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*Short Communication*

# Development of flower galls in *Prosopis cineraria* trees of Rajasthan

**R. Raj Bhansali**

*Division of Plant Improvement, Propagation and Pest Management, Central Arid Zone Research Institute, Jodhpur-34003, India, E-mail: rikhab51@gmail.com*

Plant galls are abnormal growths caused by stimulation of plant cells with the interaction by the nematodes, fungus, bacteria, mites, insect etc. (2, 24, 26). Galls can be formed in the lamina and petioles of leaves, twigs, buds, flowers or on the roots. Each type of gall-producer is specific to a particular kind of plant. The gall is a unique example of a plant-pest relationship causing harmful effects such as hypertrophies and tumorous (neoplasmic) outgrowths as well as beneficial effect to the plants in fixing nitrogen by bacteria, actinomycetes and blue-green algae. Damage by the plant galls is not only the aesthetic problem but also cause serious problems to the many host plants including *Prosopis cineraria, P. glandulosa* var. *torreyana* and *P. velutina* (7, 8, 11, 12, 17). In *P. cineraria*, four distinct types of galls have been reported by various workers (12, 13, 21). Galls damage the stem branches, rachis, leaflets and flowers portions of the *Prosopis* tree.

*Prosopis cineraria* (Khejri) is most valued food and top feed agroforestry species of arid areas of western Rajasthan. It provides nutritious and highly palatable green as well as dry fodder to the desert livestock (1, 3, 17). Green leaves of lopped tree are called as *Loong, consumed by* the camels, cattle, sheep and goats. Green as well as dry pods (*sangri* and *khokha*) are used as famine food by the local inhabitants (6). Recently production of pods from *P. cineraria* is reduced tremendously due to the severe attack of pest and diseases. Various insects and diseases have been reported causing damage to the individual plant parts to the whole tree (12, 13, 18, 19). A world-wide check-list comprising 153 phytophagous insect and non-insect pests of *P. cineraria* and *P. juliflora* has been documented (7, 8, 11, 18, 27-30). In last decade, sudden drying of the *P. cineraria* due to *Ganoderma lucidum* in Rajasthan state has been emerged as most serious threat for its survival (16, 18). Similarly, flower galls and bruchids also responsible in loss of production of pods and seeds (12, 29). Galls cause considerable loss to the pod yield. Moreover, nature of flower gall is not fully understood and no remedial measure is available. Therefore, the present study was conducted to identify the organ of flower involved in gall development and its impact on pod development in *P. cineraria* tree. Studies were conducted on more than ten unlopped *P. cineraria* adult trees during flowering period from April-August 2012. Normal and gall infested trees were selected for the study of flower galls. Flower galls and pollen grains were examined microscopically for the changes in their reproductive parts of *P. cineraria*. The general ap-

pearance of gall infested trees was sick having large number of hanging unorganized and deformed green galls during summer season (Fig. 1 & 2). They were mostly developed in bunches on flower spikes. As soon as flowering occurred in *P. cineraria* lot of insects for the pollination began visiting to the trees. Inflorescences having small green flower buds were started appearing on trees in the month of April to May. During subsequent development and opening of flower buds, small protuberances (galls) were found near the bases of flowers attached to inflorescence spikes (Fig. 1). Pollen grains were normal in shape and viable but failed to participate in fertilization process. This resulted in abnormal ovaries without pod and seed formation.

At initial stage of gall development, pale yellow flowers became green at the bases and size of ovary started bulging. Such gall infested ovaries were found oval and bigger than normal 1-2 mm size. Pedunculate spiked flowers (3-4 flowers / inflorescence) were found abnormal at bases (Fig. 4). Development of galls was observed within 20-25 days after flowering. However, cup-shaped, obscurely toothed, truncate calyx and pale yellow petals were observed normal. Stamens were free, tipped with deciduous glands from which some blackening was observed. Ovary galls were seen during the complete flowering season (April-July). In no case abnormal ovaries contained ovules and seeds. Galls were of various shapes including round, oblong, egg-shaped, spindle-shaped and vase-shaped (Fig. 4 & 5). Thin sections of developing galls have revealed the hypertrophy followed by hyperplasia of cells. The globular shaped galls turned to multi-lobbed (up to 8 lobes) structures which were also sometimes wrinkled and completely unorganized (Fig. 6). Maxi-

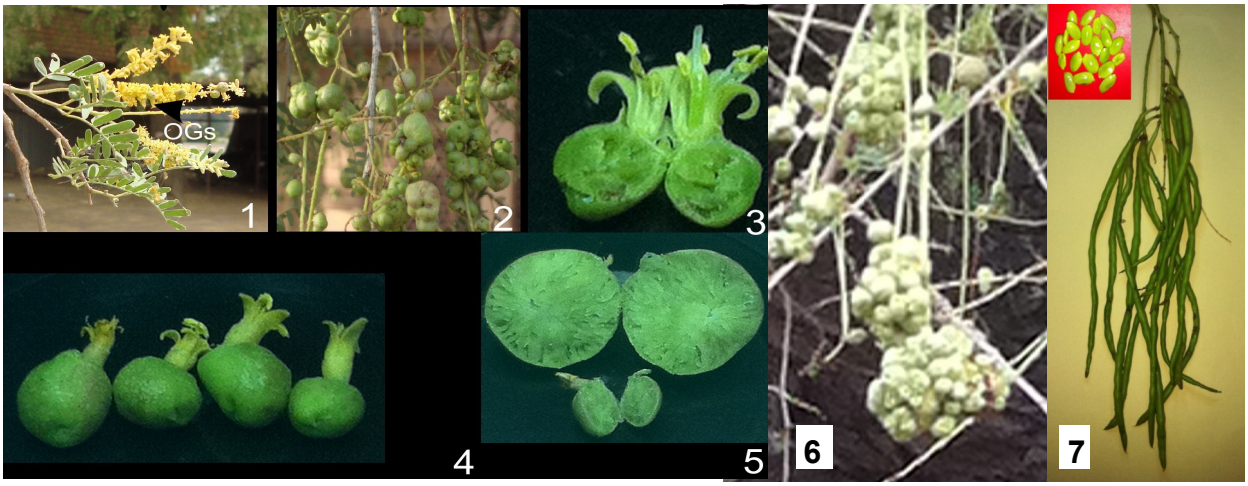


**Fig 1-7. 1**. Ovary galls on Inflorescence spikes of *P. cineraria*, **2**. Inflorescence completely devoid of flowers and pods, **3**. Unfertilized fibrous ovaries, **4**. Flowers with unorganized growth of ovaries, **5**. Transverse sections of green ovary galls having compact and fibrous strands, **6**. Multi-lobbed abnormal ovary galls, and **7.** Pods and seeds of *P. cineraria* normal ovary

mum galls on the rachis of inflorescence were recorded at the lower portion. In heavily infested trees 1-5 galls per inflorescence were noticed. These galls were initially soft but on maturation became firm to hard at outer shell when dried (Fig. 5). They were filled with fibrous or spongy tissues and were attached to the inflorescence stick (Fig. 3). Average fresh weight of the gall per ovary was 3.2g, ranging from 0.75 to 7g. Galls increased their weight and size considerably up to June period. Colour of galls changed from green to brown on maturation during end of June. Galls varied in size from few mm to 34 mm in diameter. These galls remained on the trees up to June-July (Fig. 2) and started falling with strong wind on maturation during month of July. Infested inflorescence spikes were completely devoid of pods or 2-3 pods were seen only. However, flowers on normal inflorescence ranged from 41-72 per spike. Average pods per inflorescence were 12.1. These pods were slender, pendulous, cylindrical, turgid, exocarp coriaceous, mesocarp pulpy and endocarp papery. In each pod, 10-15 seeds, oblong and compressed were recorded. Pods were 10.5-19.7 cm long and 4.4-6.8 mm broad (Fig. 7). With the onset of rains, almost all the ovary galls dropped on the ground and by the end of the August, trees were completely free from the galls. At this stage, trees appeared as if there was no gall earlier. Present study suggested that among the all flower parts, only ovary has participated in gall development whereas other parts such as calyx, corolla and stamens were normal. The increase in the growth of the ovary galls was in between 2-3 weeks. Chlorophyll content in the gall tissues decreased as the galls turned from green to yellow and then to brown. Various workers have reported that the abnormal growths within the galls are associated with the various biochemical changes in the levels of carbohydrates, proteins, nucleic acids, phenols, auxin hormone (IAA) and oxidizing enzymes (4, 5, 20-22). In case of the stem gall of *P. cineraria* induced by an unknown chalcid, the immature stem gall tissues showed almost two fold increases in the protein content. The mature gall tissues showed a very high increase in the proline content compared to the immature gall tissues indicating a stressed condition of the gall tissues. These biochemical changes altered the differentiation processes in the host tissues by proliferation of parenchyma (25). In ovary gall formation, association of more than one insect species (*Assura albicostalis*, *Anarsia triaenota*, *Eucosma lioplintha* and *Ascalenia* sp.) has been reported (14, 15). But their participation in making galls has not been demonstrated. However, Mani (10) has also reported similar flower galls in *P. juliflora* due to the mites. Therefore, still actual insect causing flower galls in *P. cineraria* is not clear and needs further investigations. Present study suggests that soft green galls when turned hard brown and become over weight, they are detached due to the heavy load and high wind speed during summers. Parihar (13) emphasized that during this period, pupae are released from the detached old brown galls. Internal spongy tissue also gets compact and woody. In severely gall affected trees pods yield was drastically reduced

from 2.5 kg to 120 gms only. Normally in healthy trees 4-5 kg pods are produced per plant (23). Though pod yield is significantly correlated with diameter at breast height of the tree but nearly 1.4 quintals of pods/ha with a variation of 10.7 % in dry locations has been reported (23). Kumar & Ahmed (7 & 8) has reported that in unlopped trees, gall formation was 49.5% of inflorescence and resultant pod production was as minimum as 3.37% where as in lopped trees gall formation reduced considerably (5.56%) and there by pod produced 13.3% more. As the flowers of *P. cineraria* are entomophilous and depend on the pollinator insects for the pod formation and seed setting (14). But there are some unknown insects actively participate in gall formation and act as a pest. In fact, these gall forming insects are attracted towards the flowers during flowering season in summers and reduce the pod and seed production by converting ovary tissues in galls. Present study indicated that flower galls are completely made up of ovary tissues. Moreover, at present little is known about the chemical nature of the gall inducing secretion. However, Ramani *et al.* (22) and Gupta (5) have reported that complex substance rich in nucleic acid and protein produced during the interaction of insect with host tissues might be responsible for the development of galls. It appears that actively growing cells of ovary in *P. cineraria* and secretion insect interacted closely in forming abnormal growths. Moreover, further research in elucidating the chemical nature of the stimuli will help in complete understanding of ovary galls of *P. cineraria*.

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