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SHORT COMMUNICATION

STUDY OF DEVELOPMENTAL SEQUENCE OF MINERAL NUTRIENT DEFICIENCY SYMPTOMS IN ORIENTAL TOBACCO

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A sand culture experiment was conducted on developmental sequence of mineral nutrient deficiency symptoms in oriental tobacco. Withholding of different nutrients from the medium resulted in development of characteristic visual symptoms on foliage and growth of plants. Yellowing of whole plant and tip drying of lower leaves were the characteristic symptoms due to N deficiency. Due to P deficiency, the older leaves were dark green, thick and narrow in proportion to length, later they turned to pale yellow color. K deficiency resulted in yellowish mottling on older leaves followed by necrosis at tips and margins of leaf. Calcium deficiency showed unexpanded terminal leaf buds and later growing point dried off. Older leaves showed interveinal chlorosis which commenced at tips and margins and spreading towards the mid rib, later whitish patches were observed on leaf due to magnesium deficiency. Due to sulpher deficiency, terminal leaves showed light green veins of same shade as intervenal tissue .Young leaves were chlorotic with dark green veins as a result of Fe deficiency. Due to B deficiency, plants had short internodes, small deformed leaves at shoot apex and lower leaves were enlarged and leathery.

***Key words*: Tobacco, nutrient deficiency, mottling, interveinal chlorosis**

Tobacco is one of the most important commercial crops of the world as well as India in recent years, the demand for oriental tobacco has been increasing because of distinct taste and aroma. Since production of oriental tobacco is confined to only a few countries, India has to depend on them to meet the requirements of aromatic tobacco. India imports about 250 tones of oriental tobacco resulting in pressure on our limited foreign exchequer. To avoid imports and to save the foreign exchange, oriental tobacco production was taken up in our country, where climatic and adaptic conditions are suitable.

Southern Zone of Andhra Pradesh has the agro climatic conditions which are comparable with those of the regions where the world finest quality oriental tobacco is produced. Oriental tobacco is one such alternative crop, which suits well for this tract. When the soil is incapable of supplying all the essential mineral in adequate amounts for normal growth and development of plant, the limiting nutrients will need to be provided by external source such as chemical fertilizers and organic waste.

To make efficient use of materials it is essential that the limiting elements identified for each site and the cheapest effective source of each limiting element may be applied to correct the problem. Hence accurate diagnosis is essential if nutritional problems are to be dealt effectively. One of the methods to find out the

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mineral nutrient deficiency is based on visual symptoms. There is little work in literature showing the developmental sequence of nutrient deficiency symptoms in oriental tobacco. In view of above, the present investigation was taken to develop and photograph visual symptoms of macro and micro nutrients deficiency in oriental tobacco grown in sand culture and produce a key to identify the nutrient deficiencies.

A laboratory experiment was conducted in sand culture during 2008-2009 in green house at Department of plant physiology, S.V. Agricultural College Tirupati. The treatments consist of T_1 (control), T_2 (without nitrogen), T_3 (without phosphorus), T_4 (without potassium). T_5 (without calcium) T_6 (without magnesium), T_7 (without sulpher), T_8 (without iron), T_9 (without boron) and replicated three times. Five week old seedlings were transplanted in plastic bucket (3 kg capacity) containing acid washed sterilized sand. The sides of containers were covered with brown paper to prevent the entry of sunlight and algal growth. The transplanted seedlings were grown initially with half strength nutrient solution of modified form of Hoagland formulation (Johnson *et al.* 1957) and increased to full strength after a fortnight. To each bucket 30 ml of nutrient solution was added at every alternative day. Double distilled water was added every day to meet the evapo - transpirational demand. The pots were flushed with double distilled water every week to remove the accumulated salts in the sand before adding fresh nutrient solution. All the containers were randomized to reduce the positional effects. The plants grown in nutrient solutions deficient in specific element were carefully observed for the development of symptoms of nutrient deficiency. The visual symptoms of nutrient deficiency were described in detail keeping the control plants as check.

The nitrogen deficiency symptoms appeared in young seedlings within two weeks after transplanting into the medium without nitrogen. The effect first becomes apparent, as decrease in the normal green color and plant growth (Fig. 1A). Further, the lower leaves turn lemon yellow to orange yellow followed by a leaf tip drying and extending towards base of lamina. The top leaves were erect and tend to retain the normal conditions apparently as their needs are met by a transfer of nitrogen from the older leaves. As the stress advanced whole plant appeared yellow and drying of older leaves can be seen in Fig. 1A. Yellowing of lower leaves and stunted growth of plant lacking nitrogen were reported in culture studies of cotton (Jayalalitha, 1991) and Tomato (Narasimhamurthy, *et al*, 2002 and Tobacco (Anuradha *et al.* 2007). Nitrogen being essential constituent of protein, deficiency of which causes a decrease in protein synthesis, which subsequently decreases cell size especially cell division. Nitrogen deficiency would have resulted in the collapse of chloroplast development which leads to yellowing of the leaves (Thomson and Weier 1962).

Symptoms of P deficiency appearing within 3 weeks after transfer into P deficiency sand medium, plants showed reduced height, erect stiff stems, which can be seen in fig: 1B. The size and shape of leaves are altered .Leaves are thick, small, narrow and appeared as dark green color. However, lower leaves turned to yellow with few spots on, at later stages and subsequently they were shed. Similar results were also observed in barley (Hoppo *et al.* 1991) and in tomato (Narasimhamurthy *et al.* 2002) and Tobacco (Anuradha *et al.* 2007). Dark green color is attributed to increase in chlorophyll content per unit area. In the absence of P, utilization of N in the synthesis of chlorophyll and subsequent reactions might have been hampered. As a result, lower leaves, soon lost their chlorophyll and turned to pale color. Under these conditions, production of photosynthates decreased resulting in the reduction of leaf size, plant height and root growth.

Initially leaf was thick with leathery texture and lower leaves lost normal green color at tips and wider part of the leaf margin accompanied by brownish yellow spots in the mottled tissue which was followed by necrosis scattered over inter venal areas of leaf (Fig. 1C.). Similar observations were also reported by Jayalalitha (1991) in cotton and Anuradha (2007) in tobacco. But Prasad *et al.* (1988) in chilies and Srinivas (1988) in black gram did not report downward curling of leaf margins as observed in the present investigation which might be due to severe deficiency of K. Scorching and presence of necrotic tips and spots on leaf were the

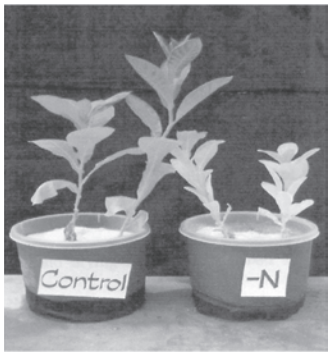

Fig. 1A. Nitrogen deficiency in tobacco

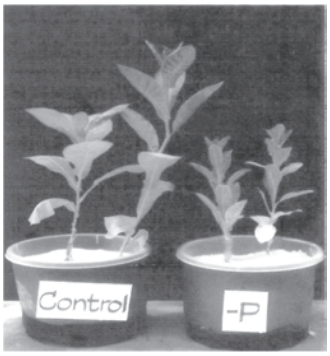

Fig. 1B. Phosphorus deficiency in tobacco

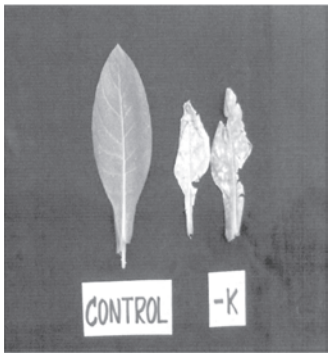

Fig. 1C. Potassium deficiency in tobacco

Fig. 1D. Calcium deficiency in tobacco

common symptoms of K deficiency in plants. The variation in the symptoms of K deficiency in different plant species may be ascribed to the variation in genetic structure and result variation in response to K deficiency.

The calcium starved plants showed distinct abnormalities in growth which induced pale yellow younger leaves, death of growing tip and reduction in plant growth (Fig. 1D). These symptoms were in line with general symptoms of calcium deficiency in plants. Calcium is very essential in the shoot and root tips for the meristamatic activity and formation of new tissues. Hence, meristamatic region of stems and roots were greatly affected, which eventually died probably due to immobilization of calcium in plant. It was established by Burstorm (1968), that calcium is required for cell elongation and cell division. Tissue containing low calcium levels has considerable disorganization and weakening of cell wall (Jones and Lunt 1967).

The older leaves developed interveinal chlorosis commencing at the leaf tips and margins and spreading inward region of the midrib followed by whitish colored patches on laminas which can be seen in Fig. 2A. The magnesium deficiency symptoms in present investigations are in close conformity with those reported in tobacco by Mc Murtrey (1941). These symptoms slightly deviated from those observed in caster (Narayanan and Gavararya 1991) and in tomato (Narasimhamurthy *et al.* 2002). As Mg is required for formation of chlorophyll, nevertheless it is an indispensable element for healthy growth of plant, any decrease in the required Mg level reduces photosynthesis and disturb pattern and extent of growth.

Although symptoms of S deficiency were not prominently exhibited on the oriental tobacco plants in the present investigation, yet light yellowing of young leaves was noticed which later spread to basal older leaves.(Fig. 2B). As S is an essential constituent of

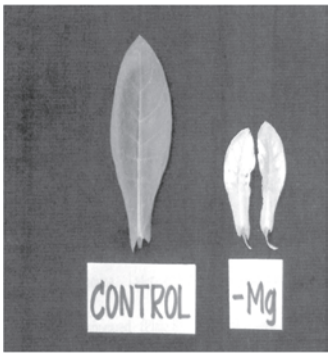

Fig. 2A. Maganesium deficiency in tobacco

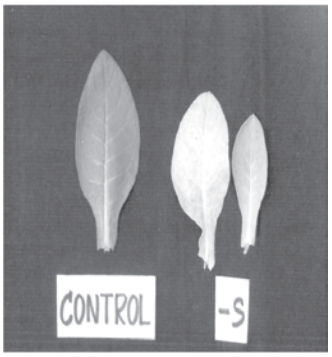

Fig. 2B. Sulphur deficiency in tobacco

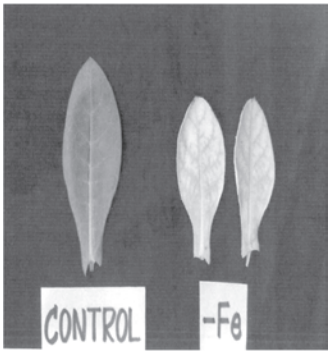

Fig. 2C. Iron deficiency in tobacco

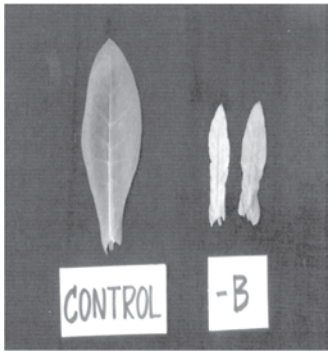

Fig. 2D. Boron deficiency in tobacco

certain protein, S deficiency resulted in inhibition of protein synthesis and thereby plant growth will be reduced further, as S is less mobile in plants unlike N, the chlorosis of leaves proceed from younger to older leaves (Kylin 1953).

Initially, the intervinal tissue was chlorotic at tips and margins of young leaves followed by necrotic patches and few yellow blotches on lamina. Later entire leaf become chlorotic and at times greenish veins appeared (Fig. 2C). As iron is essential for plants as a component of many enzymes and nevertheless, it plays a greater role in photosynthesis its deficiency leads to reduction in growth of plants. Further, Iron is essential for chlorophyll synthesis, as a metabolic iron, Fe is intermediately mobile in the plant consequently the chlorosis is first seen on younger leaves (Harris and Bledsoe 1951) .Slightly different symptoms and effects were reported in black gram (Srinivas 1988) and Castor (Parameswara Rao 1993).

The boron deficient oriental tobacco plants showed enlarged, thick, light green and leathery leaves with irregularly bent stem (Fig. 2D). Similar symptoms were noticed in chilies (Prasad *et al.* 1988) and in black gram (Srinivas 1988). The discrepancy in the symptoms due to shortage of Boron in oriental tobacco seedlings with other crops may be variation in response to boron deficiency.

Inadequate boron decreased the growth significantly which was most probably due to lower protein and RNA synthesis and low phosphate incorporation in nucleic acids, as these processes are most important for development of meristamatic tissue (Mengel and Kirkby 1987).

Finally in order to identify the mineral nutrient deficiency in oriental tobacco the following key was formulated. This key has been proposed on the basis of characteristic symptoms developed by various macro and micro element deficiencies in oriental tobacco.

I. Effects are generally on whole plant and localized on older, lower leaves

a. Effect is usually on whole plant, often, manifested by yellowing and drying of older leaves.

1. Effects are mostly generalized over whole plant, yellowing of whole plant and tip drying of older leaves – plant growth is very much stunted – **without nitrogen.**

2. Lower leaves turn dark green and rapidly they become pale yellow color and shed. Dark green young leaves – which are small, thick and narrow in proportion to length –**without phosphorus.**

b. Effects are usually local on older, lower leaves and mottling or chlorosis with or without spots of dead tissue

1. Lower leaves mottled with large spots of dead tissue – **without potassium**

2. Chlorosis commenced at the tips and margins of the leaf and spreads inwards and towards the midrib. The chlorotic areas become whitish patches – **without magnesium**

II. Effects are localized on younger leaves

a. Peculiar distortions at shoot apex

1. Older leaves thick and looked as normal, yellowing younger leaves and terminal bud dies – **without calcium**

2. Terminal leaves light green in color and lower leavers enlarged. The plant growth is considerably decreased – **without boron**

b. Terminal bud remains alive. Chlorosis of newer or bud leaves with veins light or dark green

1. Yellowing of terminal leaves without green color veins – **without sulpher**

2. Chlorosis of terminal leaves with veins of green color – **without iron.**

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