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Review Article

MIMOSA PUDICA L. A SENSITIVE PLANT

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ABSTRACT

Mimosa pudica is the herb that shows sensation on touch. There are various theories given on this activity like potassium migrates from the motor cell to intercellular spaces upon stimulation of *Mimosa.* Researches suggested that potassium may be an osmotic agent which could account for the pulvinar cell turgor decrease during the seismonastic reaction. It's found that the efflux of potassium from the pulvinar cells of *Mimosa* increases substantially during the seismonastic response by increasing potassium concentrations in the external solution, a decrease in potential was reported. The chemical sensitivity is also reported.

Keyword : *Mimosa pudica*, Lajwanti, Physiological and Metabolic Mechanisms.

INTRODUCTION

Mimosa pudica is derived from the word "mimic" means to allude, to sensitivity of leaves and "pudica" means bashful, retiring or shrinking. Mimosa, mimics the animal sensitivity that is sensitivity to light, time of day, gravity or like sundew drosera which react to the contact of insect. So mimosa is known as sensitive plant, humble plant, shame plant, sleeping grass, touch me not, lajjalu in ayurveda, namaskari in sanskrit. *Mimosa pudica* is indoor plant having fascinating behavior[1].

General description

Sensitive plant is a small, prostrate or ascending, short-lived shrub. Some authors consider it a woody herb. It may reach 1 m in height when supported on other vegetation and more than 2 m in horizontal extension. The reddish-brown, woody stems are sparsely or densely armed with curved prickles. The root system consists of a taproot and extensive fibrous roots with nodules. The twigs are fine and flexible and support leaves with one or two pairs of pinnae and 15 to 25 pairs of oblong leaflets 3 to 12 mm long. The flowers are pink and clustered in globose heads. The legume (pod) is linear-oblong, 1.0 to 1.5 cm long and 3 mm broad, with bristles on the margins. The pods are born in groups and contain two to four brown seeds[9,13]. Sensitive plant is also known as dorme dorme, dormidera, humble plant, marie-honte, mayhont, morivivi, honteuse, sleeping grass, ti mawi, touch-me-not, and many other names[8,9]. The great curiosity of sensitive plant and the source of most of its names is that when touched, it quickly folds its leaflets and pinnae and droops downward at the petiole attachment. The leaves also droop at night, and when exposed to rain or excessive heat. This response may be defenses against herbivorous insects, leaching loss of nutrients, or desiccation

Range

Sensitive plant was first described from Brazil[13] and is perhaps native to much or all of the New World Tropics[11]. Today, it is pantropical in its distribution[9].

Ecology

Sensitive plant grows on most well-drained soils, even scalped or eroded subsoils and soils with low nutrient concentrations. It requires disturbed soils to establish itself. Repeated burning may encourage its spread in pastures[18]. Sensitive plant is shade intolerant and does not compete with tall vegetation or grow under forest canopies. The species' roots produce carbon disulfide, which selectively inhibits colonization of the rhizosphere by mycorrhizal and pathogenic fungi[7]. This plant occurs in croplands, orchards, pastures, mowed areas, roadsides, and areas disturbed by construction. It may grow as a single plant or in tangled thickets. Sensitive plant grows from near sea level up to 1,300 m in elevation[9] and in areas with annual precipitations from about 1000 to over 2000 mm. The species is frost-sensitive.

Reproduction

In the Philippines, sensitive plant flowers all year and may produce as many as 675 seeds per plant per year[8]. The species is both wind[5] and bee-pollinated[14]. Air-dry seeds from Puerto Rico weighed an average of 0.0065 ± 0.0002 g/seed. With no pretreatment, seeds from this collection began germinating 7 days after sowing and reached a maximum germination of 17 percent by 94 days. In another test, 80 percent germination was obtained in 4 weeks with alternating temperatures of 20 and 40 °C[7]. Bui recommends a pretreatment with hot water followed by overnight soaking. Germination is epigeal. Seeds are transported by means of the bristles on the edges of their pods that cling to clothing or to the fur of mammals. Most nursery and home propagation is done using seeds, but summer cuttings may also be used[3].

Growth and management

In Puerto Rico, sensitive plants live 1 to 2 years. Seedlings grow slowly for 2 or 3 months and then accelerate, reaching 0.5 to 2 m of extension at the end of the first year. Growth of plants that survive into the second year is much slower. Potted and field-grown individuals are sensitive to overwatering[3]. This species has been successfully tested and recommended for erosion control plantings using potted material at a spacing of 60 x 60 cm[5].

Benefits and detriments

Sensitive plant has become a serious weed in fields of corn, soybeans, tomatoes, upland rice, cotton, bananas, sugarcane, coffee, oil palms, papayas, coconuts, and rubber in many tropical areas. It is particularly troublesome where hand pulling of weed is practiced. The species may be controlled by a number of commercial broad-leaf herbicides[3]. On the other hand, it is tolerated or valued as a forage plant in pastures[8,18]. In fact, sheep grazing is reported to control sensitive plant in pastures and plantations[16]. The root nodules have been shown to fix nitrogen[15]. Thickets of sensitive plant may be a fire hazard when dry[13]. The seeds and other plant parts of sensitive plant contain mimonsine, an amino acid that is known to cause hair loss and depressed growth in mammals[2]. An unlikely large dose is necessary to cause problems, however. The pollen is important to honeybees in the Philippines[14]. Extracts of the plant have been shown in scientific trials to be a moderate diuretic, depress duodenal contractions similar to atropine sulphone, promote regeneration of nerves, and reduce menorrhagia[14]. Anitdepressant activity has been demonstrated in humans[11]. Root extracts are reported to be a strong emetic[7].

Physiological mechanisms

The parenchymatous motor cells in the pulvini are the units of contractibility in the response[8]. It is generally accepted that the movements are caused by the diminishing or sudden loss of turgor in the motor cells. These vacuoles contract upon stimulation, presumably brought about by loss of various salts in the cell, and recovery (expansion) is brought about by uptake of the salt-rich fluid by the vacuoles It was demonstrated that this intracellular fluid or cell sap, which will be released or expelled from the cut surface of the primary pulvinus under stimulation, is rich in potassium, tannins, and other substances.[9] The tannin substances, whose function in plants is not understood at present in the tannin vacuole, which is located inside the central vacuole of the motor cells, are also found in the intercellular spaces inferred from these results that some of the cell constituents dissolved in the intracellular fluid or cell sap (presumably in vacuoles) are released to the exterior during stimulation, which may result in a decrease of motor cell turgor. Axon conductance in animals is dependent on increases in permeability to ions, and it may occur also in the motor cells of *Mimosa.* As illustrated above, exchange of ionic salts does occur between intra- and extra-cellular areas upon stimulation. It appears that unique to *Mimosa* are specialized cells in the outer phloem and inner phloem that may serve as a pathway of conduction.[10] Two types of sieve tube cells constitute the outer phloem. The first is a much wider and shorter type (where the nucleus disintegrates early during ontogenetic differentiation), and the second is a longer and narrower type (having a persistent nucleus with one or two nucleoli and cytoplasm). It is generally accepted that the normal function of the sieve tube element is for the transport of solutes along the longitudinal axis of the plant. The "conduction pathway" of *Mimosa* similar to an animal nerve, and the transmission of impulses follows similar patterns, therefore it is easy to see why these specialized phloem cells contain such persistent cellular components. These cells have resting membrane potential of -160mV on stimulation membrane of cell get polarized which is characteristic to human cell. Velocity of action potential is found to be 20 mm/sec in petioles and 41 mm/sec in pulvini. On repeated stimulation action potential show diminished activity because of rise in potential threshold.

Metabolic mechanisms

It was showed that potassium migrates from the motor cell to intercellular spaces upon stimulation of *Mimosa*[23] Researches suggested that potassium may be an osmotic agent which could account for the pulvinar cell turgor decrease during the seismonastic reaction.[20] It’s found that the efflux of potassium from the pulvinar cells of *Mimosa* increases substantially during the seismonastic response by increasing potassium concentrations in the external solution, a decrease in potential was reported. It was also found that potassium permeability of cellular membrane decreased with low external potassium concentrations. Calcium ions, mainly located in the tannin vacuole (inside the central vacuole), are when released upon stimulation bind with proteins and alter their conformation, the calcium which leaves the tannin vacuole may form a complex with the fibrils and, thus can alter their conformation. This action may promote vacuole contraction[20].

ATP-ATPase

The adenosine triphosphate (ATP) contents in the motor organs, such as the primary pulvinus of *Mimosa,* is three to four times greater than those in the no movable portions of the plant. Electrical and mechanical activity of the contractile vacuole are associated with increased leakage of ions through the plasma membrane, and concomitantly, increased ATPase activity is observed[24]. It was assumed that in *Mimosa* such an ATP-ATPase-calcium system may activate the filaments or contractile proteins which occur in the vacuolar cytoplasm, and lead to pulvinus contraction Thus on the basis of this and previous evidence, common mechanism between plant and animal contractile movement can be said to exist. It was found that stomatal opening ATP in the guard cells is involved in the uptake of this ion. It might be proposed that an ATP-ATPase system may be involved in the active accumulation of the salts or ions, and take part in the recovery process of the motor ceils in *Mimosa*[25].

Neurohumors

It was postulated that the neurohumor acetylcholine might mediate movement in *Mimosa.* Since no acetylcholine is present in *Mimosa* two amines, serotonin and norepinephrine, were assayed in various "sensitive" plants[26]. *Mimosa* contained only norepinephrine. In *Mimosa,* norepinephrine is six fold higher in the pulvini as compared to the petiole. But the role of norepinephrine in *Mimosa* is not known, till now.

Chemical sensitivity

Wallace studied effect of certain animal anesthetics was ascertained on *Mimosa* .He studied the action of ether, acetylene, chloroform, and ethylene on the nyctinastic response of *Mimosa.*[27] Only ether and acetylene had an inhibitory effect on such responses. striking is that the concentration of ether necessary to prevent the evening closing was different from that necessary to prevent the morning opening (the latter requiring approximately twice the concentration of the first; that is, 7 and 14% respectively). On seismonastic response It was found that ether vapor in concentrations from 13 to 25% (to volume of air) prevented the movement of leaflets and petioles in from 10 to 45 min after exposure and regained I few minutes. Methyl alcohol decreases plant sensitivity but ethyl alcohol. Applewhite determined the effect of chemical sensitivity on *Spirostomum* and *Mimosa to* see whether chemical were exerting specific effect on response sensitivity or induce broad general effect. They show similar result expect for picrotoxin.[28]

Theoretical interpretations

Because of evolution of plant and animal are similar they show similarity in metabolic and physiological processes. A pathway of conduction in mimosa is exhibited by electrical action potential of same quality as a nerve pathway. This conduction pathway leads to motor organs that exhibit cellular contraction and behavioral change.[20] The system is energy dependent and involves membrane permeability change and relies on monovalent cation and ion exchange between intracellular and extracellular area. The stimulating hormone but no classical neurotransmitters seem to have the same effect. Glutamate and aspartate are considered to be excitatory transmitters and 7-aminobutyric acid, glycine, taurine, and alanine are thought to be inhibitory neurotransmitters. Contractile protein or fibrils in the vacuole membrane may be activated by an ATP-ATPase system and calcium efflux, which in turn is metabolically activated, presumably through ions or amino acids, by the initial stimulus. The movements for contraction are chain like in mimosa like that of animal[21].

These studies represent investigations to determine ionic and hormonal mechanisms responsible for motor movements[22]. Mimosine, an alkaloid found in these species, which was proposed in these studies to be in part responsible for movement, was administered *in rico.* Plants were also treated with agents known to disrupt either K + efflux (tetraethylammoniumchloride), Na +,K + -adenosine triphosphatase (ouabaiuk or Ca'-~ influx (verapamil) to determine the ionic species involved in the tactile response of the *Mimosu.* Additionally, the alpha and beta adrenergic receptor blocking agents were also used. All the ionic blockers employed produced a slower response movement, as well as growth retardation. Phentolamine inhibited leaflet closing, but propranolol had no effect on leaflet growth or movement. Phentolamine was found to antagonize directly the effect of mimosine on movement in *Mimosa pudica.* Toriyama showed that tannin vacuoles contracted and later expanded as the plant leaflets closed from tactile stimulation and later re-opened[20]. It was has observed that if young plants of *Mimosa pudica* are stimulated by gentle mechanical means once or twice daily, elongation as well as flower bud production is significantly retarded. He named this response thigmomorphogenesis. The plant growth hormones, indolacetic acid (IAA) and gibberellic acid (GA3), caused the leaves to open faster and close more slowly.

There appears to be a time-dependent reduction in tannin vacuole diameter (r = 0.984} which follows a first order kinetics relationship. This may suggest atrophic effect of light to regulate tannin vacuole size. High concentrations of mimosine tended to produce a more rapid leaflet tactile response in the plant, which suggests a possible role of the alkaloid in *Mimosa pudica* responses. It was found that the tannin vacuoles of plants given mimosine had a larger mean diameter (6.3/~m) than the control plant (4.6 l~m)[20].

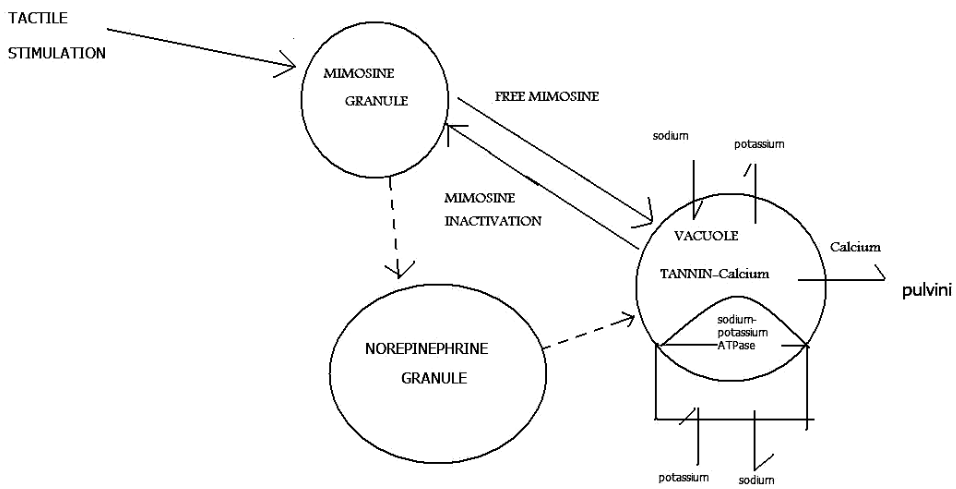

Fig. 1 : Schematic representation of a proposed molecular model for leaflet dosing.

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