INWASCON

***i* TECH MAG**

DOI: http://doi.org/10.26480/itechmag.06.2024.82.86

ISSN: 2710-5873 (Online)
CODEN: ITMNBH

CrossMark

S&T REVIEW

A REVIEW PAPER ON: NUTRITIONAL DISORDER OR PROBLEMS IN RICE, POTATO AND MANGO AND THEIR CONTROL AND MANAGEMENT

Prajwol Rijal[a], Sandhya Dhakal[b]

[a]Tribhuvan University, Institute of Agriculture and Animal Science, Rampur Campus, Khairahani
[b]Tribhuvan University, Institute of Agriculture and Animal Science, Gauradaha Agriculture Campus, Gauradaha
****Corresponding Author Email: prajjwolrijal7@gmail.com***

ARTICLE DETAILS

Article History:

Received 20 July 2024
Revised 15 August 2024
Accepted 18 September 2024
Available online 07 October 2024

ABSTRACT

Rice (*Oryza sativa)*, Potato (*Solanum tuberosum)*, and Mango (*Mangifera indica)* are staple crops integral to the global food supply, contributing significantly to human nutrition and food security. However, these essential crops face a myriad of nutritional disorders and challenges that impact both crop yields and the nutritional quality of their produce. This comprehensive review paper explores the multifaceted nutritional issues encountered in rice, potato, and mango cultivation and their implications on human health. By synthesizing current research findings and identifying gaps in knowledge, this review paper aims to provide a valuable resource for researchers, policymakers, and agricultural stakeholders working towards enhancing the nutritional quality and resilience of rice, potato, and mango production systems.

KEYWORDS

Disorder, Deficiency Symptoms, Biological, Nutritional deficiency.

1. Introduction

Nutrient deficiency occurs when a plant lacks enough of an essential nutrient required for growth. Without sufficient essential nutrients, plants will not grow well and show various symptoms to express the deficiency. Different nutritional deficiencies or toxicities may limit development and yield. N and P deficiencies are the most frequent, although deficiency of minor elements can reduce yields considerably. Nutritional problems are usually diagnosed by soil and plant tissue analyses and the observation of symptoms produced by nutritional disorders. Centro Internacional de Agricultura Tropical (CIAT)

Some of the nutritional disorders/problems associated with Rice, Potato and Mango are discussed below:

2. Black tip of Mango

2.1 Causes

Black tip is a serious disorder that is capable of causing considerable set back to the grower. Among the commercial cultivars, Dasheri is most prone to the disorder. The occurrence of Black Tip (*Tip Necrosis/ Fruit Necrosis)* must have been observed long before it was actually recorded. The first published record on black tip of mango dates back to 1909 when Woodhouse from Bihar reported that mango fruit is damaged at Sabour Farm by the smoke from the brick kilns which apparently blacken the apex of the mango and interferes with its development. Subsequently, the disorder was referred by (Naik, 1934; Allan, 1936; Pal et al., 1937). Later the disorder was noticed in 1923 by researchers in the name of 'Koeli' (De, 1923).

Figure 1: Brick Kilns with harmful fumes.

After an investigation, it is found that Mango Orchard near to the Brick Kilns are affected by the Black Tip of Mango (Das Gupta and Verma, 1939). The primary gases emanating from brick kiln fumes are reported to be Sulphur dioxide, ethylene, and carbon monoxide (Sen 1943).

Direct fumigation of mango grooves with coal fumes or by fumigating mangoes with such constituent gases of brick kilns fumes which are known to be deleterious to plants (Sen, 1943; Das Gupta and Verma, 1944; Pal et al., 1937; Ranjan and Jha, 1940). Later in 1960's, it was reported that boron was deficient in the mango fruits exposed to brick kilns fumes (Das Gupta and Sen, 1960). In laboratory experiments, the disease could be produced by exposing mango fruits to smoke and Sulphur dioxide (Das Gupta et al., 1941).

2.2 Symptoms

Figure 2: Symptom photograph of Black tip of Mango

Black tip disorder has generally been detected in orchards located in the vicinity of brick kilns. The infection of fruits is initiated right at marble stage, with a characteristic yellowing of tissues at the distal end. Gradually, the color intensifies into brown and finally black. At this stage, further growth and development of the fruit is retarded and the black ring at the tip extends toward the upper part of the fruit. The tip is flattened with outer skin turning hard arid sunken (Das Gupta and Verma, 1939). The metabolic changes and quality of black tip affected fruit were also investigated by researcher and found that catalase and peroxidase activities were more in apical portion and significantly decreased Ascorbic acid content was recorded ((Agrawal et al., 1960; Agrawal, 1962).

2.3 Control and management

A spray borax @ 3-4kg per 500litre of water at the time of fruit set, followed by two sprays at 15-day intervals might be useful in controlling the disorder (Das Gupta and Sen, 1960). Sprays of washing soda (0.5%) and caustic soda (0.8%) were found to be equally good in minimizing the disorder. Irrigation in the orchards after fruit should be maintained at regular intervals to reduce the severity of black tip.

Chimney height should be of 15 – 18m and planting of mango orchard in North-South direction and 5 to 6km away from the brick kilns may reduce the incidence of black tip at greater extent (Das Gupta and Verma, 1940). Covering the mango plants with cellophane bags will help to minimize risks of black tip of mango (Agrios, 2017; Plant Pathology).

3. Black Heart of Potato

Black heart (BH) is an important storage, transit, and market disease of potatoes as a result of poor oxygen relations. The disease usually occurs in tubers stored in poorly ventilated rooms in closely packed conditions. It also occurs in the field when temperature of the soil goes above 32°C during growth and maturation of tubers. The progress of the disease was studied by (Bartholomew, 1915). The disease occurs in transit when the temperature inside the carrying vans rises, for some time, above 32°C. Thus, a set of three distinct environmental conditions can cause this disease, viz.

(i) Poor ventilation in the store,

(ii) High temperature during transit,

(iii) Prolonged storage at low temperature (0^0 C) predisposes BH (Stewart and Mix, 1917; Link and Ramsey, 1932; Zhou et al., 2015), and

(iv) High temperature of soil during growth and maturation of tubers in the field.

In poorly ventilated rooms even low respiration by tubers uses up the available supply of oxygen (Stewart and Mix, 1917). This results in discolorations and disintegration of cells due to adverse enzymic action which continues after the supply of oxygen has diminished (Hooker, 1981). High temperature brings about some sub-oxidation by stimulating respiration. The cells of the tuber disintegrate when the interior of the potato heap in the store cannot ensure a good supply of oxygen (Chaubey and Ramji Singh, 2020).

3.1 Symptoms

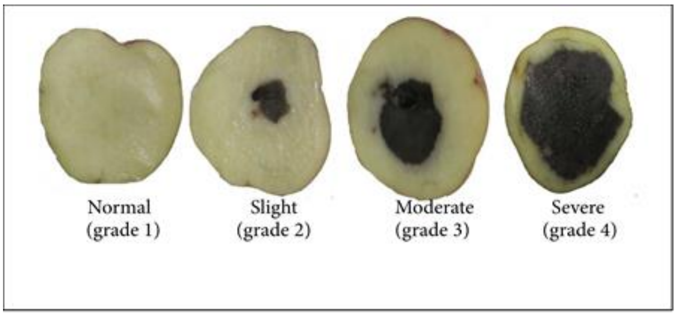

Figure 3: Example images of potatoes with different blackheart grades.

Initially, symptoms become evident at the center of the tuber. The affected tissue at the center turns dark grey to black irregularly, indicating necrosis. These darkened areas are firm initially but become soft when exposed to room conditions. In the advanced stage, the affected tissue dries out and shrinks, forming a cavity in the center. As the condition progresses, symptoms on the surface manifest as dark, sunken patches. David (1976) showed that a disease similar to a black heart could be caused by electric current, freezing, immersion in toluene or glycerin and by certain pathogens.

3.2 Control and management

It occurs primarily in storage when the tubers do not receive enough oxygen. So properly store potatoes in well-ventilated storage. i.e., avoid storage in tightly closed rooms. Avoid over-irrigation and drain the soil time and often (H.S Chaube, 2020). Avoid harvesting in extreme temperature (around 30°C) or excessively low temperatures (around 0°C). Dry the tubers quickly, to avoid condensation which may lower air Exchanges. And also maintain adequate ventilation during transport and storage to avoid asphyxia of the tuber.

4. Tip Burn of Paddy

Tip burn of paddy is leaf drying disease common in paddy plant (rice) and spreads speedily in field. It is a serious problem of rice in tropical and sub-tropical regions. The leaves turn yellow to straw colored and later wilt and dry. Burning first appears on tip of leaves and then progress down and becomes completely dried. The disease is responsible for losses due to direct damage to the commercial produce or to yield reduction as a consequence of photo-assimilates.

Although the disease has been known for such long time it is not properly known but the experiment confirmed that the disease is non-pathogenic or non-parasitic karhana (P.K., 2020). The disease was first seen in China then in India in 1914. It was first described by Dastur Iin 1937 and then by Mishra and Chakravarty in 1955 (Dastur, 1937; Mishra and Chakravarty, 1955). In 5 districts of panjab showed that the leaves of rice affected by pansukh disease were markedly deficient in K, N, Fe, Mn kanwar and sehgal 1966. The disease is also known as (kadamara, chatra, pansukh, ukra, dakhina) (Muralidharan and Reddy, 2008). The disease is similar to tungro disease of rice (Galvez et al., 1971).

4.1 Causes

The disease was an unknown physiological disorder before the experiment. Then, it is confined that the lack of oxygen supply in root zone due to water lodging in the submerged conditions in the field can cause tip burn (Dastur, 1937; Herbert, 1959). Poor soil aeration (PK and Mandal, 1957).

It is also due to the deficiencies of nutrients like calcium, nitrogen, phosphorus, sulfur boron ETC. Tip burning is also due to nutrient toxicity (Kanwar and Sehgal, 1966). It may be due to scorching effect of fertilizer and weedicides (Vashishtha, 2021). High concentration of elements in the form of their salts may prove to be harmful to plants (Soumyojit D). It may be due to the air pollution emitted from ceramic and brick factories (H.J. and E.J., 2003). Air pollution such as hydrogen fluoride (HF), ethylene, chlorine nitrogen dioxide, sulfur dioxide ETC disturb plant metabolism causing disease.

4.2 Symptoms

Figure 4: Tip Burn of Paddy

The first symptoms of the disease a is drying of leaves (Dastur, 1937). The plant shows lack of luster and tendency to bronzing and later becomes scorched at the tip (Gajanan M.,and Ghimire, 2018). Drying progresses down along the margin and finally the whole leaf completely dries. The progress of the disease in the field is quick and patches of yellowed and dried plants may be seen scattered throughout the field and if the disease is saver the entire plant dry and wilt (Sharma, 2006). If the disease affect in young stages there is reduction in no of tillers (Dastur, 1937). Clorosis may occurs due to deficincies of potasium reported in panjab (Yara Ghana web page). It is more or less similar to Khaira disease and people most often confuse it with this disease (Agriculture Guide,2023).

4.3 Note

Khaira disease of rice and tip burn of rice is not similar. They are different since the causative agents of these two are different.

Tip burn of paddy is due to deficiency of calcium and phosphorus and also due to lack of oxygen supply in root zone of crops. In tip burn disease, only tips of the leaves of the crop undergoes necrosis and becomes dries but not affect the other parts of the plant and in Khaira disease, whole leaf and leaf lamina turns brown and undergoes necrosis o occurrence of tip burn of rice crop (Agriculture Guide, 2023).

4.4 Control and management

For the control of the disease use of ammonium sulphate has been recommended for the treatment of tip burn of paddy since the disease is due to nitrogen deficiency (Dastur, 1937). According to him the field should be first drained off in early stage of crop growth and then ammonium sulphate should be applied @30-50kg/ha.

To manage the incidence of leaves, burn in paddy and increase the yield of rice green manure can be used (Sinha and Singh, 1956).

Fertilizer doses should be maintained since over fertilization can lead to dehydration. This lack of moisture can affect a plant's root system and causes dry patches and burning on green leaves (Masterclass.com, 2022).

5. Khaira Disease of Rice

Figure 5: Khaira Disease of Rice

Khaira disease in rice is a non-infectious disorder resulting from zinc deficiency, particularly in alkaline soils. It's prevalent in terai areas where zinc is scarce. This sporadic disease leads to significant rice yield losses, mainly due to reduced photosynthesis (25-30% loss) (Yoshida and Tanaka,1969). It's named after the resemblance of affected rice to catechu (known as *Khair* in India) and affects not only leaves but also roots. This disease shows huge impact in context of Nepal and other rice growing countries such as India, China, Japan, North America, Australia, Philippines, Saudi Arabia, Thailand, 2012. Khaira disease is an orphan disease of rice. It mainly occurs in the environment where water supply is scarce and it is often combined with imbalances in plant mineral nutrition, especially lack of zinc (Baranwal et al., 2013).

5.1 History

In 1966, Dr. Y.L. Nene discovered Khaira disease in rice in India's Tarai region. Initially, he investigated potential microbial or pathogenic causes for the symptoms but found no correlation. Instead, he noticed that affected areas had high soil pH, while symptom-free areas had lower pH. Recognizing that soil nutrient availability depends on pH, he conducted laboratory soil analyses, revealing that Zinc deficiency, a pH-dependent nutrient, was the underlying cause of Khaira disease in rice.

5.2 Symptoms

Figure 6: Khaira Disease (Zn Deficiency)

The pathogen attacks the crop from seedling to milk stage. The disease typically appears 10 to 15 days following the transplantation of rice plants. Initially, the leaves of the affected plants exhibit chlorosis at their base. The symptoms appear as minute spots on the coleoptile, leaf blade, leaf sheath and glume, being most prominent on leaf blades and glumes. On leaves, typical spots are brown in color with grey or whitish center, cylindrical or oval in shape resembling sesame seeds usually with yellow halo while young spots are small, circular and may appear as dark brown or purplish brown dots. Several spots coalesce and the leaf dries up.

The affected nursery can often be recognized from a distance by scorched appearance due to death of the seedlings. On susceptible cultivar, the spots are much larger and may reach up to 1 cm or more in length (Ramakrishna and Subramanian, 1977). The symptoms on leaf sheaths and coleoptiles are similar to those on the leaves. Zn deficiency places considerable burden on resource-poor farmers and it has therefore been suggested that breeding efforts should be intensified to improve the tolerance to Zn deficiency in rice cultivars (Quijano-Guerta et al., 2002; Singh et al., 2003). In severe cases, the finer roots are decimated, causing the affected plants to cease growing altogether.

5.3 Control and management strategies

5.3.1 Host strategies

Spraying of conidial suspension at booting stage during evening hours and use of susceptible spreader genotype along with test genotypes has been advocated by several researchers for better disease development and uniform results (Harahap, 1976; Kulkarni et al., 1981). Host specific toxin of H. oryzae has also been utilized for identification of resistant plants/calluses against Khaira disease (Borah and Goswami, 1986; Vidhyasekaran et al., 1990).

5.3.2 Biological control

Isolates of fluorescent Pseudomonas from soil reduced the fungal growth and brown spot incidence (Ray et al., 1990). Spray application of talc-based P. fluorescens has been found effective in reducing brown spot severity (Joshi et al., 2007). Use of slow-release nitrogenous fertilizers is advisable. Slow-release nitrogenous fertilizers is advisable.

5.3.3 Others

First, before transplanting rice seedlings, their roots are dipped in a 2% Zinc oxide water solution for 1-2 minutes to aid zinc absorption and encourage strong development. Additionally, two foliar sprays, spaced 10-15 days apart, are performed using a solution comprising 5 kg of Zinc sulfate and 20 kg of Urea dissolved in 1000 liters of water, covering one hectare of rice crops. This approach optimizes zinc intake, enhancing crop vitality. These methods are vital in zinc-deficient regions, and consultation with local experts and safety precautions are recommended during application.

6. Other Nutritional Deficiency Symptoms of Rice

Table 1: Nutritional Deficiency symptoms and growth charts

S. N	Nutrient	Visual Symptoms	Growth Effects and Notes
1	**Nitrogen**	- Narrow, short, erect, light green with chlorotic tip - Stunted, reduced tillering, low grain number	- Affects older leaves first - Entire field appears yellowish
2	**Phosphorus**	- Narrow, short, very erect, dark green - Red/purple color in some varieties	- Stunted, reduced tillering, spindly stems - Retarded development
3	**Potassium**	- Yellowish brown margins, dark brown necrotic spots - Yellow stripes along intervein	- Stunted, smaller leaves, thin stems - Reduced spikelet, filled grains, 1000-grain weight
4	**Zinc**	- Droopy, dry lower leaves, brown spots and streaks	- Uneven growth, reduced tillering, higher spikelet sterility
5	**Iron**	- Tiny brown spots on lower leaves, orange-brown.	- Stunted, greatly reduced tillering, damaged root system
6	**Sulfur**	- Light green, pale yellow, necrotic leaf tips	- Stunted, delayed development, delayed maturity
7	**Magnesium**	- Orange-yellow interveinal chlorosis	- Reduced spikelet, 1000-grain weight, grain quality
8	**Copper**	- Bluish green, chlorotic streaks on midrib	- Dark brown necrotic lesions on younger leaves, leaf abnormalities

7. Conclusion

To conclude, this review article has shed light on the nutritional disorders and problems associated with three staple foods - rice, potato, and mango. We have explored the various factors that contribute to these issues, including nutrient deficiencies, overconsumption of certain components, and environmental factors. While rice, potato, and mango are undeniably important dietary components for many people worldwide and need to know the nutritional challenges they pose. By understanding these challenges and implementing sustainable agricultural practices, we can mitigate the nutritional disorders and problems associated with these foods/ crops and promote better growth and recognition of disorders. Further research and public awareness are essential to tackle these issues effectively and ensure a disorder free of the crops. Even we can cultivate the resistant or enrich varieties on such nutrients which help to minimize the losses that farmer faced and can grow efficiently without any abnormalities.

Author's Contribution

All the authors contributed to the completion of this work. The draft was written by Sandhya Dhakal and Prajwol Rijal oversaw the literature, Journals, Books, article searches while author P. Rijal edited and rewrote the work in accordance with the journal's (review paper) style. The final manuscript was read and approved by all writers.

References

Adair, C. R., 1941. Inheritance in rice. Technical Bulletin, United States Department of Agriculture. 772, Pp. 18. https://books.google.com.np/books

Bartholomew, E.T., 1913, "Black Heart of Potatoes", Phytopath, 3, Pp. 180 – 182.

Bergman, H.B., 1959. Oxygen deficiencies as a cause of disease in plant. The Botanical Review 25, Pp. 417-485

Binod, P., 2021. Effects of Environmental Factors on Crop Diseases. Journal of plant pathology and microbiology,12(5), Pp553

Burton, W.G. 1965. The permeability to oxygen of the periderm of the potato tuber. Journal of Experimental Botany 16, Pp. 16-23.

Caroll, M. D. and Loneragan, J. F., 1968. Response of rice species to concentrations of zinc in solution I. Growth and zinc content of plants. Australian Journal Agriculture. Research 19, Pp. 859-868

Das Gupta, S. N., and Verma, G.S., 1941. Studies in the disease of Mangifera indica. III. Investigation into the effects of Sulphur dioxide on the mango fruits. Proc. Indian Acad. Sci. 13 (B), Pp. 71

Das Gupta, S.N. and Zacharia A.T., 1945. Studies in the disease of Mangifera indica. V. On the die-back disease of the mango tree. Journal. Indian Bot. Soc. 24, Pp. 101.

Das Gupta, S.N., and C. Sen, 1960. Studies in the diseases of Mangifera indica. XI The effect of the boron on mango necrosis. Phytopathology 50, Pp. 431.

Das Gupta, S.N., and C. Sen, 1960. Studies in the diseases of Mangifera indica. XI The effect of the boron on mango necrosis. Phytopathology 50, Pp. 431.

Das-gupta, S. N., Iyer, S. N., and Veema, G. S., 1956. Studies in the diseases of Manguera indica Linn. IX. Isolation of a brick-kiln fume constituent causing Mango necrosis. Indian J. Agric. Sci. 26, Pp. 259.

Dastur, J.F.1937, Pan-Sukh disease of Rice in the central province *Agric*. Live-stk. India 7(4), Pp. 509-511. https://eurekamag.com/research/013/278/013278860.php

David, W.B., 1976, Physiological Investigation of Black Heart of Potato Tubers, *Bot. Gaz.*, 81, Pp. 323 -338.

Davis, W. B. 1928. Physiological investigation of black heart of potato tuber. Botanical Gazette 81, Pp. 323.

De, P.K., Mandal, L.N. 1957. Physiological disease of rice soil science 84(5), Pp. 367-376.

Drew MC, J_M Lynch, 1980. Soil anaerobiosis, microorganism, and root function Annual Review of Phytopathology, 18(1), Pp. 37-66

Forno, D. A., Asher, C. J. and Yoshida. 1975. S., Zinc deficiency in rice. II. Studies on two varieties differing in susceptibility to zinc deficiency. Plant and Soil 42, Pp. 551-563

Forno, D.A., Yoshid S. and Asher C. J., 1975. Zinc deficiency in rice. 42, Pp. 537-550.

GE Galvez, E Shikata, MSA Miah, 1971. Transmission and Electron Microscopy of a Rice Tungro Virus Strain Journal of phytopathology, 70 (1), Pp. 53-61.

Jha, S.N., Narsaiah, K., Jaiswal, P. Bhardwaj, R., Gupta, M., Kumar, R., and Sharma, R., 2014. Nondestructive prediction of maturity of mango using near infrared spectroscopy," Journal of Food Engineering, 124, Pp. 152–157.

Kanwar, J. S.; Sehgal, J. L., 1966. A note on the chemical composition of leaves from healthy plants as compared with plants affected by pansukh disease in Rice Int. Rice Common Newsl 15(4), Pp. 24-25.

Kaul, G.L. and Pal, R.N., 1989. Black tip and internal necrosis disorders of mango. DOI 10.17660/ Acta Hortic. 1989.231.67

L.Bans.International Rice Research Institute. Annual Report for 1969. The International Rice Research Institute, Philippines, Pp. 134–137, Pp. 155–157.

M Barnwal, M. K., Kotasthane, A., Magculia, N., Mukherjee, P. K., Savary, S., Sharma, A. K., and Zaidi, N., 2013. A review on crop losses, epidemiology and disease management of khaira disease of rice, European journal of plant pathology, 136, Pp. 443–457. https://link.springer.com/article/10.1007/s10658-013-0195-6

Muhammad Imran, Shahbaz Talib Sahi, Muhammad Atiq and Amer Rasul, 2020. Khaira disease of rice An Exacerbated Embryonic Disease of Rice, Journal of innovative science,6(2), Pp.108-125, http://dx.doi.org/10.17582/journal.jis/2020/6.2.108.125

Muralidharan, k.; and Reddy, C. S. (2008): Integraded Disease Management as A Hostalic Approach to Rice Production Rev. Plant Patho. (4), Pp. 29-82.

Parajuli Monika, Chaurasia Jay, 2022. A review on comparative effect of chemicals and botanicals in management of khaira diseases of rice (Oryza.), 7(1), Pp. 127-131. https://doi.org/26832/ 24566632.2022.0701018

Ram, S., 1989. Factors associated with black tip and internal necrosis in mango and their control. Acta Hortic. 231, Pp. 797-804. Doi:10.17660/ActaHortic.1989.231.47

Rangaswami, G., Mahadevan, A., 1998. Diseases Of Crop Plant in India Prentice Hall Of India Private Limited 4th ED Pp. 187

Shrivastava, J. N., Singh, A. k., 2022. Disease of Field Crops Diagnosis and Management Apple Academic Press (1), Pp. 52

Sunder, S., Ram Singh and Rashmi Agarwal, 2014. Diseases of rice: an overview, CCS Haryana Agricultural University, Rice Research Station, Kaul 136 021, Haryana, India, 67(3), Pp. 201-215