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# EFFECT OF CHANGED $CO_2$ CONDITIONS ON PLANT DISEASE INTENSITY IN NAGPUR REGION

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**Abstract :**
Climate is a measure of the average pattern of variation in temperature humidity atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time. Plant pathogens are ubiquitous in natural and managed systems, being among the first to demonstrate the effects of climate change due to the numerous populations, ease of reproduction and dispersal and short time between the generations. The available data clearly suggests that increased $CO_2$ would affect the physiology, morphology and biomass of crops. Elevated $CO_2$ and associated climate change have the potential to accelerate plant pathogen evolution which may, in turn, affect virulence. Increased $CO_2$ will lead to less decomposition of crop residues and as a result soil borne pathogens would multiply faster on the crop residues. In view of the study results, it is concluded that there is noticeable change in the change in percentage of $CO_2$ during the last few decades. It can be concluded that there is noticeable change in damages caused by diseases to crop yield during the last few decades In view of the obtained data and it is concluded that the crop yield has gone down noticeably as a function of climatic changes due to considerable increase in disease intensity.
**Keywords :** Climate Change, Elevated $CO_2$, Plant Pathogen, Disease intensity, Decades.

## Introduction:

Climate is a measure of the average pattern of variation in temperature humidity atmospheric pressure, wind, precipitation, atmospheric particle count and other meteorological variables in a given region over long periods of time. Climate is different from weather, in that weather only describes the short-term conditions of these variables in a given region. At the beginning of the 21st century, we are faced with a rapid change in the environment. Greenhouse forcing is expected to alter temperature and rainfall patterns and atmospheric $CO_2$ concentration will continue to increase for an extended period of time. Plant Diseases are responsible for losses of at least 10% of global food production representing a threat to food security. The close relationship between the environment and diseases suggests that climate change will cause modifications in the current phytosanitary scenario. Plant pathogens are ubiquitous in natural and managed systems, being among the first to demonstrate the effects of climate change due to the numerous populations, ease of reproduction and dispersal and short time between the generations. It is estimated that average global temperatures will have risen by 1.0 °C –3.5°C by 2100 (Watson, 1996), increasing the likelihood of many vector-borne diseases. The temporal and spatial changes in temperature, precipitation and humidity that are expected to occur under different climate change scenarios will affect the biology and ecology of vectors and intermediate hosts resulting in the risk of disease transmission. The risk increases because, although arthropods can regulate their internal temperature by changing their behaviour, they cannot do so physiologically and are thus critically dependent on climate for their survival and development. Climate, vector ecology and social economics vary from one continent to the other and therefore there is a need for a regional analysis (Lindsay and Birley, 1988).

It has been reported that the impact of increased $CO_2$ concentrations on plant diseases will likely be through changes in host physiology and anatomy. Some significant changes that will likely influence plant disease severity under elevated $CO_2$ are lowered nutrient concentration, leading to partitioning of nitrogen from photosynthetic proteins to metabolism that is limiting to plant growth; greater carbohydrate accumulation in leaves; more waxes, layers of epidermal cells and fibre content production of papillae and accumulation of silicon at the sites of appressorial penetration and increased mesophyll cells (Chakraborty *et al.* 1998a). Thus, in the backdrop of the importance of $CO_2$ concentration vis-à-vis plant growth, the data pertaining to the same was collected and the results are presented hereunder.

## Material Methods:

The primary data was collected by using a reliable and valid research instrument. The process of developing the research instrument for this study was based on generally accepted principles of instrument design, and was carried out according to the standard methodology. Data was collected from July 2010 to December 2014 from Meteorology Department at Nagpur Airport, Nagpur and Agriculture Statistics Department, Government of Maharashtra, Nagpur. Ten plots were prepared on agricultural land of Plant Pathology Department of Dr. P D K V'S College of Agriculture, Nagpur. In each plot seeds were sown in 10 rows of ten seeds each. The seeds were sown at a distance of 10-15cm from each other. In one plot only one type of seeds were sown.

In the year 2011, 2012 and 2013 the seeds were sown in the first week of July depending on the rainfall and climatic conditions. Simultaneously the seed were also sown in controlled Open Top $CO_2$ Chambers at Plant Pathology Department of Dr. P D K V'S College of Agriculture, Nagpur. The seeds which were sown were the cash crops of Vidarbha region which was decided by conducting the survey of previous data bases of Nagpur districts of Agriculture Statistical Department at and which crops are highly affected by the diseases in Vidarbha district. So the crops which were selected were Cotton (*Gossipiyum herbaceum, L*), Tur (*Cajanus cajan,* L), Moong (*Vigna radiata, L*), Groundnut (*Arachis hypogaea, L*) and Soyabean *(Glycine max, L.).*

## Result and Discussion:

The results regarding the average change in ppm of $CO_2$ prevailing in the study area during the last few decades is shown in Table 6.4. The change in $CO_2$ ppm during the 1981-1990 decade was 345±2.3ppm, while during the successive decades i.e. 1991-2000, 2001-2010 and 2010 - 2015 it was 360±3.5, 379±1.9 and 397±2.4, respectively. Although there was no significant difference in the change in percentage of $CO_2$ values recorded for different decades, an increasing trend (of change in ppm of $CO_2$) was noticeable (Fig. 6.4). Thus, on the basis of the study results, it is concluded that there is noticeable change in the change in percentage of $CO_2$during the last few decades.

The above Table 6.5 presents results regarding the diseases to major crops in the study area prevailing during the last few decades. It is observed that the Cotton variety PKV H-5 suffered from the Angular leaf spot and Alternaria leaf spot with 6.2 and 17.2 disease intensity. Pigeon pea variety C-11 suffered from Wilt and stem blight with 10.8 and 32.00 disease intensity. In groundnut AG-303 it was observed that Tikka (*Cercospora arachidicola* and *Cercospora. personata*) and Rust (*Puccinia arachidis*) with 33.6 and 8 disease intensity. Further it was observed that the Greengram Green gold suffered with Cercospora leaf spot, Powdery mildew and Mosaic with the disease intensity of 12.3 and traces. Soybean variety JS-335 suffered with the *Xanthomonas* sp., *Leveillula taurica sp., Cercospora* sp. and *Alternaria* sp., with 15.3, 16.8, 12 and 15.7 disease intensity, respectively. However, the data indicates that there was a change in the trend of the disease intensity (Fig. 6.5). Thus, on the basis of the study results, it is concluded that there is noticeable change in the diseases to major crops in the study area during the last few decades.

The upper safety limit for atmospheric $CO_2$ is 350 ppm. However, the historical data indicated that the atmospheric $CO_2$ levels have stayed higher than 350 ppm since early 1988. Elevated $CO_2$ is expected to increase canopy size and density (Coakley *et al.* 1999), resulting in greater biomass of high nutritional quality, combined with higher microclimate humidity (Manning and Tiedemann, 1995). Besides, these changes will likely promote foliar diseases such as rusts, powdery mildews, leaf spots and blights (Coakley *et al.* 1999, Manning and Tiedemann, 1995). Thus, the results obtained in this study clearly indicate that the crops in the study area are at risk.

The available data clearly suggests that increased $CO_2$ would affect the physiology, morphology and biomass of crops (Challinor *et. al.,* 2009). Elevated $CO_2$ and associated climate change have the potential to accelerate plant pathogen evolution which may, in turn, affect virulence. Pathogens productiveness increased due to altered canopy environment and was attributed to the enhanced canopy growth that resulted in conducive microclimate for pathogen's multiplication (Pangga *et. al.,* 2004). Foliar diseases like *Ascochyta* blights, *Stemphylium* blights and *Botrytis* gray mold can become a serious threat in pulses under the higher canopy density. Increased $CO_2$ will lead to less decomposition of crop residues and as a result soil borne pathogens would multiply faster on the crop residues.

**Table 6.4:** Change in ppm of $CO_2$ recorded in the last few decades.

| Decade | Mean (ppm) | SD | Min | Max | 'F' ratio | P |
|---|---|---|---|---|---|---|
| **1981-1990** | 345 | ±2.3 | 333 | 358 | **1.117** | **NS** |
| **1991-2000** | 360 | ±3.5 | 334 | 370 | | |
| **2001-2010** | 379 | ±1.9 | 370 | 388 | | |
| **2010-2015** | 397 | ±2.4 | 379 | 400 | | |

**SD**: Standard deviation; **Min**: Minimum; **Max**: Maximum; **P**: Probability; **F** : ANNOVA Test, **NS**: Not Significant

**Diseases to major crops in the study area**

**Table 6.5:** Prevalence of plant diseases to major crops in the study area

| Sr.No | Crop | Variety | Name of diseases | Disease Intensity (%) |
|---|---|---|---|---|
| 1 | Cotton ***(Gossypium herbaceum, L.)*** | PKV H-5 | Angular leaf spot (*Xanthomonas axonopodis*) | 6.2 |
| | | | Alternaria leaf spot (Alternaria sp.) | 17.2 |
| 2 | Pigeon pea (***Cajanus cajan, L)*** "Tur" | C -11 | Wilt ( *F. oxysporum*) | 10.8 |
| | | | Stem blight (*Phytophthora drechsleri*) | 32-00 |
| 3 | Groundnut ***(Arachis hypogaea, L.)*** | AG -303 | Tikka(*Cercospora arachidicola* and *Cercospora personata*) | 33.6 |
| | | | Rust (*Puccinia arachidis*) | 8 |
| 4 | Greengram (***Vigna radiate, L.***) "Moong" | Greengold | Cercospora leaf spot (*Cercospora cruenta* and *Cercospora canescens*) | 12.3 |
| | | | Powdery mildew ( *Erysiphe polygoni* ) | In traces |
| | | | Mosaic (Mungbean yellow mosaic virus) | In traces |
| 6 | Soybean (***Glycine max, L.***) | JS – 335 | Leaf spot (*Xanthomonas* sp.) | 15.3 |
| | | | Pod blight ( *Phomopsis longicolla*) | 16.8 |
| | | | Cercospora leaf blight (Cercospora sp.) | 12 |
| | | | Alternaria Stem blight ( *Alternaria* sp) | 15.7 |

## Conclusion:

In view of the study results, it is concluded that there is noticeable change in the change in percentage of $CO_2$during the last few decades. On the basis of the study results, it is concluded that there is noticeable change in the diseases to major crops in the study area during the last few decades. It can be concluded that there is substantial increase in vegetative growth in plants but there is decreases in yield of plant. But previous researchers have reported that seed yield was always increased by elevated $CO_2$ Allen *et al.* (1987) summarized the photosynthetic, biomass and seed yield responses of several experiments. This may be due to disease attack on plants and which has restricted their reproductive growth and resulted in lesser yield.

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