegetable growing land might be due to the supply of organic manure and the adoption of soil management practices such as balanced fertilization and increased biomass production. Another study by Pandey et al 2018, reported that due to the intensive cropping system in some parts of Nepal, had removed essential plant nutrients from the soil, which thereby creates pressure on soil fertility.

Nitrogen has been considered a vital component of organic matter (Brady and Weil 2004). The total nitrogen content ranged from 0.09 to 0.45% with a mean of 0.22% (Table 4), this showed high nitrogen content. The medium range of organic matter in the soil might be the cause of high nitrogen content. Since nitrogen is high in the soil, 40% of the recommended nitrogen dose is required for the adequate supply of nitrogen for vegetable crops (Joshi and Deo 1975). Another reason might be a large amount of nitrogen retained in the soil after the harvest of the crop. Application of recommended rates to the vegetable field, however, might leave large amounts of residual soil mineral nitrogen, mainly after harvesting of crops before maturing example: Spinach, Cauliflower, Cabbage, Brussels sprouts (Neeteson et al 1999).

Phosphorus is the second most limiting nutrient after nitrogen and has harmful impacts on crop yield if found to be deficient (Sharma et al 2017). The available phosphorus varied from 26 to 401 ppm with a mean of 230.58 ppm (Table 4) which showed the very high nutrient status of available phosphorus. Higher phosphorus content in the soil might be due to continuous application of phosphatic fertilizers based on farmers experience rather than on soil analysis and vegetable requirements to achieve a high level of economic benefits. Being a very high status of phosphorus, 40% of the recommended phosphorus dose should be sufficient for the vegetable crops in the area (Joshy and Deo 1975).

Potassium is also required by plants in about the same or slightly larger amounts as nitrogen. Most critical physiological processes such as photosynthesis, carbohydrate transport, and water regulation are influenced by potassium. Management of optimum levels of potassium in the soil and the plants helped in disease resistance, increased drought tolerance and vigorous vegetative growth (Nair 2018). The study showed medium (97.4 ppm) (table 4) available potassium content in the soil. This might be nutrient mining due to the insufficient supply of their source for the crops. The region with low to the medium status of available potassium application of 100% and 60% respectively of the recommended potassium dose is required for the adequate supply of potassium (Joshi and Deo 1975).

CONCLUSION

Overall soils were moderately acidic in reaction in Thaha municipality, daman, Palung, and it is advisable to use agricultural lime periodically for its amelioration. The sand, silt and clay content were indicated as loam and sandy loam in texture which is good for agricultural land. In the same way, the medium range of soil organic matter was observed which means there was optimum organic matter in the soil. Also, total nitrogen and phosphorus were observed high which might be due to medium range of organic matter. But the available potassium content was medium therefore it is recommended to use 60% of recommended dose of potassium. this study might help to know the soil fertility status of that area and could guide the practices required for sustainable soil fertility management.

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AUTHOR'S CONTRIBUTION

S Joshi: conceptualized the topic, analyzed soil sample in the laboratory and analyzed the data and prepared the manuscript.
D Khadka: Regular constructive comments, collected soil sample and analyzed in the laboratory.
R Amgain: Revised the draft and helped in the soil samples analysis in the laboratory.

CONFLICT OF INTEREST

The authors have declared that there is no conflict of interest regarding the publication of this manuscript.

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