Impact of Soil on the Productivity of Mango Crop in Malda District, West Bengal

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Abstract: In this paper an attempt has been made to study the impact of soil texture and problem soil on the productivity of mango based on secondary data. Correlation co-efficient has been computed between block wise mango productivity and different soils. Choropleth map has been generated to show spatial variation of soil and mango productivity. The result shows that loamy, silt loam, sandy and sandy loam soils are positively correlated and clay and clay loam soils are negatively correlated with the productivity of mango. All the problem soils are negatively correlated with mango productivity with varying degree. The detailed account shows that the Barind tract due to dominance of clay to clay loam soil accompanied with acidic and micro-nutrient deficient soils achieved low to medium productivity in the district. On the other hand, the Diara being most fertile part of the district possess higher to medium productivity. The Tal region due to possession of loam to silt loam and alkaline soil shows medium to high productivity.

Key Words: Soil Texture, Problem Soil, Mango Productivity, Orchard Health, Integrated Nutrient Management

I. Introduction

The mango, Magnifera indica L. (Pandey & Dinesh, 2010) which belongs to the family of Anacardiaceae is grown in India for over 4000 years (Mukherjee, 1967). Since the ancient times this delicious fruit crop assumed great cultural, socio-economic and religious significance in Indian subcontinent. Magnifera indica L. has originated from Indo-Burma (Myanmar) region (Pandey & Dinesh, 2010). This fruit crop from tropical centre of origin is now gradually moved to subtropical land and largely cultivated, hence it is now considered as pan tropical fruit. It is grown at the equator and at latitude of 35°-37° in southern Spain (Mukherjee & Litz, 2009). Soil is the source of essential plant nutrients. So, its physical and chemical properties have fundamental importance for healthy growth of plants and productivity. The ability of soil to support plant’s growth and productivity is positively related to its fertility status. Cropping pattern and farming system of any region is largely determined by the properties of soil. Thus the soils serve as reservoir of nutrients and water for crops and also provide mechanical anchorage and favourable tilth (Murthy & Hirekerur, 2005).

It is now well established that soil is the harbinger of agricultural prosperity and economic welfare for the farmers. The type of crops grown and agricultural development of any region is largely favoured by the pedological characteristics of the region concerned. Though mango can be cultivated in a wide range of soil, yet its profitable cultivation is limited to a certain groups of soil only. For the best performance, it requires deep, well drained soils of loamy texture (Singh, 1967). It can be grown from alluvial to lateritic soils including red soils, medium black soils and deep red loam (Pandey & Dinesh, 2010). Like most other fruit crops, it prefers a slightly acidic soil. It does not perform well in soils beyond a pH of 7.5 (Majumdar & Sharma, 1990). Saline and alkali soils, sandy, clay and black cotton soils are not conducive for profitable mango cultivation. However, the pedological characteristics of the present study area do have strong influence on the large scale mango production and its productivity.

II. Study Area

The district Malda lies between 25°32’8”N and 24°40’20”N latitude and in between 88°28’10”E and 87°45’50”E longitude. The district is surrounded by North Dinajpur and South Dinajpur in the North, the river Ganga in the south, and Bangladesh in the east and Purnia district of Bihar in the west. In 1935, the total area of the district was 1,987 sq. miles as per report on the survey and settlement operations. At the time of partition of India it covered 2,004 sq. miles, but now the area is 3,733 sq. km. Its ranking in respect of area is 11th (eleventh) in the state (District Census Handbook, 2001). Geographically the district can be divided into three physiographic
regions viz. 1. Tal 2. Barind and 3. Diara. The mango is cultivated in all three geographical regions with significant variation in area, production and productivity. According to broad classification (based on soil texture and age of its formation) of soils, the district of Malda has three different kinds of soils i.e. i) Old alluvium soils covering 77700 hectare, ii) Vindhyan alluvial soil covering 17130 hectare and iii) Ganga alluvial soils spreading over 243540 hectare of the district (NABCONS, XIth Plan Period). This classification of soil of the district is concomitant with the natural divisions i.e. i) The Barind Region, ii) Tal Region and iii) Diara Region respectively. Since ages, the Ganga and its tributaries deposited sediments in the gap between Rajmahal hills on the west and Garo hills on the east and the district is located on the western part of the filled gap. Thus the entire area is covered by alluviums, which is however of two different ages with different physical and physiographic characteristics (Sengupta, 1969).

III. Objectives of the Study
The present research work makes an attempt to study the following objectives:

- To study the spatial distribution of soil texture and problem soils in the district.
- To study the nature of interrelationship between block-wise mango productivity and different soils.
- To analyse the impact of different types of soil on mango productivity.

IV. Database and Methodology
The entire study is based on the secondary data. The data on mango productivity were gathered from Deputy Director of Agriculture (Fruits), Malda. The data on block wise soil texture and problem soils were collected from the final report entitled Comprehensive District Agricultural Plan (C-DAP) -Malda prepared by NABCONS. To analyse the spatial extension of different soils, a simple percentage (block-wise percent share of gross area under each soil to total geographical area) has been calculated and plotted on map using bar graph. Choropleth map has also been prepared to depict block wise variation in mango productivity. The correlation co-efficient (r) has been calculated to study the nature of interrelationship between the variables mango productivity and soil texture as well as mango productivity and problem soil.

V. Result and Discussion
The analysis and findings in connection with the objectives incorporated in the study are presented and discussed under the following major heads.

A. Spatial Distribution of Soil Texture
The study clearly finds that in Malda district, there is large scale variations in the amount of distribution of soils classified based on texture. The map (Fig 1.1) depicts that in the Barind region, larger proportion of clay and clay loam soil are found. The clay loam soils occur in greater proportion in the northern part of Tal region. The loamy soils are abundantly found both Diara and Tal region and silt loam soils also follow the same suit of loamy soils. Sandy and sandy loam soils occur mainly in the Diara strips and also occur in the Tal region. On an average, the loamy soil covers about 21.66% of the total geographical area in the district. The loamy soils occur mainly in the Diara and Tal region. The study clearly finds that higher amount of loamy soils ranging between 32.88% and 45.72% areas to respective block’s total geographical area are sprawl over Ratua-I, Ratua-II, Kaliachak-I, Kaliachak-II, Kaliachak-III and Manikchak whereas lower amount of loamy soils ranging between 7.19% and 20.03% areas to respective block’s total geographical area are spreading over Harishchandrapur-I, Chanchal-I, Gazole, Habibpur, Bamongola, Old Malda and Englishbazar. Rest of the blocks possess medium percent of loamy soils ranging between 20.03% and 32.88%. Larger proportion of silt loam soil occurs in the blocks of Diara and Tal. It is to be mentioned that data of silt loam soils are not available for all the blocks of Barind and some blocks of Tal region. However, a spatial feature is discernable that all the blocks of Barind tract are accounting for lower percent of loamy soils whereas two other physiographic units viz. Tal and Diara are accounting for all the three category of soils.

The study indicates that lower range of sandy soil (0.28% to 3.22% areas to respective block’s total geographical area) has areal extension over the blocks viz. Harishchandrapur-II, Chanchal-I and Chanchal-II whereas higher range of sandy soil (6.16% to 9.08% areas to respective block’s total geographical area) has areal coverage over Diara part of the district viz. Manikchak, Kaliachak-I, Kaliachak-II and Kaliachak-III. The data is not available for 40% blocks of the district viz. Harishchandrapur-I, Gazole, Habibpur, Bamongola, Old Malda and Englishbazar. The distribution pattern of loamy soils is also followed by the sandy loam soil. Thus it is clear that above discussed soils mainly sprawl over the Diara region followed by Tal region.

The map depicts that higher and lower concentration of clay soil occur in all the blocks of Barind tract and Diara region respectively. All the blocks of Barind region are having more than 40% area to total geographical area under clay soil whereas Tal region accounting for less than 8% area to total geographical area under this soil.
However, the data are not available for most of the blocks of Diara region. The block wise distribution of clay loam soils reveals a different pattern. Sprawling over about 84319 hectare areas, the clay loam soils accounting for over 23% of the total geographical area of the district. These soils occur mainly in larger proportion in the northern part of Tal region where more than 45% areas to total geographical area occur under this soil. They are also found in good proportion in the Barind region accounting for about 28% areas to total geographical area. From the above discussion, it can be concluded that the three distinct physiographic regions possess different soil texture. Clay and clay loam dominate in the Barind tract. Admixture of sand and clay are dominantly found in the Tal region. Recent alluvial soils possessing a fine admixture of silt, silt loam and sand found in Diara region.

B. Spatial Distribution of Problem Soils

The map (Fig: 1.2) depicts the extent of problem soils in the district. As reflected in the map the district possesses enormous amount of problem soils. Maximum area of 70,700 hectares has been affected due to acidic problem and the severity is maximal in the blocks like Gazole, Habibpur, Bamongola and Old Malda. On an average, more than 50% areas of Barind tract are affected by low pH value which varies from 4.2 to 5.5. This part receives higher rainfall in comparison to other part of the district (NABCONS, XIth Plan Period). On account of higher rainfall and sloping topography, the soluble bases formed are leached down and carried away by the drainage waters, resulting in the replacement of calcium, magnesium, potassium and sodium ions by hydrogen ions and thus forming acid soils with low pH (Murthy & Hirekerur, 2005). Microorganisms decompose organic matter in the soil and organic acids are continuously being formed which is not neutralized by free lime. This is the cause of acidic soils in this tract (NABCONS, XIth Plan Period). The alkaline soil covers about 23520 ha areas accounting for about 6.45% of the total geographical area which are sprawling over 13 blocks of the district. The problem is severe to medium in all the blocks. Tal region is most alkaline affected part where about 10% of the total geographical area is affected by higher pH value.

The iron toxicity soil is spreading over 7.08% area of total geographical area of the district. The higher concentrations are occurred in Old Malda block where the problem is severe. The iron toxicity problem is medium to severe throughout the Tal region. The Diara is least affected by this problem soil. As the data indicate 9.68% of the total geographical area of the district is having micro-nutrient deficient soils. The higher proportion of this problem soil is found in Old Malda and Bamongola block where more than 30% of total
reporting area is affected. The problem is severe to medium in the blocks viz. Chanchal-I, Chanchal-II, Ratua-II and Manikchak and Kaliachak-I. In all these blocks, soils with micro-nutrient deficiency covered more than 10% of the total geographical area. This problem soils occurred in lower proportion in Ratua-I, Gazole and Habibpur.

![Spatial Distribution of Problem Soil](image)

C. Spatial Variation of Mango Productivity

Mango is cultivated in every part of the district, but there is remarkable spatial variation in terms of productivity depicted in the map (Fig: 1.3). The study reveals that there are 20% blocks of the district (three in number) where productivity is low. On the other hand, there are 20% blocks of the district where productivity is high. Rest of the blocks (nine in number) accounts medium range of productivity. The two lowest productivity blocks (Bamongola and Habibpur) are located in the Barind region and one (Harishchandrapur-I) is in north-western part of the district. The two higher mango productivity blocks (Englishbazar and Kaliachak-II) are located in the Diara region and one (Ratua-II) is in the Tal region. The blocks with medium productivity are spreading over three physiographic units.

D. Nature of Interrelationship between Soil Texture and Mango Productivity

The correlation co-efficient (r) has been computed between block-wise mango productivity (MT/ha) and amount of soil texture (ha). The study shows that the relationship of clay and clay loam soil with mango productivity is negative. In other words, the variable mango productivity is statistically negatively dependent on the amount of clay as well as clay loam soils. This clearly indicates that the blocks which have larger areal expansion of clay soil and clay loam soil decrease the productivity of mango crop to some an extent. On the other hand, the result shows that the relationship of loamy, silt loam, sandy and sandy loam with mango productivity is fairly positive. In other words, there is fairly positive statistical dependency between mango productivity and amount of loamy, silt loam, sandy and sandy loam. This clearly indicates that the blocks which have larger areal expansion of loamy, silt loam, sandy and sandy loam moderately increase the productivity of mango crop.
The correlation co-efficient (r) computed between block wise mango productivity (MT/ha) and amount of problem soils (ha) shows that block wise mango productivity is negatively correlated with all type of problematic soils in the district. There moderate negative relationship is found between mango productivity and acidic soils; and mango productivity and micro-nutrient deficiency soils in the district, whereas weak negative relationship is found between the variable mango productivity and alkaline soils; and mango productivity and iron toxicity soils in the district. Thus it clearly indicates that these problem soils have limited the productivity of mango with varying degree. In other words, it implies that higher the amount of problem soils lower the productivity of mango crop in the district.

E. Physiographic Region Wise Impact of Soils on Productivity of Mango

Among different physical elements, components and characteristics of soils set the cropping pattern and level of productivity for any crop. In Malda district, soils exert strong influences on mango productivity. The detailed account based on above findings reveals that the Barind tract, in addition to undulating topography and high surface run-off possess higher proportion of acidic soil and clay to clay loam soil; lower proportion of silt loam
to loamy soil and sandy loam to sandy soil which are limiting factors to achieve higher productivity of the crop. Thus the productivity for the entire Barind tract is low except Old Malda block where the orchard concentration found along the Mahananda. The Tal region shows medium to high productivity. In this particular physiographic unit, the productivity of northern part is low whereas it is relatively high in the southern part. The blocks of northern part of this natural region viz. Harishchandrapur-I, Harishchandrapur-II, Chanchal-I and Chanchal-II have higher proportion of clay loam soil and alkaline soil lead to lower productivity. Besides, the region being a low lying basin is highly prone to flood. Thus this part due to soil related limitation and land inundation accounts for medium to low productivity. The southern part comprising Ratua-I and Ratua-II blocks accounts for high productivity due to higher ratio of light loam to silt loam soil having neutral soil reaction which is most suitable for mango plantation. All the high to medium productivity blocks are located in the Diara region, the most fertile track of the district, pH value varies from 6.8 to 7.5 which is suitable for fruitful mango cultivation. The higher proportion of loam to silt loam soil is conducive to mango cultivation. The study area is covered by alluvium, which however is of two different ages displaying different physical and physiographic properties have great influence on mango production and productivity.

VI. Recommendation and Conclusion

Physiographic region wise impacts of soil texture and problem soils have been discussed in the previous section. Mango fruit yielding 15 tonnes per hectare is estimated to remove 235 kg of N+P2O5+K2O from the soil (Tandon & Tiwari, 2008). Thus the proper and balance application of primary and secondary nutrients is essential to harvest potential economic yield. Farmers generally applied macro-nutrients in the soils. For better economic return from the orchard the balance application of micro-nutrients is equally needed. The deficiency or excess of these nutrients leads to failure of the crop. In this context some recommendations have been made.

- To estimate the lime requirement of soil, both soil texture and soil pH can be used. However, a lime
  requirement test (buffer-pH test) is recommended to estimate more accurately the amount of limestone
  required to increase soil pH in the plow layer to a desired level (McFarland, A. Haby, Redmon, & Bade, 2001).
- Soil testing to estimate the level of macro and micro-nutrient status is highly required to maintain soil
  health for mango crop. Soil test based application of fertilizer is pre-requisite condition for sustainable
  soil health management.
- Awareness cum demonstration camp for the farmers regarding the importance and application of bio-
  fertilizer, green manure, macro and micro-nutrient to enhance soil fertility required for this delicious
  fruit crop.
- Soil health card for every mango grower need to be introduced in the district.
- Promotion in-situ moisture conservation strategy along with recommended doses of fertilisers and
  application of improved technology (Success Stories, 2016).

The entire district can be turned into highly productive zone if integrated nutrient management practices are
introduced.

References

http://www.crida.in/Success/NN%20Reddy.pdf
[7] NABCONS. COMPREHENSIVE DISTRICT AGRICULTURAL PLAN (C-DAP) FOR MALDA – FINAL REPORT. NABARD
Consultancy Services Pvt Ltd., Kolkata, (Xth Plan Period) p 1-152.

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