Original Research Article

Effect of High Voltage on Texture, Color, and Growth of *Aloe vera* Leaves

ABSTRACT

With the growth in transmission lines all over the world an evident observation comes in front regarding the effect of high voltage on the plants. High-voltage transmission lines are used to transmit electric power over long distances. High voltage may have positive or negative effects on plants and other living beings. The objective of this study is to investigate the effect of high voltage on *Aloe vera* plants with respect to changes in texture, colour, and growth of leaves after exposure to high voltage for different durations. *This* plant is chosen due to its various properties and uses in dermatology.The leaves of *this plant* contain a soothing thick sap that is valuable for healing and curing of wounds and diseases .Images of exposed as well as unexposed *Aloe vera* leaves were taken and analysed over a period of ten days. Other control variables like temperature, humidity, sun light were maintained almost the same for all observations.

Keywords: Aloe vera, effect of high voltage, Tesla coil.

1. INTRODUCTION

Revolutionary and ever growing field of electrical engineering have enhanced the high voltage transmissions in day to day life. Since last few decades high voltage transmission is becoming a vital part of our life. The high voltage has much effect on living organisms as well as human beings. Plants are also multicellular, complex organisms like human beings and some studies have reported the effect of high voltage on them as well [1]. The growth and development of the plant can be affected by mechanical stimulations like wind, vibrations, and touch. This process is called thigmomorphogenesis [2]. In plants, there are various natural and artificial impacts along with large variation of potential. These days, huge amount of information regarding electrical effects in plants is available. Plants play a significant role in the living world as main producers of food and oxygen; therefore it would be advantageous to investigate their relations with today's increased exposure to high voltage electrical fields. *Ksoy et al. [3] in 2010 investigated the growth of Allium cepa bulbsin pots for three days on treatment area on which 380* kV *high voltage power lines were passing*. Ten bulbs were set up for each treatment area. *Triticum baeoticum boiss*. subsp. baeoticum seeds were collected at same distance from power lines on planted field. Ten seeds from each area were germinated in petri dishes for three days in laboratory. The treatment groups were compared with the control group for mitotic index and chromosome aberrations. Data obtained from this revealed that the electromagnetic fields from high

voltage power lines improved the mitotic index and chromosome aberrations. Maziah et al. [4] investigated that electromagnetic field could be used as a tool to promote mustard growth by means of photosynthesis once the right EMF strength is exposed. The effects of electromagnetic fields at high voltage transmission line on biochemical and antioxidant system changes in mustard leaf (*Brassica chinensis*) were investigated under field condition. Mustard leaves were exposed to EMF from power lines at various distances. The effects of EMF on leaf mustard planted at different distances from the power line showed that the leaf mustard planted within 20 m from the power line had considerably higher protein, soluble protein, soluble nitrogen, and chlorophyll contents due to the higher EMF strength which decreased with increasing distance from the line. Higher EMF strength closer to the 275 kV power line resulted in higher peroxidase enzymatic activity, and chlorophyll content. Thus the new and energetic area of scientific research is the studies associated with the high voltage effects. Agricultural science takes interest not only in the general and valued crop-forming factors, but also in those which are inexpensive and generally underestimated, though more pro-ecological ones which include ionizing, laser, ultraviolet radiation, electric, and magnetic fields [5]. The objective of this paper is to investigate the effect of high voltage on texture, colour as well as on the growth of the *Aloe vera* plants. This plant been chosen because of its numerous applications. The plant and its characteristics are described in Section 2. The methodology is presented in Section 3 and results and discussions in Section 4 along with the conclusions in Section 5.

2. ALOE VERA

Aloe vera is a perennial liliaceous plant which has juicy green leaves attached at the stem in a whorled pattern [6]. It is a hardy, perennial, tropical, drought-resistant, succulent plant and has been used for a variety of medicinal purposes. It is a stem less or very short-stemmed plant growing upto 60– 90 cm in height. The stem has dormant root buds that develop to form new roots. The leaves are thick and fleshy, green to grey-green, with some varieties showing white flecks on the upper and lower stem surfaces [7]. Mature plants can be grown as tall as four feet with average height around 30 inches. Each plant has an average of 15 leaves usually and weighs up to 2-3 kg when fully matured. The *Aloe vera* plant can be harvested following every 6 to 8 weeks by removing 3-4 leaves per plant [8]. The peripheral bundle sheath cells of the plant produces extremely bitter, yellow latex, which is commonly known as aloe juice or sap [9]. *Aloe vera* has also been used for medicinal purposes in several countries like India, Mexico, Greece, Egypt, China and Japan [10]. Fig. 1 shows *Aloe vera* tree grown in a house.

Fig. 1 Aloe vera

Aloe vera has extensive applications in Ayurveda for its anti-burn effect. It also acts as a tonic, antiseptic, antibiotic, anti-diarrheal, anti-fungal, anti-viral, and also a good hair conditioner [11]. In Ayurveda, which is also the traditional medicine of India, this plant has manifold uses such as it is used as a laxative, in haemorrhoid remedy, and as a uterine stimulant. It is also use to treat eczema or psoriasis [12]. Recently, the plant has been used

to treat canker sores [13]. The most important part of the plant is Aloe gel. *Aloe vera* gel is 99% water. It has a pH of 4.5 and is a common ingredient in many non-prescription skin salves. The gel also consists of the bulk of the leaf substance, which serves as the water storage space organ for the plant. In addition to this, the gel consists of polysaccharide, glucomannan, etc. [14].

3. METHODOLOGY

The research was carried out on *the* plant to study the effect of high voltage on its leaves with respect to texture, colour, and growth. In this research, the photograph of *Aloe vera* leaf before high voltage exposure was taken and it was studied. After that the *Aloe vera* plant was exposed to high voltage. The Tesla coil shown Fig. 2 was used to produce high voltage of order 50 kV.

Fig. 2 Tesla coil

Tesla coil is an electrical resonant transformer which is used to produce high voltage low current, high frequency alternating current electricity. It is essentially a high frequency air core transformer. Tesla coil can produce comparatively higher voltages than other artificial sources of high-voltage discharges or electrostatic machines. The voltage across the Tesla coil was 50 kV. After that two plants were taken and were was kept at a distance of 15 cm and 50 cm respectively from the Tesla coil respectively. Three leaves from each plant was taken to study the effect of high voltage on it. On each of the leaves two surface electrodes were attached at a distance of 6.5 cm in between them. The high voltage experimental setup can be explained in the Fig. 3. Then these plants were kept in Faraday cage along with the Tesla coil to study the effect of high voltage. Faraday cage is a metallic enclosure that prevents the entry or escape of high voltages or electromagnetic field. It is an enclosure formed by conducting materials which blocks external effect of high voltages. For best performance, the cage should be directly connected to an earth ground. A heavy duty Faraday cage can shield against direct lightning strikes. The exposed leaf was kept under natural environmental condition for ten days i.e. the control variables like temperature, humidity, sun light were maintained same for all observations. The plant was watered every day. The leaf was observed with respect to change in physical properties like texture, colour and growth. The texture and colour was observed by taking images of the leaf and the growth was recorded by a thick thread measured from the base of the leaf just above the root to the tip of the leaf. The setup to record the growth of the leaf is shown in Fig. 4.

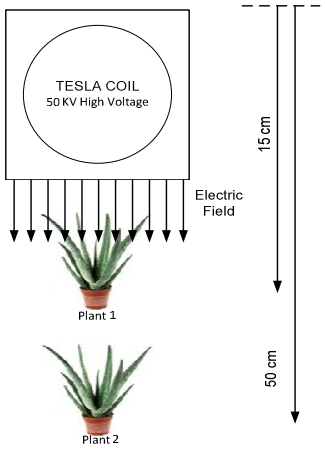

Fig. 3 Block diagram of the experiment

Fig. 4 Setup to record growth of Aloe vera leaves

4. RESULTS AND DISCUSSIONS

Investigations were carried out using both normal *Aloe vera* leaves and high voltage exposed leaves for the determination of the change in texture, colour, and growth. Two different plants were taken to study the effect of high voltages on them. Three leaves from each plant were selected to study the change in the texture, colour, and growth. One leaf from each plant was unexposed to high voltage radiations by wrapping it with the thin aluminum foil. The texture of the leaf was hard and the colour was natural green. The length of the leaf of Plant 1 was measured and was found to be 30 cm on the 1st day without exposure. Similarly, the length of the leaf of Plant 2 was measured with and without exposure and it was found to be 30.5 cm on 1st day with and without exposure to high voltage. The analysis of the images shows that the texture of the leaf does not have any noticeable effect but the colour of the leaf was slightly faded to yellow green from natural green and the length of the leaf which was at a distance of 50 cm got shirked at the tip by 1 cm while the leaves which were unexposed to high voltage did not showed any change in it. Also the distance of the leaf from the Tesla coil has a significant effect on the leaves as the leaf nearer to the coil L1 showed more damage as compared to the other leaves away from it. Table I shows texture, colour, growth, and damage of *Aloe vera* leaves exposed to high voltages. Here D0 corresponds to leaves before exposure to high voltages. It was also observed that the exposed leaves had died out after few days of the exposure than the unexposed leaves, leading to reduction in the growth of the plants.

Table I. Texture, colour, and growth of Aloe vera leaves before and after exposure to high voltages.

DAY	PARAMETER	PLANT 1 L1	PLANT 1 L2	PLANT 1 L3 (UNEXPOSED)	PLANT 2 L1	PLANT 2 L2	PLANT 2 L3 (UNEXPOSED)
D0	TEXTURE	HARD	HARD	HARD	HARD	HARD	HARD
	COLOUR	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN
	LENGTH	30 CM	31 CM	28 CM	29 CM	30.5 CM	28.5 CM
	DAMAGE	NIL	NIL	NIL	NIL	NIL	NIL
D1	TEXTURE	HARD	HARD	HARD	HARD	HARD	HARD
	COLOUR	GREEN	GREEN	GREEN	GREEN	GREEN	GREEN
	GROWTH	29CM	31 CM	28 CM	28 CM	30.5 CM	28.5 CM
	DAMAGE	LIGHT BLACK SPOTS	NIL	NIL	ONE BIG AND ONE SMALL BLACK SPOT	TIP OF LEAF STARTED SHRINKING	NIL
D3	TEXTURE	HARD	HARD	HARD	HARD	HARD	HARD
	COLOUR	YELLOW GREEN	GREEN	GREEN	YELLOW GREEN	GREEN	GREEN
	GROWTH	29 CM	31 CM	28 CM	28 CM	30 CM	28.5 CM
	DAMAGE	DARK BLACK SPOTS	NIL	NIL	PROMINENT BLACK SPOTS	NIL	NIL
D5	TEXTURE	HARD	HARD	HARD	HARD	HARD	HARD
	COLOUR	YELLOW GREEN	YELLOW GREEN (STARTED FADING)	GREEN	YELLOW GREEN	YELLOW GREEN	YELLOW GREEN
	GROWTH	28 CM	31 CM	28 CM	29 CM	30 CM	28.5 CM
	DAMAGE	DARK BLACK SPOTS	VERY SMALL BLACK SPOTS	NIL	DARK BLACK SPOTS	TIP OF THE LEAF SHRINKED FURTHER	NIL
D7	TEXTURE	HARD	HARD	HARD	HARD	HARD	HARD
	COLOUR	YELLOW (FADED)	YELLOW	STARTED TO FADE YELLOW.		YELLOW	YELLOW
	GROWTH	15 CM	31 CM	28 CM	29 CM	30 CM	28.5 CM
	DAMAGE	TOTALLY DAMAGED AND LEAF FALLEN OFF	SMALL BLACK SPOTS	NIL	NIL		

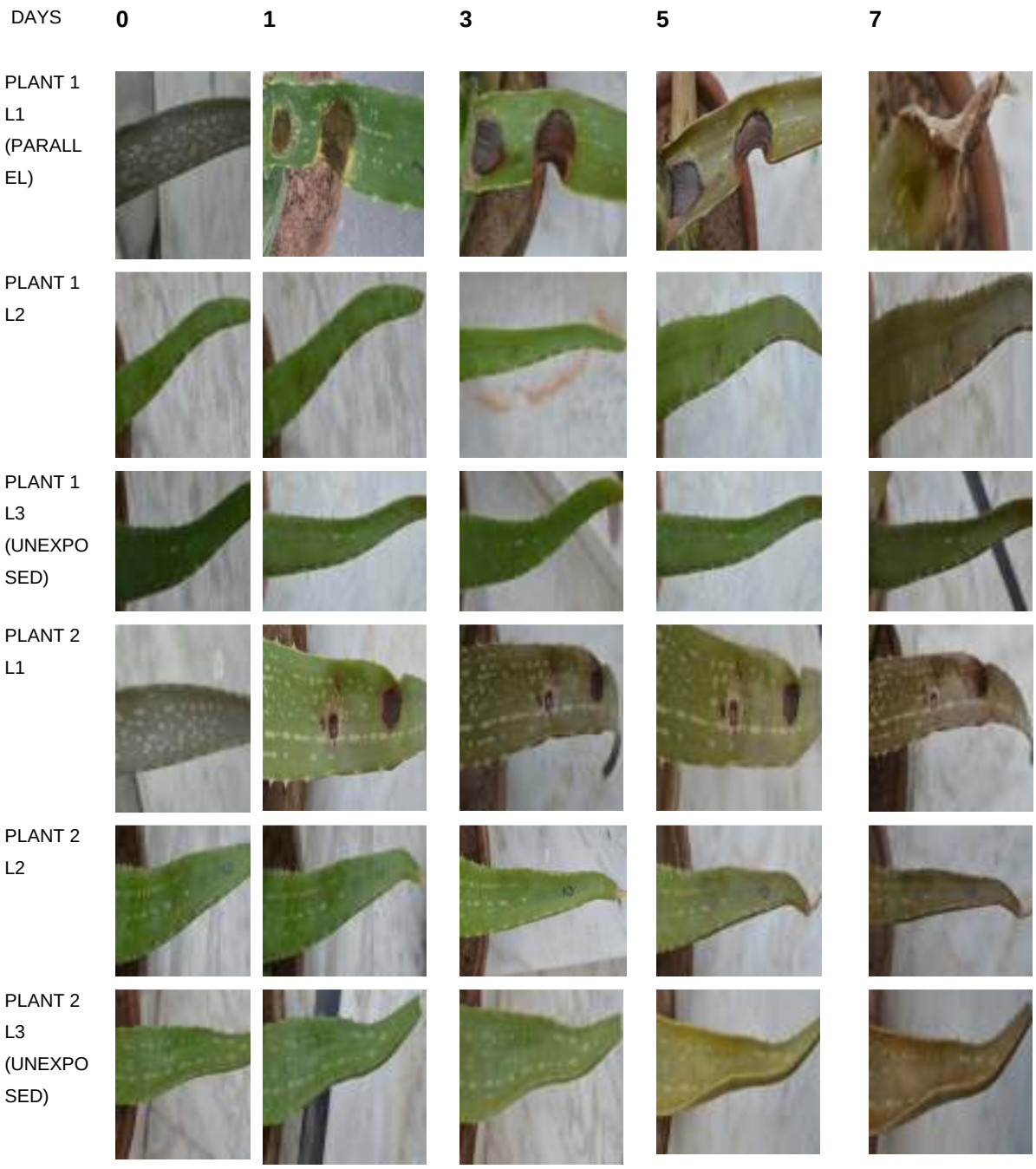

Fig. 7 Images of Aloe vera leaves taken on 1st, 3rd, 5th and 7th day.

5. CONCLUSIONS

The experiments were conducted to study the effect of high voltage on *Aloe vera* leaves, which is an important plant because of its useful properties and uses in dermatology. The analysis of the results showed that high voltage has a definite adverse effect on the *Aloe vera* leaves and growth. The distance of the leaf from the Tesla coil also plays an important role as the leaf nearer to the coil showed more damage as compared to the other which was

far away from it. It was also observed that with passage of time, the recovery process of the plant tries to minimize the damage. If the level of the exposure is very high, the damage is irreversible. Some colour changes were also observed in the unexposed leaves. This may be due to the wrapping of the leaves, which stops the sun light in the wrapped portion of the leaves. This type of damage is easily recovered within 2-3 days. And finally, it is also observed that the exposed leaves have died out after few days of the exposure, leading to reduction in the growth of the plants or agricultural yield.

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