Original Research

Journal Home page : www.jeb.co.in ★ E-mail : editor@jeb.co.in

Journal of Environmental Biology


JEB™

ISSN: 0254-8704 (Print)
ISSN: 2394-0379 (Online)
CODEN: JEBIDP

DOI : http://doi.org/10.22438/jeb/39/1/MRN-512

# Characterization of available nutrients that influence pear productivity and quality in Jammu & Kashmir, India

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Key words

Available nutrients
Pear productivity
Physiographic altitudes
Quality index

Publication Info

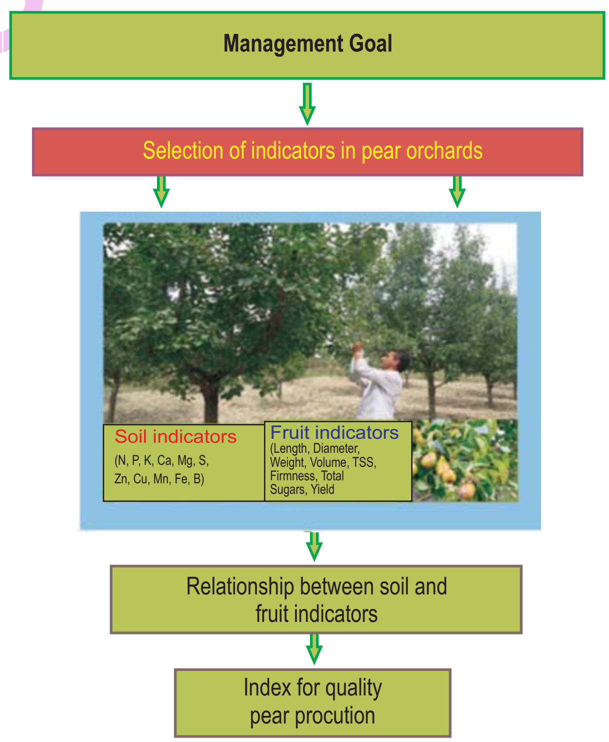
Paper received : 07.11.2016
Revised received : 06.05.2017
Accepted : 24.06.2017

## Abstract

**Aim :** A survey was conducted to evaluate the inherent fertility status and study the effect of available nutrients on yield and quality parameters of pear fruit selected from twenty four representative pear growing orchards in three established physiographic altitudes in district Pulwama during 2014-15.

**Methodology :** The composite soil samples and fruit samples were analysed for available nutrients and quality parameters as per the prescribed standard procedures.

**Results :** The available N and P status was low to medium and exhibited significantly positive relationship with fruit length, diameter, volume, weight, firmness, TSS, total sugars and yield, whereas K in medium status was significantly and positive by correlated with yield and most quality parameters, for except fruit diameter and volume. Available K was significantly the most variable nutrient (CV=40.66%) followed by Cu (CV=33.02%), Fe (CV=30.70%) and among the quality attributes, total sugars followed by TSS showed significantly higher variability (CV=18.33% & 13.54%). Significantly negative relationship of Ca with length (-0.386*), diameter (-0.363*), volume (-0.445*), weight (-0.603*) and significantly positive relationship with firmness (0.561*) and yield (0.621*) were recorded. The DTPA extractable Zn, Cu and Fe showed significant and positive relationship with all quality attributes except fruit firmness, where Mn observed significantly positive relationship with diameter (0.390*) and TSS (0.405*). Boron exhibited significant and positive relationship with length (0.499*), diameter (0.534*), TSS (471*) and yield (643*).




**Interpretation :** These results indicate significant effect of available nutrients on yield and quality attributes in plant metabolism reflecting from the relationship studies.

## Introduction

Pear fruit is native of Central Asia, stands second after apples as the most important delectable tree fruits, is grown throughout the world under warm temperate to temperate climatic conditions. In India, pear occupies third place in temperate fruits in area and production and can be grown from foot hills to high hills experiencing 500 to 1500 chilling hours (Rathore, 1991 and Dar *et al.*, 2012). Due to high chilling requirements, the superior cutivars of pear (*Pyrus communis)* are confined to high hills of Jammu and Kashmir, Himachal Pradesh and Uttaranchal. In Jammu and Kashmir, the diverse agro-climatic zones offer the favorable agro-ecological potential for pear (*Pyrus Communis*, "William Bartlet") production like apple (Wani *et. al*., 2016). Currently, the area under pear fruit is 13883 ha with annual production of 54847 MT in our state (Anonymous, 2015). The climate of Kashmir valley is sub-humid temperate. The mean annual rainfall is 887.6 mm with mean annual maximum temperature of 20.2°C and minimum 8.60°C (Anonymous, 2015). The area qualifies for mesic and warm temperate region. The soils vary and are characterized by uneven topography, luxurious vegetation, different parent material. The crop production and soil managements greatly differ with kind of soil and their physico-chemical behavior (Charan *et al.*, 2012 and Wani *et. al*., 2016). Amongst the various factors required for sustainable production of better quality fruit, the soil medium and site-characteristics influence to a large extent the tree health and fruit production (Najar *et al*., 2009).

Soil fertility and plant nutrition are two closely related subjects that emphasize the forms and availability of nutrients in soils, their movement and their uptake by roots and utilization of nutrients within the plants. It is therefore, inevitable to consider the analysis assessing the nutritional availability of fruit growing crops with deep and ramified root system (Najar *et al*., 2009). Nutrition plays an important role in maintaining the quality and production of fruits (Fallahi *et al*., 2010). In recent years, the nutrition of fruits has received a considerable attention because of its role in high production of quality fruits as well their relationship to physiological disorders and other effects like reduce respiration, delayed ripening and increasing fruit firmness, thereby extending the storage and shelf of fruits (Buchloh, 1974; Fallahi *et al*., 2010 ; Dar *et al*., 2015). The availability of nutrients to plants depends upon many factors, which include plant species, root stock, climate, soil type, soil pH, humus content of soil, oxygen content, base saturation and above all nutrients in the soil (Blazek and Hlusickova, 2007; Dar *et al*., 2012). The nutrient supplying power of a soil depends on dissociation of the nutrients from the exchange site, which in turn depends on the degree of saturation of the nutrients on the exchange site, type of clay and complementary ion-effect (Foth and Ellis, 1997). Continued removal of nutrients, with little or no replacement has aggravated the potential for future nutrient related plant stress and yield loss. The information regarding the effect of available nutrients on yield and quality parameters in pear growing soils is limited, and thus it is verified to need better balance production and quality characteristics. The objective of the present study was carried out in pear orchards of Kashmir valley to determine and characterize inherent soil nutrient status and ascertain the relationship between available nutrients and quality as well yield parameters of the fruit.

## Materials and Methods

Twenty four pear (*Pyrus communis cv.* William Bartlett) orchards selected from twelve representative pear production areas in Pulwama district in Jammu and Kashmir were sampled for soil and fruit analytical studies. Sampling sites recorded by GPS coordinated in the center covered pear orchards of uniform age group (15-30 years), growth and vigour from physiographically three different established zones with average altitudes viz., high (1825 mts. amsl), mid (1650 mts. amsl) and low (1585 mts. amsl), respectively. Stratified random soil sampling was preferred due to large number of pear orchards present in this region. Composite soil samples collected at an interval of 30cm were taken at more than 20 random points in each selected pear orchard. The soil samples were collected, processed and analysed for various available nutrients using standard procedures outlined by Jackson (1973) and Piper (1966). The fruit samples consisting of ten fruits were collected from twenty four pear orchards as per the procedure of Waller (1980). They were washed, dried and analyzed for different quality parameters. The fruit length and diameter were measured with vernier calliper, while fruit weight was recorded in a sensitive monopan balance. The fruit volume was measured by water displacement method and fruit firmness with the help of penetrometer. The total soluble solids (TSS) were determined by hand refractometer and total sugars as per AOOC (1990). The mean fruit yield was recorded also. Data generated through the study were analyzed for mean, confidence interval at 95% level of significance (95% CI) (Gomez and Gomez, 1984) and correlation coefficient for different soil available nutrients with quality parameters with SPSS statistical software 17.0 versions for Windows.

## Results and Discussion

Among the available primary nutrients, available nitrogen and phosphorus status was low to medium and varied statistically (95% CI) from 265.88 to 416.50 kg $ha^{-1}$ and from 8.92 to 17.28 kg $ha^{-1}$ with a mean value of 372.45 and 14.50 kg $ha^{-1}$, respectively, while as available potassium was medium ranging from172.26 to 260.92 with a mean value of 226.34 kg $ha^{-1}$ (Table 1). These results are in line with the findings of Dar *et al.,* (2012) while studying the nutrient status of pear orchards. Potassium was significantly the most variable nutrient (CV=40%) followed by phosphorus (CV=28.97%) and nitrogen (CV=21.86%). A greater differential distribution of potassium with altitude may be attributed to differences in weathering intensity under climate and

**Table 1 :** Status of available nutrients of pear orchard soils in Kashmir valley

| Nutrient | Statistical range (95% CI) | Mean | Standard deviation | CV (%) |
|---|---|---|---|---|
| Nitrogen* | 265.88 – 416.50 | 372.45 | 81.43 | 21.86 |
| Phosphorus* | 8.92 – 17.28 | 14.50 | 4.20 | 28.97 |
| Potassium* | 172.26 – 260.92 | 226.34 | 92.04 | 40.66 |
| Calcium* | 1840.26 –2635.60 | 2355.22 | 285.08 | 12.10 |
| Magnesium* | 252.28 - 290.61 | 278.82 | 29.85 | 10.71 |
| Sulphur** | 18.03 – 27.21 | 24.02 | 4.72 | 19.68 |
| Zinc** | 0.34 – 2.02 | 1.54 | 0.43 | 27.92 |
| Copper** | 0.64 - 2.85 | 2.15 | 0.71 | 33.02 |
| Manganese** | 18.20 – 64.30 | 44.90 | 11.83 | 26.35 |
| Iron** | 17.40 – 76.24 | 58.82 | 18.06 | 30.70 |
| Boron** | 0.46 – 1.71 | 1.14 | 0.09 | 9.01 |

* indicates kg $ha^{-1}$ and ** indicates ppm (mg $kg^{-1}$); Values represent the means of composite soil samples from 12 pear orchard sites

topographical gradients resulting significant variation in nature and type of potassium bearing clay minerals (Wani *et. al*., 2016). Secondary nutrients like calcium and magnesium were found in high status, where as available sulphur was found to be in medium status. At 95% CI, the available calcium, magnesium and sulphur ranged from 1840.26 to 2635.60, 252.28 to 290.61 and 18.03 to 27.21 with mean values of 2355.22, 78.82 and 24.02, respectively. Among the secondary nutrients, high variability (CV=19.68%) in available sulphur results from appreciable differential distributing pattern of organic matter/carbon with altitudinal variation of pear orchards. Similar results were reported by Sharma *et al.* (2005) and Najar *et al.* (2009). Among the micronutrient cations, the DTPA-extractable zinc and copper status was medium to high and ranged statistically (95% CI) from 0.34 to 2.02 and 0.64 to 2.85 with mean value of 1.54 and 2.15 ppm, respectively. However, manganese and iron status was high in pear orchard soils in all three altitudes with statistical range (95% CI) from 18.20 to 64.30 and 17.40 to 76.24 with mean values of 44.90 and 58.82 ppm. These observations corroborate the results of Dar *et al.* (2012). Micronutrient anion viz, boron with low to medium status ranged statistically (95% CI) from 0.46 to 1.71 with mean value of 1.14 ppm and standard deviation of 0.09. Copper (CV=33.02%) showed significantly higher degree of variability followed by iron (CV=30.70%), zinc and manganese among micronutrient cations. Soil boron was least variable available nutrient with a coefficient of variation (CV=9.01%), followed by magnesium (10.71%) and calcium (CV=12.10%) among three altitudes. A comparatively low coefficients of variation of available magnesium and calcium in the study area reflect the soils having been formed from the same basement complex of parent material (calcareous nature) during soil formation (Najar *et. al*., 2009; Wani *et. al.*, 2016).

Physical parameters of fruit length, diameter and weight statistically ranged (95% CI) from 58.90 to 87.12, 47.20 to 60.02 and 84.10 to 136.40 with mean values of 76.88 mm, 54.70 mm and 118.24 g respectively as shown in (Table 2). At 95% CI, the statistical range of fruit volume, firmness and total soluble solids (TSS) was found to be 71.30 to 114.68, 13.70 to 24.05 and 9.30 to 13.50 with mean values of 98.21 $cm^3$, 21.85 lb $sq.inch^{-1}$ and 12.48% respectively (Table 2). A similar range for quality indices was earlier reported by Dar *et al.,* (2015) while studying such relationship in pear orchards. Total sugars and yield of pear fruits were recorded to be ranging statistically (95% CI) from 4.28 to 5.96 and 75.00 to 140.20 with mean values of 5.51 (%) and 105.80 (t $ha^{-1}$), respectively. Total sugars (%) recorded significantly higher variability (CV=18.33%) between three different altitudes, where TSS showed higher CV=13.54% between altitudes followed by fruit firmness with CV=10.07% among the studied quality parameters of pear fruit. Comparatively higher variability in quality indices of fruit firmness, TSS and total sugars results from the variation in available moisture content and depth of water table between three altitudes that are essential for nutrient uptake hence quality improvement for the crop growth (Bheruguvanshi *et al.,*2012; Dar *et al.,* 2015).

Available nitrogen exhibited significant and positive correlation with fruit length, diameter, volume, TSS, total sugars and yield as well (Table 3). These results could be attributed to its effect on cell division and cell elongation leading to development of large and efficient leaf area (vegetative growth), stimulation of buds, flower initiation, flower formation and fruit set with significant increase in yield and quality attributes. The results corroborate with the findings of Kumar and Chandel (2004; Fallahi *et al.*, 2010; Dar *et al.,* 2012). Analysis of correlation matrix reveal significant and positive relation between available phosphorus with fruit length, diameter, volume, TSS, total sugars and yield at 5% level of significance. This could be due to its role as essential constituent in cell and its organelles and in plant metabolism. Similar findings were earlier reported by Kumar and Chandel (2004); Kumar *et al.* (2015). Phosphorus participates in some of the vital metabolic processes by supplying energy, increasing acid neutralization and sugar synthesis, resulting in less acidic but more sugary fruits (Kader, 2008).The available potassium revealed positive and significant correlation with fruit length, weight, firmness, TSS, total sugars and yield. Being a quality

**Table 2 :** Status of yield and quality parameters of pear orchards in Kashmir valley

| Quality parameter | Statistical range (95% CI) | Mean | Standard deviation | CV (%) |
|---|---|---|---|---|
| Length (mm) | 58.90 – 87.21 | 76.88 | 4.20 | 5.40 |
| Diameter (mm) | 47.20 – 60.02 | 54.70 | 3.61 | 6.58 |
| Weight (g) | 84.10 – 136.40 | 118.24 | 3.12 | 2.55 |
| Volume ($cm^3$) | 71.30 – 114.68 | 98.21 | 3.28 | 3.33 |
| Firmness (lb $sq.inch^{-1}$) | 13.70 – 24.05 | 21.85 | 2.20 | 10.07 |
| TSS (%) | 9.30 – 13.65 | 12.56 | 1.70 | 13.54 |
| Total sugars (%) | 4.28 – 5. 96 | 5.51 | 1.01 | 18.33 |
| Yield (t $ha^{-1}$) | 75.00 – 140.20 | 105.80 | 3.56 | 3.44 |

Values represent the means of fruit samples from 12 pear orchard sites

**Table 3 :** Correlation coefficient (r) of available nutrients with fruit yield and quality parameters

| Nutrient | Length | Diameter | Weight | Volume | Firmness | TSS | Total sugars | Yield |
|---|---|---|---|---|---|---|---|---|
| Nitrogen | 0.534* | 0.656* | 0.827* | 0.452* | 0.280 | 0.704* | 0.427* | 0.627* |
| Phosphorus | 0.728* | 0.502* | 0.641* | 0.808* | 0.192 | 0.486* | 0.538* | 0.804* |
| Potassium | 0.447* | 0.380 | 0.526* | 0.401 | 0.406* | 0.729* | 0.389* | 0.488* |
| Calcium | -0.386* | -0.363* | -0.445* | -0.603* | 0.561* | -0.397 | -0.306 | 0.626* |
| Magnesium | -0.249 | -0.195 | -0.028 | -0.044 | 0.316 | -0.136 | -0.125 | -0.287 |
| Sulphur | 0.484* | 0.469* | 0.284 | 0.301 | 0.123 | 0.365 | 0.298 | 0.475* |
| Zinc | 0.804* | 0.682* | 0.387* | 0.512* | 0.074 | 0.710* | 0.455* | 0.848* |
| Copper | 0.501* | 0.815* | 0.365* | 0.401* | 0.258 | 0.602* | 0.427* | 0.184* |
| Manganese | 0.318 | 0.390* | 0.227 | 0.179 | 0.290 | 0.405* | 0.331 | 0.197 |
| Iron | 0.675* | 0.792* | 0.409* | 0.605* | 0.337 | 0.544* | 0.673* | 0.601* |
| Boron | 0.499* | 0.534* | 0.281 | 0.104 | 0.041 | 0.471* | 0.304 | 0.643* |

* Correlation is significant at 5% level of significance



nutrient, its role is indicated by increased enzyme activation, translocation of photosynthates for efficient utilization, promoting cell division and development of meristematic tissues. These lines corroborate with the results of Farooqui *et al.,* (2004; Kumar *et al.,* 2015). Stino *et al.* (2011) determined that potassium directly influences fruit growth, maintains cell turgidity and is associated with good equilibrium between acid and sugar contents, good ripening and good eating quality. At 5% level of significance the available calcium revealed significant and negative correlation with fruit length, diameter, weight, volume, where as significant and positive correlation was observed with fruit firmness (r= 0.561*) and yield (0.626*). This is because calcium plays a central role on cell functioning and essential for formation pectin substances which enhance the fruit firmness (Dar *et al.,* 2015) and Kumar *et al.,* (2015). High Calcium level in pear is associated with slower degradation of cellular structure. However, available magnesium showed non-significant relationship with yield and quality attributes. The available sulphur exhibited significant and positive correlation with fruit length (r= 0.484*), diameter (r=0.469*) and yield (r= 475*) indicates its role in cell division and activation; of several enzymes and as constituent of many amino-acids (Mansour *et al.,* 2008 and Fallahi *et al.*, 2010). Among the micronutrient cations viz., zinc, copper and iron showed significant and positive correlation with fruit length, diameter, weight, volume, TSS, total sugars and yield where as manganese exhibited positively significant relation with fruit diameter and TSS at 5% level of significance (Table 3). Zn has been identified as component of almost 60 enzymes and it has a role in synthesis of growth promoter hormone (auxin) which is directly associated with improvement of fresh weight of fruits (Shivanandam *et al.,* 2007; Dar *et al.*, 2015). Copper indicates significantly positive relationship as it is involved in a number of physiological processes such as the photosynthetic and respiratory electron transport chains and as a co-factor or as a part of the prosthetic group of many key enzymes involved in different metabolic pathways, including ATP synthesis (Harrison *et al.*, 1999). Significantly positive correlation of available boron with quality attributes indicates its role in pollen germination and elongation of pollen tube growth in deciduous fruits hence resulted in increased fruit set and yield (Roy *et al.,* 2006) as well as its role in cell division, cell elongation, sugar metabolism and accumulation of carbohydrates (Fallahi *et al.*, 2010; Kumar *et al.,* 2015).

The information presented here contributes towards achieving a model that can predict and optimize for better quality of pear production in areas of similar conditions. Considering that most soil properties are dynamic in nature, site-specific evaluation of soil test-plant response relationship would further strengthen the calibration and validation of suggested approach in predicting nutrition and production more accurately.

### Acknowledgments

The authors feel privilege to acknowledge the Vice Chancellor, Director Research of SKUAST-K and the Head of the Department for their scientific and technical support and University Grants Commission (UGC) of India for the financial support.


### References


Anonymous: Area and production of horticultural crops in Jammu and Kashmir State. Directorate of Horticulture. J&K Government (2015).

A.O.O.C.: Official and Tentative Method of Analysis. Association of Official Agricultural Chemists.15th Edn., Washington, DC. USA, p. 484 (1990).

Bheruguvanshi, S. R., T. Adak, K. Kumar, V. K. Singh, A. Singh and V. K. Singh : Soil moisture, organic carbon and nutrient dynamics and their interrelationship in drip irrigated mango orchard. *J. Soil Water Conser.,* **3,** 316-322. (2012)

Blazek, J. and I. Hlusickova : Orchard performance and fruit quality of 50 apple cultivars grown or tested in commercial orchards of the Czech Republic. *Horticul. Sci. (Prague*), ***34***, 96–106 (2012).

Buchloh, G.: Problems and plant physiology in relation to bitter pit: The function of calcium. *Acta Horticul.,* **45**, 43-47 (1974).

Charan, G., G. V. Bhartii, G. V. Jadhav, S. Kumar, S. Acharya, P. Kumar, D. Gogoi1 and R.B. Srivastava : Altitudinal variations in soil physico-chemical properties at cold desert high altitude. *J. Soil Sci. Plant Nutri.,* **13,** 267-277 (2012).

Dar, M. A., J. A. Wani. S. K. Raina, M. Y. Bhat and M. A. Dar. : Effect of available nutrients on yield and quality of pear fruit Bartlett in Kashmir Valley, India. *J. Environ. Biol.,* **33**, 1011-1014 (2012).

Dar, M. A., J. A. Wani. S. K. Raina, M. Y. Bhat and M. A. Malik : Relationship of leaf nutrient content with fruit yield and quality of pear. *J. Environ. Biol.,* **36**, 649-643 (2015).

Fallahi, E., B. Fallahi, G. H. Neilsen, D. Neilsen and F.J. Peryea : Effects of mineral nutrition on fruit quality and nutritional disorders in apples. *Acta. Hortic*., **868**, 49-60 (2010).

Farooqui, K. D., K.M. Bhat and A. Mehmood : Effects of different levels of fertigation on quality and production of apple cultivars. *Progres. Horticul..,* **36**, 216-220 (2004).

Foth, H.D. and B.G. Ellis : Soil fertility. 2nd Edn., Lewis CRC Press LLC., USA, p. 290 (1997).

Gomez, K.A. and A.L. Gomez : Statistical procedures for agricultural research. An International Rice Research Institute Book. *Willey Interscience Publication*. New York, pp. 1-450, (1984).

Harrison, M.D., C.E. Jones and C.T. Dameron : Copper chaperones: Function structure and copper-binding properties. *J. Biol. Inorg. Chemi..,* 145–153 (1999).

Jackson, M.L.: Soil Chemical Analysis. Prentice Hall of India Private Limited, New Delhi, p. 498. (1973).

Kader, A. : A perspective flavor quality of fruits and vegetables. *J. Sci. Food Agricul.,* **88**, 1863-1868 (2008).

Kumar, J. and J. S. Chandel : Effect of different levels of N, P, K on growth and yield of pear cv. Red Bartlett. *Progres. Horticul.,* **6**, 202-206 (2004).

Kumar, J., R. Kumar, R. Rai and D. S.Mishra : Response of 'Pant Prabhat' guava trees to foliar sprays of zinc, boron, calcium and potassium at different plant growth stages**.** *The Bioscan,* **10**, 495-498 (2015).

Mansour, A. E. M., F. F. Ahmad, E. A Shaban and A. Fouad Amer.: The beneficial effects of using citric acid with some nutrients for improving productivity of LE-contre, pear trees. *Res. J. Agr. Bio. Sci.* **4**, 245-250 (2008).

Najar, G.R., F. Akhtar. S R. Singh and J. A. Wani : Characterization and classification of some apple growing soils of Kashmir. *J. Indian Soci. Soil Sci.,* **57,** 81-84 (2009).

Piper, C.S.: Soil and Plant Analysis. 5th Edn., Hans Publisher, Bombay, p. 464. (1966).

Rathore, D. S. : Pears : In : Temperate Fruits. (Eds.: S. K. Mitra, T. K. Bose and D. S. Rathore). Horticulture and Allied Publishers, Kolkata, pp. 123-178 (1991).

Roy, R., N.A. Finck, G.J. Blair and H.L.S. Tandon : Plant nutrition for food security. A guide for integrated nutrient management. Food and Agriculture Organization of the United Nations, Rome (2006).

Sharma, S.D., H.S. Bhatia and R.P. Singh : Influence of climate on bloom, fruit set, yield and quality of apple in Himachal Pradesh. *Prog. Hort.,* **37**, 298-302 (2005).

Shivanandam, V.N., S.L. Pradeep, K.M. Rajanna and Shivappa : Effect of zinc sulphate on growth and yield of mango varieties and hybrids. *J. Soil Crop.,* **17**, 225-229 (2007).

Stino, R. G., A.T. Mohesen, M. M. Yehia and M. A. El-Wahab.: Enhancing the productivity and fruit quality of le Conte pear via growth regulators, nutrients and amino acids. *J. Hort. Sci.Ornam. Plants,* **3**, 65-74 (2011).

Waller, W. M.: Use of apple analysis. *Acta Horticulture,* **92**,71-82 (1990).

Wani, S. A., G.R. Najar, T. Ali and F. Akhtar : Morphology, genesis and classification of pear growing soils of pulwama district in lesser himalayas of temperate Kashmir. *J. Environ. Biol.,* **37,** 1021-1027 (2016).