An impact of simulated acid rain of different pH-levels on some major vegetable plants in India

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Abstract:-The impact of simulated acid rain with pH-levels of 5.0, 4.0 and 3.0 was studied on three most popular vegetable plants species viz *Capsicum annuum, Lycopersicon esculentum* and *Solanum melongea* of the family *Solanaceae.* The species were raised pure in earthen pots with agriculture soil. In all the three species the growth parameters and fruiting was severely curtailed with increasing acidity. However, the chlorophyll content was more or less unaffected. [Report and Opinion 2010;2(4):38-40]. (ISSN:1553-9873).

Keywords: *Solanaceae;* acid rain; growth parameters; vegetable plants; pH; India.

Introduction:

The impact of industrial civilization on the environment may be unparalleled in history of the biosphere. Indiscriminate and ever-growing use of energy may not only cause wide spread degradation of natural resources but may also influence our life support system. Acid rain is one of the serious problems resulting from rapid industrialization. According to Anon (1984), "Acid rain is an unseen plague of the industrial age". Acid rain is infact cocktail of mainly H_2SO_4 and HNO_3 where the ratio of these two may vary depending up on the relative quantity of oxides of sulphur and nitrogen emitted This potential problem is most relevant to forest and other natural vegetation compared to agricultural land which is regularly treated with liming agent to reduce soil acidity (Barett and Benedict, 1970). In the current study three different genera of vegetable plants of same family *Solanaceae*, which are very common and grown in every condition, were taken in this experiment, *Lycopersicon esculentum* Mill. (Tomato), *Solanum melongea* L. (Brinjal) and *Capsicum annuum* L. (Chilly). Large scale production of these vegetables is being carried out around towns and large cities, areas where the problem of acid rain is large. In the current study we have tried to assess the impact of simulated acid rain of different concentration (pH) on the production of these major crops.

Material and Methods:-

Site description:

The study area was located between the 25^0 19' N to 25^0 54' N and 83^0 04' E to 83^0 58'E longitude in Ghazipur district of eastern Uttar (Colin Tudge 1989). Acidity as well as harmful action of toxic elements damages vegetation while susceptible microbial species are eliminated from the soil affecting processes such as decay and decomposition of organic debris and the capacity of a balanced regulation of nutrients. Soils in general have a greater buffering capacity than aquatic system. However excessive amount of acids introduced by acid rains may disturb the entire soil chemistry (Bunyard, 1985). Effects of acid rain on crops have important economic and agricultural implications. In general, growth reduction in crops is not observed until pH are more acidic than 3.0. Pradesh (India) in alluvial plain of the middle Ganga valley. The climate is characterized by hot summer, cold winter and heavy rainy season. The period of high rainfall is between June to September which contributes to 80% of the annual rainfall of the total 120-130cm. The lowest humidity was recorded in the month of April (38.7%) while in other months it ranged between 52-75%. The mean annual temperature of the area was 25.3^0C the mean minimum temperature was in January which is around 5^0C and the mean maximum in June 43^0C.

Methodology:

48 earthen pots of 30X20X20 cm were taken in this experiment. Pots were filled with 500 g (dry weight) agricultural field soil. 48 plants of each of the three species *Lycopersicon esculentum, Solanum melongea* and *Capsicum annuum* were raised and transplanted in 12 pots each (4 plants per plot). Theses were grown in ambient conditions for 4 weeks and then 3 pots of each species were exposed to simulated acid rains with pH 3, 4 and pH 5 and 3

pots of each species were kept as control. Simulated acid rain was prepared in laboratory by different pH-level capsules dissolved in 10ml of distilled water.

This solution was made upto 100ml by adding distilled water. The solution was applied to the potted plants using an agricultural sprayer daily for 4 weeks. Number of leaves, branches, flowers and shoot length was measured at weekly intervals and root length and biomass and chlorophyll content was measured after 4 weeks. For chlorophyll estimation, leaf samples were collected randomly from simulated acid rain exposed plants. 1g of leaves of each plant samples was crushed with the help of mortar in presence of small amount of $MgCO_3$ and 80% acetone. This solution was centrifuged and kept in incubator for 24 hours and then make this solution up to 100 ml by adding acetone. After 24 hours the chlorophyll content was estimated with the help of absorbance at 663nm and 645nm. The concentration of chl_a and chl_b were calculating using formula.

$$Chl_a = 12.7A_{663} - 2.69A_{645}$$
$$Chl_b = 22.9A_{645} - 4.68A_{663}$$

Results:

The effect of acid rain on the growth parameters of 3 species of vegetable plants was investigated in 1week after spraying simulated acid rain of pH-3.0,4.0, 5.0. The acid rain of all pH 5, 4, 3 appear to the injurious to plants but the magnitude of affect varies. In all the three species flowering and fruiting in plants was either absent or drastically suppressed by the acid rain. The plant growth was hampered and the biomass reduced (Table1). Chlorophyll a and b were not significantly reduced by simulated acid rain treatment relative to controls at all pH-levels. In comparison to control the shoot length was reduced by approximately 20% in *L.esculentum*, 30% in *C.annuum* and 25% in *S. melongea*, root length was reduced 40% in *L.esculentum*, 70% in *C.annuum* and 50% in *S. melongea* under impact of acid rain of pH-3.0 (Table 1). The impact of increasing acidity in the rain on leaves was drastic. The leaf number in comparison to control was reduced 60% in *L.esculentum*, 50% in *C.annuum* and 70% in *S.melongea* and biomass was reduced 45% in *L.esculentum*, 60% in *C.annuum* and 55% in *S.melongea* under the influence of acid rain of pH-3. Flowering was 100% reduced in all plants species to increasing the acidity.

Table1. Growth parameters, plant biomass and chlorophyll concentration in *L.esculentum,C.annuum and S.melongea* plants under stimulated acid rain of different pH.

		L.esculentum				*C.annuum*				*S.melongea*			
Parameters		Control	pH5	pH4	pH3	Control	pH5	pH4	pH3	Control	pH5	pH4	pH3
Shoot length (in cm)		16	15	13	13	11	9	9	8	8	7	6	6
Root length (in cm)		17.6	12.5	14	10	22.5	8	6.6	6	18.1	18	11.2	8
Leaves (in no.)		90	72	64	32	36	33	30	15	20	15	14	5
Branches (in no.)		13	5	5	4	6	5	4	2	6	4	2	2
Flowering (in no.)		10	2	0	0	14	1	0	0	10	0	0	0
Fruiting (in no.)		7	1	0	0	10	0	0	0	7	0	0	0
Biomass (in gm)		15	14	11	10	2.7	1.2	1.6	1	8.3	5	4	4
Chlorophyll content	Chl_a	4.28	4.25	3.47	3.34	4.00	3.95	3.84	3.35	4.68	4.27	4.00	3.48
	Chl_b	5.45	4.16	2.37	2.30	3.85	3.80	3.75	3.05	5.09	3.85	3.36	2.57

Discussion:

According to Asthana and Asthana (2001), in action of aluminium is enhanced under acidic conditions (pH-5 or lower) causing plant injury. Plants become stubby, stunted and brittle. Photosynthetic response of leaves to acid rain varied among plant species.

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Decrease of photosynthetic rate with acid rain was mainly related to the decreased of chlorophyll content of leaves. Dry weight in most crops except rice reduced with simulated acid rain in the case that its acidity was more than pH-3.0 (Jiro Harada, 1992). Studied proved that the old leaves of all these plants are readily exposed and abscission of leaves started on first week of exposure. SO_2 damage cells on the surface of leaves, depending on the concentration and the amount of water present, they cause stomata either to close or to open, in either case disrupting the flow of water through plants. (Sharma and Kaur, 1994) The effect of acid precipitation on vegetation indicates reduce rate of photosynthesis and growth and increased sensitivity of drought and disease. Acid rain affect soil in many ways, plant nutrient such as potassium is gradually leached out of soil. At the same time, a toxic element like Zn accumulates due to acid rain (Sharma and Kaur, 1994). Beneficial microorganisms in the soil are reduced and reduced the growth of crops and also reduced the biomass. Plants can easily absorb Cd from the acidified soil through roots and root system are damaged because when high level of Cd- absorbed by plants are injurious for plant growth. The reduction in the root growth may be due to acidification of the soil directly or indirectly by through fall from leaves, branchesBun and stem and toxicity of Aluminium which may blocking the nutrient uptake necessary for root growth which is also reflected in leaves with decreased chlorophyll content (Sharma and Kaur,1994). According to Asthana and Asthana, 2001 young seedlings are more susceptible to the toxic effect of the all than older plants. The phosphorus is more important nutrient for the proper growth of fruits which is reduced by the accumulation of Al-toxicity released from the acidic soil. The growth of plants is also affected by external and internal factors not only pH. As we know that the growth due to various physiological processes, so the factors are light, temperature, oxygen, CO_2, H_2O and food material. Soils very considerably in the preponderance of the hydrogen ion (H^+) of hydroxyl ion (OH^-), the soil are greatly influenced by the nature of soil colloids, soil solution.

In brief acid rain can severely impact the production of fruits in the species of the study causing large scale economic bases to the poor and marginalized formers of India.

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