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Effect of soil constituents on the chemical characteristics of saffron

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Abstract
The present study was attempted to examine the macronutrient status in the karewa soils of Jammu & Kashmir and their effect on chemical characteristics of saffron. The study was based on 7 soil samples (90 composite samples), collected at a depth of 0-100 cms. The selection of sample sites was made purposively after taking physicochemical composition of the area into consideration, so that the sampling site becomes the true representation of the region. The pH and electrical conductivity value decreases with respect to the sampling sites from one area to another area in the region. It may be responsible for the differences in the chemical characteristics of saffron in terms of its colour and aroma. The other components like Nitrogen and phosphrous organic matter concentration also depict variations across various sites from one area to another. The study shall be of great significance not only in understanding the agricultural resource base of the region but will also provide a new strategy to curb malnutrition which is prevalent in the area.

Keywords: Saffron, soil, nutrients

Introduction
Soil acts as an engineering medium (Ritter, 2006) with tremendous range of available niches and habitats and contains most of the earth's genetic diversity [1]. It is composed of both macro and micro nutrients which are critically important component of earth's biosphere and therefore plays an important role in the maintenance of biodiversity and habitat [2]. It controls fertility of the soils, yields and growth of plant [3, 4]. The characteristics of soils differ widely depending upon the geophysical constraints like nature of the rock, climate and topography, soil pH and the susceptibility of the soil to compaction are dependent on the constituents of the original parent rock [5]. Soil fertility is determined by the presence or absence of macro and micronutrients that are not uniformly found in the soils [6] leading some soils have surplus and other deficient in terms of concentration. These nutrients are essential for the life cycle of normal growth of plants, deficiency of which can be corrected by supplying the elements [8]. Nutrients are available as ions in three forms i.e. ions held as colloidal particles, ions absorbed on colloidal surface and ions in solution form. Of these three forms, those in solution form are the most readily available to plants [9]. Nutrients are continuously removed from the soils by cropping [10] in addition to losses by runoff [11] and even a high fertile soil is exhausted of reserve nutrients, as the crops are grown continuously. It was estimated that about 4.17 million tons of Nitrogen, 2.13 million tons of phosphorus and 7.42 million tons of potassium are removed annually by agricultural cropping in India, thus affecting the soil fertility as it depicts a positive association with plants like rice.

Out of the 16 plant nutrients, Nitrogen (N), Phosphorus (P) and Potassium (K) are referred as macronutrients; as they are required in large quantities for growth, increase plant productivity, leaf and grain yield and also help in the occurrence, diversity, distribution, and relative abundance of the species [12]. Similar is the case with micronutrients like Zn, and Mn deficiency can cause nutritional imbalance in the soils which may results in significant reduction in the productivity of the crops (Wani *et al*., 2014) including saffron. Production of good quality saffron possessing optimal levels of safranal and crocin are the basic requirements towards saffron quality assurance. The spatial maps on micronutrient status generated during the study will be helpful for the farmers or researchers for the location specific correction of nutrient deficiency and for guiding the farmers accordingly.

Material and Methods

The study was attempted to assess the macronutrient status among the saffron soils across the various sampling sites in the Jammu and Kashmir valley. The study is based on 7 soil samples collected at a depth of 0-100 cms. The selection of sample sites was made purposively after taking physicochemical composition of the area in to consideration so that the sampling site becomes the true representation of the region. Represented soil samples were collected with wooden tools to avoid any contamination of the soils. Three to five pits were dug for each sample. From each pit sample was collected at a depth 0-30 cm. A composite sample of about 1kg was taken through mixing of represented soil sample. All composite samples were dried, ground with wooden mortal and passed through 2 mm sieve. After sieving all the samples were packed in the labeled polythene bags for laboratory investigations. Soil tests were done at Central Institue of Temperate Horticulture (CITH) Rangrate Srinagar, India by using following respective methods:

1. pH by standard pH meter in a 1:2 soil-water suspension.
2. Organic carbon (OC) by Walkley and Black rapid titration method (1934).
3. Available nitrogen (N) by Alkaline Permanganate Method (Subbiah and Asija, 1956).
4. Available phosphorus (P) by Olsen’s Method (1954).
5. Available potassium (K) by flame photometry as described by Jackson, 1973.
6. Electrical conductivity was also measured.

Results and Discussion

The effect of soil pH is profound on the solubility of minerals and nutrients. It is regarded as a useful indicator of other soil parameters. Particularly, it yields useful information about the availabilities of exchangeable cations (e.g. Ca^{2+}, Mg^{2+}, K^{+} etc) in soils. Most minerals and nutrients are more soluble or available in acid soils than in neutral or slightly alkaline soils. The average pH of Karewa soils varies from 6.5 to 8.0 with an average value of 7.94 indicating their slightly alkaline nature.

The analysis of the Table 3 reveals that there exist great variations in the soil pH across the various sample sites in the region in which certain sample sites show high pH content as compared to the other sample sites where the value of pH has been found relatively very low. The soils of Budgam and Charisharief are more alkaline than other locations. However, the soils from Kishtwar, Pamopre and Dooru show pH ranging between 6.86-7.00. The other cause responsible for the high pH content in the soils of Budgam and Charisharief is because these soils remain waterlogged during frequent periods of the year due to poor drainage system in the area.

Table 3: Soil pH across various Sample Sites

Sample Sites	pH
Doru Anantnag	6.90
Pampore-2	6.88
Kishtwar	6.99
Pampore-3	7.00
Budgam	7.93
Chaarisharief	7.92
Kishtwar	6.86
Average	7.21

The analysis of Table 3 shows phosphorus and nitrogen content among various sample sites. It has been revealed that there exists little variation in phosphorus content across various sample sites in the region while the maximum concentration of phosphorus content has been found in Kishtwar (14 Kg/hectar) and Chaarisharief (18 Kg/hectar). However on the other hand, the low concentration of the phosphorus content across the various sample sites has been found in case of Pampore-2 (11.5 Kg/hectar) and Pampore-3 (11.2 Kg/hectar). In case of nitrogen concentration, the results has been quite similar where the abundant amount of nitrogen concentration have been found in the soils of Kishtwar and Chaarisharief (210.21 Kg/hectar) and the least has been found in Pampore-3 R2 (205 Kg/hectar).The study thus depicts that there exists positive correlation between nitrogen and phosphorus concentration in the soils across various sample sites in the study area.

Table 3: Phosphorus and Nitrogen content across various Sample Sites

Sample Sites	Phosphorus (Kg/hectar)	Nitrogen (Kg/hectar)
Doru	9.86	210.3
Pampore-2	11.5	205.0
Kishtwar	9.43	210.0
Pampore-3	11.2	205.0
Budgam	10.45	205.4
Charisharief	12.35	210.1
Kishtwar	14.0	210.2
Average	11.26	208

The organic matter of soils includes the remains of plants, animals and microorganisms in all stages of decomposition. The level of organic matters in soils influences a number of soil chemical and physical properties. Karewa soils have high organic carbon (OC) ranging from 0.57 to 0.60% indicating an important role of organic carbon (OC) for saffron growth. The analysis of the Table 3 reveals that there exists strong variations in the organic matter concentration in the soils across the various sample sites while the maximum organic matter concentration has been observed in the soils of Chaarisharief (0.66) and the low concentration has been found in Budgam (0.57). It has also been revealed the low Saffranal and Crocin content has been attributed to the main factor behind the highest concentration of organic matter along the various sample sites in the region but its relationship has also been found quite insignificant across various sample sites in the region indicating that higher levels of organic carbon does not have profound impact on the chemical characteristics of Saffron.

Table 3: Soil Organic Matter across various Sample Sites

Sample Sites	Organic Carbon (%)
Doru	0.62
Pampore-2	0.64
Kishtwar	0.60
Pampore-3	0.58
Budgam	0.57
Charisharief	0.66
Kishtwar	0.58
Average	0.60

Inherent factors affecting electric conductance (EC) include soil minerals, climate, and soil texture which cannot be changed. Salts originate from disintegration (weathering) of minerals and rocks. Furthermore, salts move with water; low areas, depressions or other wet areas where water accumulates tend to be higher in electric conductance (EC) than surrounding higher-lying, better drained areas. Electrical conductivity levels can serve as an indirect indicator of the amount of water and water-soluble nutrients available for plant uptake. Soil microorganism activity declines as electric conductance (EC) increases. This impacts important soil processes such as respiration, residue decomposition, nitrification, and denitrification.

The analysis of the Table 3 reveals that the electrical conductivity does not show any similarity but it depicts great variations across various sample sites in the region. It has been revealed that the soils of Budgam show higher electric conductance (EC) in comparison to other locations while Kishtwar and Pampore show lower electric conductance (EC) in comparison to other locations. The higher E.C in Budgam Karewa soils has been attributed with its higher pH value. Electric conductance (EC) values of Kishtwar and Pampore Karewas show lower values in comparison to other location, which are again consistent with their lower pH values. The study indicates that the E.C and pH are very much controlling factors for the production of Saffranal and crocin in saffron.

Table 3: Electrical Conductivity (EC) across various Sample Sites

Sample Sites	Electrical Conductivity (EC) (dsm^{-1})
Doru	0.17
Pampore-2	0.18
Kishtwar	0.16
Pampore-3	0.16
Budgam	0.23
Chaarisharief	0.21
Kishtwar	0.14
Total	0.18

Conclusion

There seems no significant relation between the nature of soil constituents and chemical characteristics of saffron in terms of its aroma and colour. However pH and electric conductivity values of soil may affect the quality of saffron. Higher and lower values of pH and electric conductivity may be responsible for variation in the chemical characteristics of saffron of different locations.

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