

## PHYSIOLOGICAL CHANGES IN PEPPER (*Piper nigrum* L. cv Panniyur 1) ASSOCIATED WITH WATER-LOGGING

Continuous oxygen supply is of prime importance to higher plants for a regular supply of metabolic energy through aerobic respiration. Most of the crop plants being mesophytes are adversely affected by water-logging and subsequent annoxia around the root system (Kramer, 1969; de Wit, 1978). Annoxia in the rhizosphere not only impairs root functioning, but also causes serious damage to the shoot system. Kramer (1969) listed a series of symptoms resulting from root annoxia such as yellowing, wilting, and epinasty of leaves and complete inhibition of shoot growth ultimately leading to death of the plant unless adventitious roots developed. Wilting is caused by increased root resistance to water absorption and injury to roots. Flooding injury is more serious on sunny days than cloudy days (Erickson, 1965) and under high temperatures as compared to cool weather (Letey *et al.*, 1962). Further, absorption of minerals and synthesis of hormones such as gibberellins and cytokinins by roots are also inhibited which in turn become injurious to shoot.

Identification of changes in parameters which are manifested early in response to environmental stresses is of much importance, both for varietal screening for stress resistance and for adopting proper measures for relieving from the stress in crop management. Changes associated with water stress such as proline accumulation (Wright and Hiron, 1969) osmotic changes (Ackerson *et al.*, 1980), leaf temperature (Clawson and Blan, 1982), stomatal resistance (Ackerson *et al.*, 1980), membrane stability (Levitt, 1972), etc., have been used as parameters to assess water stress. Thermostability of the membrane system has been adopted for quantitative assessment of the genotypic variation in high temperature injury in soybeans (Martineau *et al.*, 1979). Induction of alcohol dehydrogenase activity and ethanol accumulation are similar parameters that have been studied in connection with annoxia (Crawford, 1978). In the present study an attempt is made to assess whether there is any change in cell membrane permeability on account of root annoxia resulting from waterlogging. Further, comparison is also made between water-logged and control plants with respect to stomatal resistance, transpiration rate and leaf temperature.

Cuttings of *Piper nigrum* cv, Panniyur 1 were obtained from the Government Farm, Koothali, Calicut. Three cuttings per pot were planted during June 1982 in pots containing 20 kg of sieved laterite soil mixed with farmyard manure. Two sets of 4 pots each with 3 vines were used to study the effect of water-logging during July 1982.

The first set of 4 pots was placed in a water tank with water level maintained upto the soil surface to stimulate the condition of water-logging. A second set of 4 pots kept outside served as control. Membrane permeability changes

were quantitatively evaluated at intervals of 24 h upto 120 h after water-logging by the method of Martineau *et al.* (1979) and Blum and Ebercorn (1981) with modifications.

Physiological parameters such as stomatal resistance, rate of transpiration and leaf temperature were recorded with a steady state diffusion porometer (LI-1600, LI-COR inc., U. S. A.) only on the 7th day of water-logging at 13.00 h.

Water-logged plants showed the first signs of wilting of the young leaves by the third day, some of them showed signs of necrosis. Decay of the stem initiated by the sixth day. Symptoms of yellowing and necrosis of leaves were severe by the 7th day of water-logging and the lower leaves started abscission. About 80% of the plants showed recovery when relieved from water-logged condition. Water-logging for 10 days resulted in severe damage to the main stem with the consequent shedding of almost all the leaves; when relieved, about 90% of the affected plants failed to recover from injury (Fig. 1). Since most of the days were cloudy during the experiment the appearance of the symptoms might have been delayed (Erickson, 1965). Further studies are needed to evaluate the effect of varying relative humidity on the development of injury due to water-logging.

Eventhough visible symptoms of yellowing and necrosis were prominent even during early stages of water-logging, no statistically significant changes could be detected in membrane permeability between water-logged and control plants (Fig. 2).

Observations made on important physiological parameters such as stomatal diffusive resistance, rate of transpiration, and leaf temperature showed significant changes due to water-logging (Table 1). In the present study, observations were taken only on the 7th day of water-logging. The results showed that there was significant increase in stomatal diffusive resistance and leaf temperature, while considerable reduction was recorded in the rate of transpiration of water-logged plants over the control. Significant increase has been reported in stomatal resistance due

Table 1

Effect of water-logging on stomatal resistance, transpiration and leaf temperature in pepper (*Piper nigrum* L. cv. Panniyur 1 seedlings)

Parameters	Control	Water-logged
Stomatal resistance ( $\text{scm}^{-1}$ )	0.65	7.73**
Transpiration ( $\mu\text{g cm}^{-2} \text{s}^{-1}$ )	16.70	1.81**
Leaf temperature ( $^{\circ}\text{C}$ )	30.50	31.37**

\*\* Significant at 0.01 level

to water-logging in dwarf beans (Wright, 1972). The results show that these parameters could be used to evaluate the adverse effects of water-logging. Structural deterioration of the membranes in leaf tissue associated with senescence and yellowing reported earlier (Sacher, 1957; Poovaiah and Leopold, 1973) was not apparent in the present situation in pepper where yellowing was induced by water-logging. Estimation of the loss of chlorophyll might be a better parameter to assess the water-logging injury in pepper. The data indicate that intolerance of pepper to flooding is an important barrier to regeneration of the species in sites subject to periodic inundation.

സംഗ്രഹം

ജലനിമഗ്നത മൂലമുണ്ടാകുന്ന പ്രതികൂല ഫലങ്ങളെ വിലയിരുത്തുന്നതിനു വേണ്ടി തന്തുസ്മരപ്രവേശ്യത, ആസൂരന്ദ്ര വ്യാപക പ്രതിരോധം, സസ്യസ്പേഷനാനുപാതം, ഇലയുടെ ഉഷ്മാവ് എന്നീ സസ്യശരീര ധർമ്മശാസ്ത്രപരമായ മാനദണ്ഡങ്ങളിൽ വരുന്ന വ്യതിയാനങ്ങളെപ്പറ്റി നടത്തിയ പഠനങ്ങളിൽ ആസൂരന്ദ്ര വ്യാപക പ്രതിരോധത്തിലും ഇലയുടെ ഉഷ്മാവിലും ഗണ്യമായ വർദ്ധനവുണ്ടാകുന്നതായും, സസ്യസ്പേഷനാനുപാതത്തിൽ പ്രബലമായ പതനം ഉണ്ടാകുന്നതായും തെളിഞ്ഞു. എന്നാൽ, തന്തുസ്മരപ്രവേശ്യതയിൽ പ്രബലമായ വ്യതിയാനങ്ങൾ ഉണ്ടാകുന്നില്ലെന്നും കാണുകയുണ്ടായി. ഇടവിട്ട് ജലനിമഗ്നമാകുന്ന പ്രദേശങ്ങൾ കൂരുമുളകു കൃഷിയ്ക്ക് അനുയോജ്യമല്ലെന്നും ഈ പഠനഫലങ്ങൾ സൂചിപ്പിക്കുന്നു.

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Fig. 1

Injury in pepper caused by waterlogging for 7 days

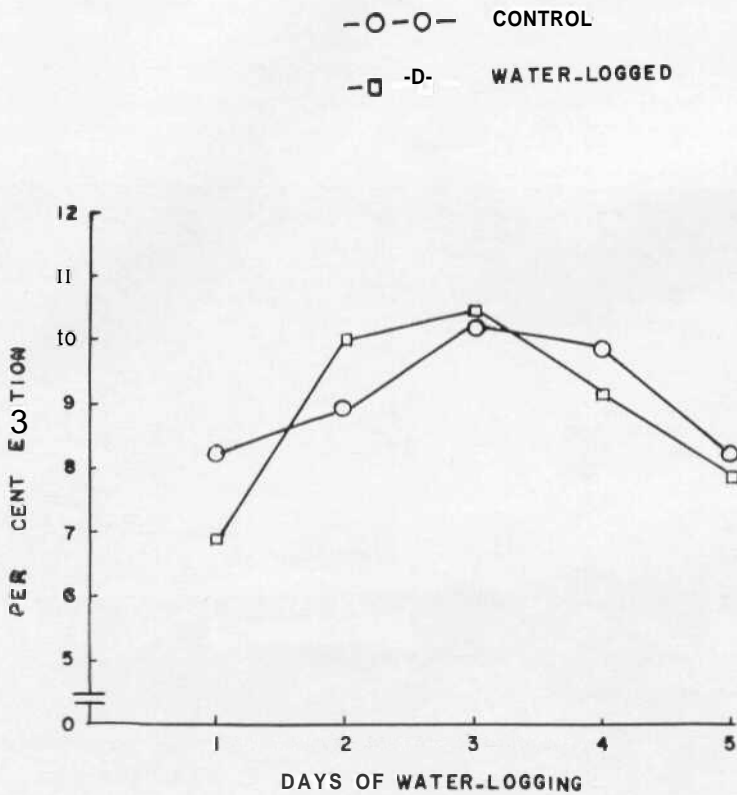


FIG-2. EFFECT OF WATER-LOGGING ON MEMBRANE PERMEABILITY IN PIPER NIGRUM CV PANNIYUR-1

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