Pollution Index and Air Ion Variation in Different Vegetation area at the Rural Station Bhilawadi (16°59’N, 74°28’E)

G B Patil*, S D Pawar2, J L Bhosale3 and P G Patil4

1Department of Physics, Secondary School and Junior College, Bhilawadi. 416303, India
2Department of Physics, A.C.S. College, Palus.416316, India
3Department of Physics, Dr Bapuji Salunkhe College, Miraj, 416410, India
4Department of Chemical Engineering, Institute of Chemical Technology, Jalna, India. Email: *gajananpatil2004@gmail.com

Abstract: All are surrounded by air ions which shows the good and bad impact on us. These airborne particles have charge and conductivity. These are positive and negative air ions. The negative air ions have a positive effect on human health. We feel happy, relaxed, and breath easily due to them. But positive air ions are responsible for discomfort, headache, high blood pressure, nervousness in human life. The air ion concentrations in Grape, Sugarcane, Chickpea, and Onion vegetation in rural area Bhilawadi (16059’20” N, 74028’2” E) is measured with the help of a Gerdien condenser-based air ion counter developed and designed at A.C.S. College, Palus. Temperature, humidity, transpiration, radon exhalation, wind speed is responsible for variation in air ions. Onion, sugarcane, grapes, and chickpea have a higher concentration of negative air ions than positive air ions. Ionization by cosmic rays and gamma radiation is almost constant in daily cycles. Air ion concentration near the ground varies mostly with the exhalation of 222Rn and its progenies. Due to ionization, photosynthesis, transpiration, and radon exhalation process of vegetations ion concentration are different. The pollution index and air ion assessment coefficient show good air quality of sugarcane and onion as a natural air ionizer.

Introduction

Air ions are classified as small, medium, and large air ions depending upon their size and mobility. Radioactive material, cosmic rays, ultraviolet rays, hydrolysis of water molecules, plant tips discharge, the photovoltaic effect of green plants, volcanic eruptions, lightning, thunderstorms, snow and storms, corona discharge, radiation are sources of air ions [1]. The production of cosmic rays and other elements is nearly constant. Mainly uranium, thorium decay series have radioisotopes producing gamma rays of sufficient energy [2] and produces positive or negative air ions. Out of this negative air, ions have a positive effect on human and animal health. And they are said to be air vitamins. It is a significant important source of energy. Human beings feel happy, relaxed, and can breathe easy which results in good work productivity and mood and peaceful sleep [3].

Headache, insomnia, fatigue, nervousness, joint aches, high blood pressure, discomforts due to the higher number of positive air ions [4]. Radon is the main source of radiation on the ground surface...
for air ion production [5]. Plants are affected by air ions also produce various air ions including negative air ions under normal conditions [6]. Different plants produce a different number of air ions depending upon the vegetation area. With the help of the Gerdien type air ion counter, air ion concentration at grapes, Sugarcane, Onion and Chickpea vegetation area was measured.

The pollution index is the ratio of the number of positive air ions to the number of negative air ions. It should be less than one for healthier human life. A pollution index greater than one is harmful to human beings. Sugarcane, Grapes are cash crops that remain in the field throughout the year. Chickpea and Onion are seasonal crops.

**Instrumentation**

Air ion counter is designed and developed at A.C.S. College, Palus. It is based on the principle of the Gerdien condenser [7]. It works on the principle that air ion current is directly proportional to air ion concentration. It is operated at rural station Bhilawadi. It is 250 km south of Pune. The measuring instrument consists of a Gerdien condenser, power supply, Laptop, Datalogger and the aluminium box containing a circuit of operational amplifier ADC549JH to convert current to voltage measurement, battery and anemometer. A caged box is fabricated for the safety of the instrument and is kept in different fields like sugarcane, Onion, Grapes and Chickpea. Figure 1 shows particulars that are kept in for measurement of air ions in the fabricated box. Figure 2 shows the scenario in the grape's vegetation area. Figure 3 and 4 show the position of the instrument in the Chickpea area and the sugarcane area. Air ion concentrations of positive and negative ions were recorded in the data logger.

![Experimental Setup for measurement](image1)

![In the Grapes vegetation area](image2)

Onions are mostly cultivated in India, China and Egypt. It is a vegetable called bulb onion or common onion. The flower stalk of it nearly 25 to 150 cm in length. Stinging sensation in the eyes is caused by volatile liquid syn-propanethial-S-oxide and its aerosol by freshly cut onion. Red Bhima variety of onion is used for the study.

A grape is a delicious fruit. China, France, Italy, the United States are mainly producers of grapes. It is about 6 feet in length. Its leaves are dark and crowdy which plays important role in the transpiration and photosynthesis. Tas-Ganesh variety of grapes is used for measurement of air ion concentration in the garden.

Sugarcane is the world’s largest crop mainly cultivated in Brazil, India, and South Asia. Its leaves are responsible for the corona effect for the production of air ions. Co-86032 variety is used for the experiment in the Bhilawadi vegetation area.

Phule G-12 variety of Chickpea is used for the measurement of air ion concentration. It grows nearly 20 to 50 cm in height. It has small and feathery leaves. It is energy and protein feed for animals.
Photosynthesis is the oxidation-reduction process in which many chemical and photochemical reactions. In this process, oxygen is given out. A very simple reaction of photosynthesis is given by Brown [8]. It takes place in the presence of Chlorophyll and sunlight in which oxygen is released which plays important role in the formation of air ions.

Photosynthesis is the oxidation-reduction process in which many chemical and photochemical reactions took place. In this process, oxygen is given out.

\[
6\text{CO}_2 + 12\text{H}_2\text{O} \rightarrow \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{H}_2\text{O} + 6\text{O}_2
\]

This released oxygen acquires energy from radon gas and produces positive or negative air ions. From 222Rn decay of α-particle as the energy of 35MeV and that of β-particle and γ-rays have 33.8ev which is sufficient to produce \(10^5\) air-ion particles [9].

This production of air ions due to Rn decay is ten times more than ion production by cosmic rays. The time duration of air ions is from millisecond to minute.

**Method and Discussion**

Air ion concentration is measured with the help of an air ion counter based on Gerdien condenser [10] designed at A.C.S. college Palus [8] and operated at rural station Bhilawadi (16°59'20" N, 74°28'2" E) which lies in Sangli district of Maharashtra (India). The observatory is used for the Sugarcane CO86032 variety, Tas-Ganesh variety of grapes, Phule G-12 variety of Chickpea and Red Onion-Bhima for Onion vegetation area was used. The Air ion counter was placed at a height of one meter from the ground. These vegetation areas are well irrigated by the Krishna river irrigation system. Air ion variation is measured from 9 Nov to 16 Nov 2019. Air ion variation recorded with time variation of 30 seconds.
Figures 5, 6, 7, and 8 show diurnal variation of positive and negative air ions of chickpea, Grapes, sugarcane, and onion vegetation respectively. Chickpea graph shows negative air ion concentration is more during early morning time 3 am to 9 am during in the afternoon, the concentration of positive and negative air ions is very low. The maximum count of negative air ions is 762 $\times 10^3$ ions per cm$^3$ and that of positive air ions is $494\times 10^3$ ions per cm$^3$. The average pollution index is 0.65 which is beneficial for humans and animals. The sour liquid on the leaves of chickpea helps to settle aerosol in the atmosphere so found an increase in positive air ions.

![Grapes Diurnal Variation](image1)
![Chickpea Diurnal variation](image2)
![Diurnal Variation of Sugarcane](image3)
![Onion Diurnal Variation of Ions](image4)

Figure 5-Diurnal Variation of air ions in Grapes vegetation area. Figure 6-Diurnal variation of air ions in Chickpea vegetation area.

Figure 7- Diurnal Variation of air ions in Sugarcane vegetation area. Figure 8- Diurnal variation of air ions in Onion vegetation area.

Diurnal variation of Tas-Ganesh grapes shows negative air ion concentration is more in the early morning between 6 am to 9 am. The maximum count is $91 \times 10^3$ ions per cm$^3$. The concentration of
positive air ions is maximum between 7 pm to 10 pm. The maximum value of positive ions is \(117 \times 10^3\) ions per cm\(^3\).

The negative air ion concentration of sugarcane is maximum from 4 am to 10 am, in the morning. The maximum count of negative air ions was \(5.5 \times 10^3\) ions per cm\(^3\). Positive air ion concentration onwards 11 am up to 6 pm and its maximum count is \(842\) ions per cm\(^3\). The pollution index for the sugarcane area is 0.15. Its pointed leaves are also responsible for air ion production. It is clear that Sugarcane, Grapes, Onion, and Chickpea crops are beneficial as are the rich producer of negative ions and also are cash-crops. Cultivation of these crops is beneficial for human beings. Table 1 shows the pollution index, variety and botanical names of the sample studied.

Table 1. Pollution Index and variety of crops studied

| Sr. No | Name of Plant | Botanical Name          | Variety Studied | Pollution Index |
|--------|---------------|-------------------------|-----------------|----------------|
| 1      | Sugarcane     | Saccharum officinarum   | CO86032         | 0.15           |
| 2      | Grapes        | Vitis vinifera          | Tas-Ganesh      | 0.77           |
| 3      | Chickpea      | Cicer arietinum         | Phule G-12      | 0.65           |
| 4      | Onion         | Allium cepa             | Red Onion Bhima | 0.21           |

Diurnal variation of onion shows that in the morning between 5 am to 11 am, the concentration of negative air ions is more. The peak of the negative ion count is at 6:28 am. Its value is \(231 \times 10^3\) ions per cm\(^3\). Positive air ions are maximum from 12 pm to 2 pm. Its maximum value is \(48 \times 10^3\) ions per cm\(^3\). The pollution index is 0.21 for onion. A pollution index greater than one is harmful but less than one is beneficial for humans and animals. Rural areas are free from pollutions. As compared to the evening period morning period is very healthy for human health at rural station Ramanandnagar [11].

Pollution Index or Unipolarity ratio must be less than one for good air quality and a healthy atmosphere. Observations show that sugarcane and onion are best for good environmental air quality. These crops produce more negative ions. A pollution index greater than one is harmful to human beings.
Air quality is also determined by the air ion assessment coefficient [C.I.] [12]. It is the ratio of negative air ions to the 1000 times pollution index. For best air quality C.I. always greater than one. The larger value of C.I. indicates better quality of air. It is pollution less and contains more negative air ions. Also, it shows the healing effect percentage is more.

The negative air ion concentration is more in the morning is due to pollution and a dust-free environment. Plant transpiration and photosynthesis also increase the production rate of air ions. Radon gas is close to the ground surface is responsible for ion production. It decreases exponentially with temperature [13]. During noon, pollution from vehicles, and smoke, wind direction, mobility of air ions reduced amount of radon are responsible for a reduced amount of negative air ions. Air ions affect vegetation processes but plants themselves generate ions, especially negative air ions under specific conditions. It is in good agreement with Nemeryuk's about the transpiration of salt in the atmosphere [14].

**Conclusion**

From overall observations, it is clear that different plants produce various number of air ions. This count changes concerning vegetation area and daily cycle. It is clear that the concentration of negative air ions is more in the morning period generally between 5 am to 9 am. This air is rich in negative ions due to which people going for morning walk consume more healthy air ions from the atmosphere. Work efficiency of farmers and workers is more during the morning, they feel good and delightful. Air pollution during the evening period can affect human health in several ways such as eye irritation, respiratory system, and viral infections. Thus, for healthy and good air quality pollution index must be less than and the air ion assessment coefficient must be greater than one.

Air ions generated by different plants is different at a different period. From observations, Sugarcane and Onion vegetation area are more generators of negative air ions compared to grapes and chickpea. Plant transpiration, leaf area, humidity light, and radon exhalation are different for different crops so there is variation in the air ion concentration. So instead of using an artificial air ionizer, it is better to go in nature or vegetation areas for natural air ionizer.

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