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Soil Diversities in Regards to Horticultural Variabilities

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ABSTRACT

This review paper focuses on the impacts of soil diversity on a variety of horticultural crops in India. Different soil types of India have been discussed in this paper with their preferable horticultural crops those grow best on them. Major horticultural crops including fruits, vegetables, flowers, plantation crops, spices and medicinal crops with their appropriate soil types have also been highlighted. Important measures can be taken both scientifically and economically for the improvement of soil health that will eventually lead to increase in horticultural crop yield.

Keywords Soil diversity, Biota, Horticulture, pH, Crops.

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INTRODUCTION

Soil is the storehouse of enormous minerals, abundant in organic materials and gases. It also provides a home for various life forms referred as biota. Agriculture is the backbone of India in which horticulture plays a vital role. It helps to boost up the Indian economy as well. In regards to fruit and vegetable production India stands next after China. Horticultural crops accounts 30.4% of the gross domestic product of agriculture as a whole by using only 13.1 % of gross cropped area in India (Tiwari *et al.* 2021).

Soil diversity represents divergence among soils in different regions of a particular land. Several agro-ecological zones provide different types of soil. The utmost importance is to understand the various soil resources, its limitations and the numerous methods i.e., used to manage such soils for agriculture and non-agriculture purpose as well (Bhattacharyya 2016). Numerous factors determine the diversity of soil that includes both intrinsic and extrinsic factors. Intrinsic factors are the characteristics within the soil itself whereas extrinsic indicates environmental factors those are caused by different spheres of earth such as anthroposphere, lithosphere, biosphere, hydrosphere, atmosphere, hydrosphere, and ecosphere. Each of these factors play vital roles in soil formation and regulation (Mikhailova *et al.* 2021). Variability in soil including soil texture, pH, composition, structure greatly influences the cultivation of crops. A good soil enriched with nutrients and minerals along with its physical and chemical composition can lead to better yield.

From the beginning of life, soil has played an

important role in growing crops. It is one of the crucial factors in determining the kind of crop a specific land can cultivate. As different horticultural crops grow on different soil types, the diverse nature of soil allows variety of horticultural crops to grow in different regions, mitigating the needs of the crops accordingly. There are plenty of reasons that may illustrate the relationship between soil diversity and crop production. Hence in the present review, we have tried to throw the light on variable soils and how these soils support variable horticultural crops according to their requirements.

Major soil types throughout the country

There are vast differences among the types of soil in this country. The diverse nature of climatic conditions in different regions, type of parent rock and vegetation plays an important role on determining soil types. Soils of India are divided into eight categories by the Indian Council of Agricultural Research (ICAR). The All India Soil Survey Committee was founded by the Indian Council of Agricultural Research (ICAR) in 1963, and it categorized Indian soils into eight broad types.

Alluvial soil: It is a fertile soil that holds around 46% of the share in India (Dwevedi *et al.* 2017). This soil originates from the sediment deposition by Ganges throughout the Indo-Gangetic plains and spread over a large area from Punjab to Assam to the valleys and plains of river Narmada, Tapti, Mahanadi, Godavari, Krishna and Kaveri (Balasubramanian 2017). It has two types - Khaddar (newly formed soil) and Bhangar (old alluvial soil). The soil is having good porosity for its sandy loamy nature. The soil has a range of colors, from light grey to ash grey. It has a lot of organic matter and minerals, particularly humus and potash. These are good for vegetation purposes, but it lacks nitrogen and phosphorus content. Vegetables like cucurbits, tomatoes and spinach can be grown on alluvial soils (Sahu and Mishra 2005).

Black soil: It is also known as black cotton soil as cotton grows very well in this type of soil (Balasubramanian 2017). It is mostly found in central, western and southern states of India such as Maharashtra, western parts of Madhya Pradesh, Gujarat and few parts of Andhra Pradesh, Karnataka and Tamil Nadu. This type of soil is deficient in organic carbon, nitrogen, phosphorus and sulfur (Das 2011). Horticultural crops like mango and jackfruit can be grown on this type of soils and it is unsuitable for crops like potato, radish and carrot due to its weak physico-chemical properties (Yadav *et al.* 2023).

Red soil: This soil can be seen in tropical and sub -tropical regions of India. It is primarily found in the peninsular regions of India and along east-coast moving up to Assam in North-East. Additionally, East Central India has it. The pH of the soil ranges from 6.3-8.0 (Das 2011). Red soil is fertile when irrigated properly. Horticultural crops like potato, brinjal and fruits like mango, sapota, jackfruit, guava, papaya can be grown successfully on this soil (Sahu and Mishra 2005).

Lateritic soil: These types of soil cover the North Eastern Hill ranges, Eastern Himalayas, Central Highlands, Eastern and Western Ghats, Deccan Plateau and Konkan Coastal lands in India (Sehgal *et al.* 1998). This soil is low in pH with color brick red or purplish or brown to yellowish (Ghosh 2019). This soil becomes very hard when expose to air. Fruits like mango, jackfruit, banana, guava and sapota can be cultivated in this type of soil (Sahu and Mishra 2005).

Desert soil: These types of soils are present in certain regions of Rajasthan as well as in Punjab and Haryana. Its pH range is 8.0–8.8, and it lacks organic matter. The desert soil is primarily sandy and ranges in color from pale brown to yellow brown. The soil is fertile because phosphate and nitrate are present (Das 2011). Crops that are mainly grown in such soil are as tomatoes, eggplants, summer squash and herbs like basil (Gatzke 2012).

Mountain soil: These kinds of soils can be found in mountainous areas with enough rainfall, both at high and low elevations. Mountain soil covers around 8.7 % of the total land area of India and have extended its regime up to Himalayan region of Jammu and Kashmir, Himachal Pradesh and Uttarakhand also to some parts of Western Ghats, Eastern Ghats and the Peninsular plateau. Potash and phosphorous content

are low but it is rich in humus content. Though this type of soil is infertile for crop production but some crops like tea, coffee, and spices can be grown in it. However, it would require sufficient amount of fertilizers for these crops to be cultivated in mountain soil (Dwevedi *et al.* 2017).

Saline soil and alkaline soil: Saline soil is mostly found in arid and semi-arid region where rainfall is less and evaporation rate is high. The soil is mostly found in varied regions of India such as Gujarat, West Bengal, Rajasthan, Maharashtra, Orissa, Andhra Pradesh, Andaman and Nicobar Island, Haryana, Bihar, Uttar Pradesh, Kerala, Tamil Nadu and Karnataka. The pH of the soil is less than 8.5. The soil color is white in appearance due to formation of white crust of salts on the surface. Water and air permeability of the soil is in abundant form but salt problem is a demerit of this soil (Kumar and Sharma 2020). Alkali soils on the other hand is mostly found in the Indo-Gangetic plains of Haryana, Punjab, Uttar Pradesh, Bihar, Rajasthan, Madhya Pradesh. This soil has soluble salts like sodium carbonate and sodium bicarbonate, and 2-4% of calcium carbonate. This soil has pH up to 10.5. It has poor physical properties with restricted water and air movement (Abrol and Gupta 1990). As sugar beet is a highly salt tolerant vegetable crop, which can be developed in saline soil. Beside this pea, tomato, cucumber, spinach can be cultivated in this soil. Also, some fruit crops like citrus and strawberry can be grown (Kumar and Sharma 2020). Jamun, imli, guava, ber, pomegranate and amla can grow in alkali soil if adequate drainage practice is available (Singh *et al.* 1997).

Peaty soil: This type of soil is mostly found in Kerela, south-east coast of Tamil Nadu, coastal area of Orissa and West Bengal (Das 2011). These soils are heavy, containing high amounts of organic matter up to 20% – 35% and slightly acidic with low pH (less than 4). These soils are generally black or dark brown in color. Due to high water logging condition, only water tolerant crops are suitable on these soils. Vegetables like lettuce, carrot, onion, potato, sugar beet and salad crops grow well on these soil types (Lockhart and Wiseman' s Crop Husbandry Including Grassland, Tenth Edition 2023).

Major horticultural crop cultivation in different soil types

Horticultural crops are one of the main sectors that have a huge impact on Indian economy and in our society as well (Jaskani and Khan 2021). Each crop prefers a different condition to grow. Soil is one of the crucial factor in crop production. Soil provides necessary nutrients to the crops and act as a supportive media for them. Some of the major horticultural crops with their preferable soil conditions are as follows.

FRUITS

Mango – *Mangifera indica* well known for its distinct flavor, taste. It is beneficial for health also. Ratnagiri district of Maharashtra is famous for mango production. Cultivation of mango is best in lateritic soil (Salunkhe *et al.* 2021). It grows well on multiple soil types, but red loamy soil has been found the best for mango cultivation. Nutrient rich, well drained, deep and aerated soils having pH range of 5.5-7.5 provides ideal condition for mango cultivation (Shangmugavelu 1987).

Banana – Banana farming works best in alluvial and loamy soils that are friable, well-drained, and high in organic matter. Soils with 6.5-7.5 range of pH, good drainage system and adequate moisture supports the growth of this crop (Bose 2001).

Papaya – Papayas can be established on a variety of soil types, including the alluvial soil found in deltas and on the banks of rivers. Papayas grow best in rich, loamy soils that are fertile, well-drained, and rich. For this crop, the pH of the soil should be between 6.5 and 7.0 (Singh 1990).

Citrus- Citrus is well with wide variety of soils such as coarse sands to heavy clay. But soils from alluvial sources with good drainage and medium textured property are highly suitable for citrus cultivation. The soil must be airy, well drained with a pH range from 5 to 6 is best for this crop (Chattopadhyay 2007).

Guava – This fruit requires of soils ranges from alluvial to lateritic. Soils with rich top soil, well drained, less water logging and deep friable properties with a

pH range from 4.5 to 8.2 is best for guava cultivation (Bose 2001).

***Apple* –** Loamy soil with a pH of 5.5 – 6.5, proper aeration is suitable for apple cultivation. The soil must have good drainage system and rich organic matter. The soil must be devoid of waterlogged conditions. In case of flat soils, channels with proper drainage facility are must to prevent soil borne diseases like collar root and root rot (Handbook of Horticulture 2001).

Vegetables

***Potato* –** Potatoes grow well in nearly every kind of soil, including lateritic, sandy, loamy, and alluvial soil with a pH range of 5.5 to 8.0. Rich in organic matter, the soil needs to be properly drained and aerated. It cannot be cultivated in alkaline and saline soil (Thamburaj and Singh 2001). Potato scabs are common disease found in alkaline or neutral soils. This particular disease caused by *Streptomyces scabies* which is susceptible to low pH or acidity in the soil. Studies have shown that low pH in soil favors bacterial wilt in potatoes (Singh 1995).

***Onion*–** When it comes to cultivation and growth, this is one of the most profitable crops in India. This crop grows well on a range of soil types, from sandy loam to clay loam. The soil needs to be humus-rich and well-drained. Soil pH should be between 5.8 and 6.5. Onion cultivation should not be done in soils that are highly salted or alkalinized (Thamburaj and Singh 2005).

***Cauliflower* –** Cauliflower is best grown in deep loamy soil with a pH content of 5.5-6.6. Fertile soils with sufficient organic matter and well drained condition are suitable for this crop. Soil pH range more than 7 leads to boron deficiency that cause browning of cauliflower (Dhaliwal 2008)

***Pumpkin* -** With a pH range of 6.0–7.0, it can be grown in a variety of soil types. Loamy soil that is deep and well-drained is perfect for growing pumpkins. Clay loam soils and sandy loam soils with adequate aeration are preferred for increased crop yield and early maturity (Hazra and Som 2015).

Flowers

***Rose*–** It's a perennial woody plant. Production of roses requires high water holding capacity and adequate drainage during cultivation. The ideal pH range for medium-loam soil is 6.0–7.5 for the plant (Handbook of Horticulture 2001).

***Tuberose*-** Tuberose cultivation works best with sandy-loam or loam soil that has a pH of 6.5 to 7.5 and is rich in organic matter. Tuberose requires soil that have good drainage, adequate aeration, and the ability to hold moisture (Bose and Yadav 1989).

***Carnation*-** A rich loam or sandy loam soil with a pH level of 6.5 to 7.5 is best for carnation growth. A soil with proper organic matter, well drainage properties and good aeration system are its prerequisites (Pun 2021).

***Chrysanthemum*-** It can grow in many types of soil but well drained sandy loam having pH from 6.2 to 6.7 is ideal for its cultivation. Soil should contain optimum range of nutrients. It must be well drained and proper aeration should be there for growth of chrysanthemum (Bose and Yadav 1989).

Plantation crop

***Tea*–** It can be cultivated on sandy loam, heavy clay and clay loam soils sound in organic matter with a good amount of phosphorus, potassium and silicon. The pH range should be in between 4.5-5.0. The cultivated land should have proper drainage facilities as the plant is sensitive to waterlogging condition (Syamal 2014).

***Coffee* -** It requires alluvial and colluvial soils. Soil depth should be at least 2 m. slightly acidic soil with pH of 5.5 - 6.5 is good. Coffee roots have high requirement of oxygen so light soil with well drainage properties is best suited for its development. As coffee is a tap rooted crop, any hard pan present in the soil, should be broken during field preparation (Parthasarathy *et al.* 2006).

***Coconut*-** Can be successful in wide range of soil types such as laterite, lateritic red, sandy soil, alluvial

coastal and alluvial soil. Soil rich in organic matter, well drained with good water holding capacity is well suited for coconut production. It can be grown on soils with pH levels of 4.5 to 6.8 (Handbook of Horticulture 2001).

Spices

Turmeric- *Curcuma longa* L. belongs to the family Zingiberaceae is a well-known rhizome bearing herbaceous crop. The crop performs fairly in varied range of soil but well drained soil rich in organic matter or sandy loam and clay loam soil, with pH from 5 to 7 is ideal for turmeric cultivation (Syamal 2014).

Cardamom – Well-drained humus rich soil enriched with organic matter and nutrients content, with pH range in between 4.5-6.0, is ideal for cardamom cultivation.

Black Pepper – The crop is highly sensitive to water-logged condition. Porous soil, rich in organic matter, minerals and nutrients along with water holding capacity and proper drainage facilities is suitable for the production of black pepper. Clay loam soil with pH content of 4.5-6.0 is best for growing these crops. The crop is widely cultivated in varied range of soil such as red and sandy loamy soil (Chattopadhyay *et al.* 2017).

Ginger – A friable loamy soil with pH range between 6.0-6.5 is ideal for ginger production. Sandy loam, clay loam, red loam or lateritic loam soil is preferable for its cultivation. Soil with proper drainage facility, porosity, texture and humus rich, high amounts of organic matter, minerals and nutrients are required.

Medicinal

Ashwagandha – For its cultivation, sandy loam soil or light-textured reddish-black soils with a pH range of 7.5-8.0 are preferred. (Rao *et al.* 2012). Heavy soil with well drainage properties is good for exhwagandha production. Loose and deep soil is also suitable for this crop (Jat *et al.* 2015).

Isabgol – Isabgol growing works best in light sandy to sandy loam soils with good drainage properties and a pH range of 7.2–7.9. The crop also suitable for growing in varied range of soils such as clay loam, medium black, black cotton and heavy black soils. Irrigation system must be well maintained during cultivation (Jat *et al.* 2015).

CONCLUSION

As we have already seen different crops have diverse array of soil preferences for their growth. Each type of horticultural crop grows well under different soil characteristics. These characters of soil include soil types, texture, pH of the soil, their water holding capacity and many other. Crop plants can change the chemical and physical condition of soil. Root growth improves soil aeration and loosens the soil. However, Soil degradation is raising concerns today. So, more science-based strategies need to be incorporated to make a good use of healthy and diversified soil to increase horticultural crop yield. More investments and participation are required in this regard.

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