

DISTRIBUTION OF MACRO NUTRIENTS IN SURFACE AND SUBSURFACE SOILS UNDER SAFFRON GROWING AREAS OF PULWAMA DISTRICT OF JAMMU & KASHMIR, INDIA

Abstract

One hundred eighty (180) composite soil samples were collected from surface and subsurface layers from 18 saffron growing villages of Pulwama district to study the available primary and secondary nutrient status of the soils. None of the soil were found to be deficient in available nitrogen, phosphorous, potassium, calcium, magnesium and sulphur. The soils were medium in available nitrogen and phosphorous and medium to high in potassium with mean values of 338.46, 21.25 and 258.83 kg ha⁻¹ respectively in surface soils (0-15 cm) and mean values of 318.07, 18.82 and 232.03 kg ha⁻¹ respectively in sub-surface soils (15-30 cm). All the soils were high in available calcium and magnesium with average values of 1677.1, 317.7mg kg⁻¹ and 1692.5 and 352.3mg kg⁻¹ in surface and subsurface soils respectively. The soils were low to medium in available sulphur content with surface and subsurface sulphur content of 10.51 and 8.70 mg kg⁻¹ respectively.

Keywords: Saffron growing soils, Pulwama, Available primary and secondary nutrients

1. INTRODUCTION

The term "saffron" is derived from "Zaffran," the Arabic name for this spice. In India, it is also known as "Kesar" and holds a traditional significance in culinary practices. Saffron (*Crocus sativus* L.) belongs to the Iridaceae family and is the sole economically significant product obtained from any *Crocus* species. The herb is believed to have originated in Greece, Asia Minor, and Persia, gradually spreading eastwards to China and Kashmir. The saffron plant has adapted to a Mediterranean-type climate and thrives in temperate conditions at altitudes ranging from 1500 to 2400 meters above mean sea level (MSL). Its cultivation spans a vast geographical range, extending nearly 90 degrees' longitude (from Spain to Kashmir) and 25 degrees' latitude (from England to Persia). Saffron gained popularity as a medicinal substance during the Arab regime, leading to its cultivation in Spain around 921 A.D. Subsequently, its cultivation expanded to neighbouring countries in southern Asia and Europe[1].

“India occupies the second largest area and produces approximately 7 per cent of the total world production” [2]. Jammu and Kashmir is enjoying monopoly to grow this crop in the country and is being cultivated in Pulwama, Srinagar, Budgam and Kishtwar districts over an area of 3657 ha during 2022. According to reports from the Directorate of Agriculture, Jammu and Kashmir, there has been no significant increase in saffron production, and a notable decline in productivity has been observed. The productivity decreased from 2.80 kg per hectare in 1996-97 to 1.88 kg per hectare in 2016. Recognizing the impact of soil nutrients on saffron productivity, a soil nutrient survey was conducted to assess the fertility status of saffron growing soils in the Pulwama district.

2. MATERIALS AND METHODS

The study area i.e., Pulwama district is situated between the geographical coordinates of 33°37' to 34° 06' N Latitude and 74°33' to 75°14' E Longitude and 1500 to 2000 m amsl altitude is bounded by Srinagar in the North, Budgam in the West and Anantnag in the south. The area experiences typical sub-humid temperate climate and qualifies for udic moisture regime dominantly and mesic or warmer temperature regime. The physiography is highly uneven characterized by moderately steep to very steep slopes in upper reaches, moderately undulated at mid-elevated plateaus (Karewas) and flat to moderately sloping land under cultivation and near habitation.

One hundred eighty (180) composite soil samples were collected from two depths viz., 0-15 cm and 15-30 cm from 18 saffron growing villages (Fig. 1) of Pulwama district by following simple random sampling method. “The collected composite samples were air dried in shade and after drying the samples were ground with wooden pestle and mortar and sieved by using 2mm sieve to separate coarse fragments (>2mm). The sieved sample was used for analysing various soil parameters. Available Nitrogen was determined by **alkaline potassium permanganate method** as described by Subbiah and Asija” [3]. Available phosphorous content of soil was extracted by 0.5N sodium bicarbonate at pH 8.5 [4] and was estimated by ammonium molybdate method as described by Jackson [5]. “Available potassium was extracted with neutral normal ammonium acetate and the content of potassium was estimated by using flame photometer. Available sulphur in soil was determined by turbidimetry method as described by Chesnin and Yien” [6]. “Calcium and magnesium content in the soil samples were determined by versenate titration method” [5].

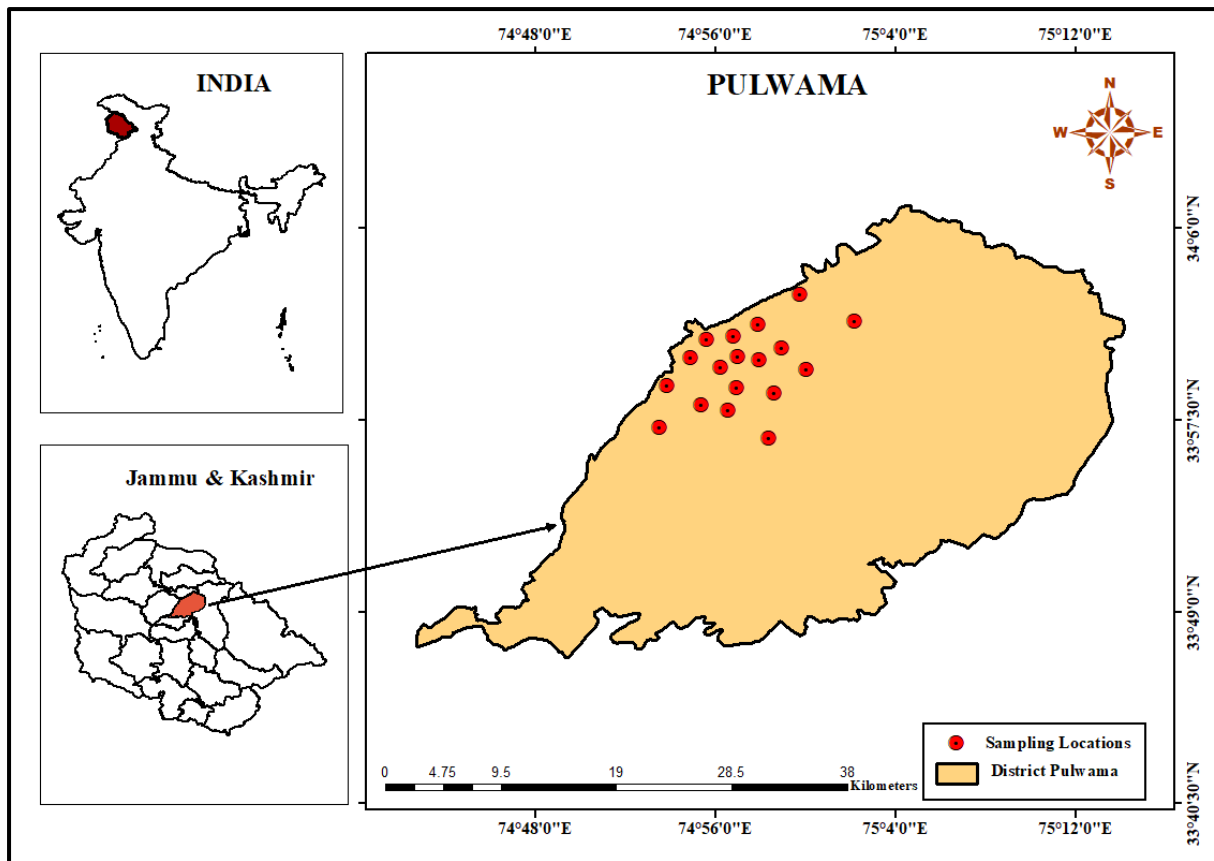


Fig 1: Study area map of Pulwama District

3. RESULTS AND DISCUSSION

3.1 Primary nutrients

The primary nutrient status of saffron growing soils of Pulwama district is presented in table 1. The available nitrogen content of surface and subsurface soils varied from 274.1 to 413.2 and 251.8 to 391.2 kg ha⁻¹ with mean values of 338.46 and 318.07kg ha⁻¹ respectively. Nitrogen content of surface soils was found to be higher than subsurface soils and showed a decreasing trend with depth. The available nitrogen exhibited significant variation among the different locations. Nitrogen content in these soils was found in medium range. The decrease in available nitrogen with increase in soil depth may be due to presence of high organic matter content and favourable environmental conditions for mineralization in surface layers than in sub-surface layers. The variation in nitrogen content among different locations is due to variation in climatic and physiographic conditions and organic matter content. The results are in agreement with the findings of Dar [7], Singh and Rathore [8], and Bhat [9].

Table 1: Available primary nutrient status of saffron growing soils under Pulwama district

Location	Available Nitrogen (Kg ha ⁻¹)		Available Phosphorous (Kg ha ⁻¹)		Available Potassium (Kg ha ⁻¹)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Konibal	329.6	315.4	20.35	18.16	284.2	259.8
Pompore	308.1	292.3	20.84	18.37	270.4	257.2
Samboora	290.5	276.4	18.31	16.73	188.6	165.2
Baras	397.3	378.2	24.19	21.75	226.0	208.2
Mueej	378.2	355.8	24.00	21.94	238.4	214.2
Krunchoo	274.1	253.4	17.02	15.37	201.0	183.8
Wuyen	349.8	321.0	21.70	19.42	228.4	214.4
Munpur	413.2	391.2	26.91	22.78	317.2	297.6
Lethpora	304.8	291.8	19.10	17.09	286.8	247.2
Ladhu	334.6	310.6	21.05	18.90	244.6	226.8
Chandhara	278.0	251.8	17.13	14.01	335.6	310.8
Dussu	344.1	323.6	21.60	19.51	295.4	263.4
Khrew	332.0	317.6	21.47	18.85	220.0	171.0
Kakapora	408.2	376.0	25.23	22.45	225.8	182.4
Zaintrag	399.4	376.4	24.68	22.13	297.2	267.8
Namblabal	283.5	269.3	18.62	16.09	312.0	278.8
Kadlabal	296.2	272.0	18.30	15.32	204.6	174.0
Sharshali	370.3	351.6	22.09	19.91	282.8	254.0
Range	274.1-413.2	251.8-391.2	17.02-26.91	14.01-22.78	188.6-335.6	165.2-310.8
Mean	338.46	318.07	21.25	18.82	258.83	232.03
SEM	11.06	10.62	0.68	0.63	10.46	10.64

Available phosphorus of surface soils varied from 17.02 to 26.91 kg ha⁻¹, with a mean value of 21.25 kg ha⁻¹, whereas, in subsurface soils it ranged from 14.01 to 22.78 kg ha⁻¹, with a mean value of 18.82 kg ha⁻¹. The available phosphorus showed a decreasing trend with an increase in soil depth. The available phosphorus status of soils under study was found in medium range. The results are in accordance with similar results were obtained by Dar [7] and Kumar [10]. The high amount of available phosphorus in surface layers as compared to sub-surface layers may be due to high amount of organic matter in surface soils, which decreases with depth. The present findings are in line with the results obtained by Fida [11] and Bhat [9]. The available phosphorus content in soils of different locations varied significantly with high content in soils with high organic matter followed. This could be attributed to favorable soil reaction and high organic matter content leading to the formation of organophosphate complexes and coating of iron and aluminum particles by humus. This is supported by the research work of Singh and Bhandari [12], Akhter [13] and Wani [14].

The present study revealed that the available potassium of surface and subsurface soils ranged between 188.60 to 335.60 kg ha⁻¹ and 165.20 to 310.80 kg ha⁻¹ with mean values of 258.83 and 232.03 kg ha⁻¹ respectively. The status of available potassium was observed between medium to high. It may be due to prevalence of potassium rich clay minerals like illite and application of potassium fertilizers as well as manures. These results are further supported by the findings of Dar [7] and Fida [11].

3.2 Secondary nutrients

The secondary nutrient status of saffron growing soils of Pulwama district is presented in table 2. It was observed that exchangeable calcium content of surface soils ranged from 1487.0 to 1841.2 mg kg⁻¹ with a mean value of 1677.1 mg kg⁻¹, whereas, in subsurface soils it varied from 1494.2 to 1855.7 mg kg⁻¹ with a mean value of 1692.5 mg kg⁻¹. Available calcium of sub-surface layers was high than that of surface layers and it showed an increasing trend with an increase in soil depth. The saffron growing soils under study were found to be high in available calcium. These results are in accordance with the findings of Wani [15] and Dar [7]. Exchangeable calcium was high in the soils. It may be due to presence of calcium rich minerals with substantial quantities of dolomite and shale, which

Table 2: Available secondary nutrient status of saffron growing soils under Pulwama district

Location	Calcium (mg kg ⁻¹)		Magnesium (mg kg ⁻¹)		Sulphur (mg kg ⁻¹)	
	0-15 cm	15-30 cm	0-15 cm	15-30 cm	0-15 cm	15-30 cm
Konibal	1787.4	1794.0	314.4	347.2	8.32	7.69
Pompore	1841.2	1855.7	298.2	323.3	11.56	9.61
Samboora	1487.0	1494.2	334.0	365.2	7.36	6.12
Baras	1775.4	1789.2	341.2	380.0	12.57	10.35
Mueej	1631.8	1653.4	387.8	413.6	8.51	7.61
Krunchoo	1690.3	1701.0	311.6	342.8	8.63	6.14
Wuyen	1568.4	1575.3	239.3	286.1	11.32	9.21
Munpur	1760.1	1771.9	287.9	329.7	12.02	10.01
Lethpora	1776.2	1794.6	332.2	363.1	7.09	5.69
Ladhu	1727.1	1756.2	345.3	399.4	13.29	11.58
Chandhara	1821.1	1843.0	287.3	315.8	12.07	8.64
Dussu	1676.9	1691.3	327.5	372.4	14.68	12.60
Khrew	1667.3	1683.5	339.6	364.5	12.69	10.39
Kakapora	1698.9	1721.4	375.4	399.7	8.66	7.64
Zaintrag	1564.7	1582.2	302.7	337.1	13.27	11.64
Namblabal	1638.4	1657.2	321.5	348.2	9.24	7.61
Kadlabal	1491.2	1502.8	304.2	357.3	8.31	6.51
Sharshali	1584.0	1597.8	268.8	296.2	9.56	7.63
Range	1487-1841.2	1494.2 -1855.7	239.3 -387.8	286.1 -413.6	7.09-14.68	5.69-12.60
Mean	1677.1	1692.5	317.7	352.3	10.51	8.70
SEM	25.36	25.80	8.44	8.16	0.55	0.63

encircle whole valley of Kashmir in the form of cliffs as reported by Wadia [16]. The calcareous nature of parental material as reported by Handoo [17] may also be a responsible for high available calcium content of these soils. These observations were also reported by the findings of Dar [18] and Bhat [9]. The calcium content of the soils increased with depth which may be due to leaching of calcium from surface to sub-surface layers. The results are in agreement with those of Ahmad [19] and Bhat [9]. The variation of available calcium among different locations may be due to difference in amount of calcium bearing minerals, pH of soils and elevation. These results are further supported by the findings of Yogeeshappa [20], Shaaban and El-Fouly [21] and Masrat [22]

The available magnesium content of surface and sub-surface soils varied from 239.3 to 387.8 mg kg^{-1} and 286.1 to 413.6 mg kg^{-1} with mean values of 317.7 and 352.3 mg kg^{-1} , respectively. It was also observed that available magnesium content showed an increasing trend with soil depth and sub-surface soils were high in available magnesium than surface soils. Available magnesium content was high in these soils. Similar results were also reported by Talib [23] and Bhat [9]. Available magnesium content in soils under study was observed high, which may be due to presence of dolomite and chlorite type of minerals in Kashmir as reported by Najjar [24]. The results are further supported by the findings of Dar [18], Masrat [22], Bhat [9], and Wani [14]. Magnesium concentration showed an inconsistent trend with soil depth. Similar results were observed by Singh [25], who also didn't observe any definite relationship of exchangeable magnesium with soil depth. Dar [7], while studying the effect of altitude on nutritional status of soils of Kashmir valley also reported that the available magnesium did not exhibited any consistent trend in its vertical distribution.

The available Sulphur was in the range of 7.09 to 14.68 mg kg^{-1} with a mean value of 10.51 mg kg^{-1} in surface soils, whereas, in sub-surface soils it varied from 5.69-12.60 mg kg^{-1} with a mean value of 8.70 mg kg^{-1} . Surface soils were high in available sulphur than sub-surface soils. The available sulphur showed decreasing trend with the soil depth. The results are supported by the findings of Antoo [26] and Masrat [22]. These soils were found low to medium in available sulphur content. This may be attributed to the temperate climate resulting in low mineralization of organic matter, hence low release of available sulphur. The results are in conformity with the findings of Sharma and Bhandari [27], Masrat [22] and Wani [14]. Surface soils were high in available sulphur than sub-surface soils. This may be attributed to high content of organic matter present in surface soils as compared to sub-surface soils. The results are supported by the findings of Arora [28] and Wani

[15].

4. CONCLUSION

The study's findings indicate that the saffron growing soils in the Pulwama district are characterized as having medium levels of available nitrogen and phosphorus, and medium to high levels of potassium. Calcium and magnesium were observed to be in the high range, while available sulphur was in the low to medium range. This investigation provides valuable insights into the fertility status of saffron growing soils in the Pulwama district. The information gathered will contribute to the development of a nutrient management plan aimed at enhancing saffron productivity.

REFERENCES

1. Nehvi FA, Qadri H, Singh SP. Saffron in India and Iran: A review of production, processing and marketing. *Indian Journal of Crop Science*. 2008;3(1):15-20.
2. Bhagat N, Vakhlu J. Effects of biocontrol *Bacillus* sp. strain D5 on the pathogenic *Fusarium oxysporum* R1 at the microscopic and molecular level in *Crocus sativus* L.(saffron) corm. *FEMS Microbes*. 2024.
3. Subbiah BV, Asija GL. A rapid procedure for the estimation of available nitrogen in soils. *Current science*. 1956 Aug 1;25(8):259-60.
4. Olsen SR. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. *US Department of Agriculture*; 1954.
5. Jackson ML. Soil chemical analysis, pentice hall of India Pvt. Ltd., New Delhi, India. 1973; 498:151-4.
6. Chesnin L, Yien CH. Turbidimetric determination of available sulphur. *Proceedings Soil Science Society of America*. 1951; 15:149-151.
7. Dar MA. Effect of altitude on nutritional status of pear orchard soils of Kashmir valley. Ph.D. thesis submitted to Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, 2009, 225.
8. Singh DP, Rathore MS. Available nutrient status and their relationship with soil properties of Aravalli mountain ranges and Malwa plateau of Pratagarh, Rajasthan, India. *African Journal of Agricultural Research* 2013; 8(41):5096-5103.
9. Bhat ZA, Akther FA, Padder SA, Rehman HU, Gnaiaie AQ. Nutrient Status of Grape Orchard Soils of Jammu and Kashmir, India. *International Journal of Agricultural Science and Research (IJASR)* ISSN (P): 2250-0057; ISSN (E): 2321-0087. 2017; 7(2):363-372.

10. Kumar A, Mishra VN, Srivastava LK, Banwasi R. Evaluation of soil fertility status of available major nutrients (N, P and K) and micronutrients (Fe, Mn, Cu and Zn) in vertisols of Kabeerdham district of Chhattisgarh, India. *International Journal of Interdisciplinary and Multidisciplinary Studies*. 2014; (2):72-79.
11. Fida M, Khan S, Razzaq A, Nawaz I, Izhar-ul-Haq. Fertility status of guava orchards in Kohat district of Pakistan. *Journal of Soil Science and Environmental Management*. 2011; 3(9):260-268
12. Singh N, Bhandari AR. Relation between nutrient contents of apple leaves and nutrient status of soils. *Journal of the Indian Society of Soil Science*. 1992;40(3):483-7.
13. Akther F. Studies on relationship between fruit yield and quality with soil and leaf nutrient content in apple orchards of Zangier block of district Baramulla Kashmir. Ph.D. thesis submitted to Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, Srinagar, 2005, 117.
14. Wani SA, Najar gR, Akhter F, Padder BA, Maqbool M. Assessment of Macro-Nutrient Status of Pear Orchards in Jammu and Kashmir, India. *Int. J. Curr. Microbiol. App. Sci*. 2017;6(6):2720-4.
15. Wani GN. Studies on the distribution of secondary nutrient elements (Ca, Mg and S) in apple orchard soils of North Kashmir. M.Sc. (Agri.) thesis submitted to Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, Srinagar, 2001, 75.
16. Wadia DN. *Geology of India*. 2nd edition. Tata McGraw Hill Publication Company Limited, New Delhi, 1981, 11-21.
17. Handoo GM. Organic matter fractions in soils of Jammu and Kashmir State developed under different bio and climo-sequence. Ph. D thesis. Himachal Pradesh KrishivishvaVidyala, Palampur, 1983, 180.
18. Dar MA, Wani JA, Raina SK, Bhat MY, Malik MA. Relationship of leaf nutrient content with fruit yield and quality of pear. *Journal of Environmental Biology*. 2015; 36:649-653.
19. Ahmad ZA. Characterization and nutrient indexing of apple (*Malus domestica* Borkh.) orchard soils of Bangil area of district Baramulla. M. Sc (Agri.), Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir. 2003;104.

20. Yogeeshappa H, Tolanur SI, Gali SK, Channaland HT, Patil DR. A survey of soil fertility status and index tissue analysis of vineyards. *Karnataka Journal of Agricultural Sciences*. 2008; 21(2):280-281., 2008; 8(16):1477-1481
21. Shaaban SHA, El-Fouly MM. Impact of the nutritional status on yield of some grape (*Vitis vinifera* L.) cultivars fertilized through drip irrigation and grown on sandy soil. *Journal of American Science*. 2012; 8(7):156-163.
22. Masrat M. Effect of different land use systems (LUS) on physico-chemical properties and nutrient status of soil in district Ganderbal. M.Sc. (Agri.) thesis submitted to Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, 2015, 63-88.
23. Talib AR. Studies on the pedogenesis and potassium supplying capacity of the benchmark soils of Kashmir. Doctoral dissertation, Ph. D. thesis submitted to Himachal Pradesh Krishi Vishwavidyalaya, Palampur, HP, 1984.
24. Najar GR. Studies on pedogenesis and nutrient indexing of apple (Red Delicious) growing soils of Kashmir. Ph.D. thesis, submitted to Sher-e-Kashmir University of Agricultural Sciences & Technology of Kashmir, Shalimar, Srinagar, 2002, 204.
25. Singh K, Ahuja RL. Distribution of primary nutrients in relation to soil characteristics in the Ghaggar river basin. *Journal of the Indian Society of Soil Science*. 1990;38(4):733-5.
26. Antoo MH. Studies on soils of command area of Zaingier canal Sopore district Baramulla. M. Sc (Agri.) thesis submitted to Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar, Srinagar, 2000, 178.
27. Sharma U, Bhandari AR. Survey of the nutrient status of apple orchards in Himachal Pradesh. *Indian journal of Horticulture*. 1992;49(3):234-41.
28. Arora CL, Chibba IM, Takkar PN, Bara JS. Nutrient status of soils and plants in some peach orchards of Punjab. *Indian Journal of Horticulture*. 1989; 46(3):368-375.
29. Bhat ZA, Akther FA, Ganaie AQ, Rehman HU, Dar NA, Gill RK. Nutrient Status of Grape Orchard Soils of Jammu and Kashmir, India. *MOJ Ecology & Environmental Science*. 2017;2(5).