The Bioscan 5(1) : 81 - 83, 2010
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES

ANT POLLINATION OF AN INVASIVE NON-NATIVE WEED, *EUPHORBIA GENICULATA* ORTEGA IN NORTH WEST HIMALAYA (INDIA)

MOHD. ARAF, SATISH KUMAR* AND I. A. HAMAL
Department of Botany, University of Jammu, Jammu -180 006, INDIA
E-mail: mohd.araf@gmail.com

KEY WORDS
Andromonoecious
Cyathium
Euphorbia
Geitonogamy
Pollinators

Received on :
10.10.2009
Accepted on :
21.12.2009

***Corresponding author**

ABSTRACT
Euphorbia geniculata is an andromonoecious, self-compatible weed with higher seed set, viability and germination. The species is visited by hymenopterans, lepidopteron and dipterans. Out of hymenopterans, necterivorus ant (*Camponotus compressus*) comprised largest group (52.6 %). However at two study sites, it is exclusive visitor of the plant. Pollen exposed to ants revealed no significant reduction in viability. Seed set is limited by pollen availability, which is substantiated mainly by ants in this invasive weed.

INTRODUCTION

Invasive species often require mutualistic relationship to successfully invade new area and insect pollination is an example of mutualism that increases seed set (Jesse *et al*., 2006; Morale and Aizen, 2002, 2006). This guarantees the maintenance and eventual spread of populations (Parker, 1997). Many ecosystems are becoming more susceptible to invasion by exotic plants due to numerous mutualistic partners. Incorporating perspective on mutualism in screening protocols improve our ability to predict whether given plant is able to invades a particular habitat (Richardson *et al*., 2000).

Euphorbia geniculata is a troublesome weed of Neotropical origin, produces upto four generations per year (Dafni and Karneili 1979). With higher regeneration potential and seed set (Kigel *et al.,* 1992) it is a major threat to the local flora. In India the species was introduced in 19th centaury (Mayurnanthan, 1934) and now it is major weed of economically important crops like cotton, soybean (Mishra and Singh 2000, 2003, Mishra *et al*., 2003), coffee (Mayurnanthan 1934), maize, fodder crops as well as roadside weed in North West Himalaya. Inspite of its invasive potential, little is known about its reproductive strategies (Kigel *et al*., 1992). It is an annual herb characterized by the cyathium, an inflorescence of many reduced male flowers and single female flower and enclosed by a hypanthium like involucre provided with glands. The cyathia are aggregated terminally in umbel like structures. Flowering commences in June and ends in November. The plant is andromonoecious, self compatible and male cyathia bloom earlier thus pollen is available prior to female phase in hermaphrodite cyathia, the later being protogynous. Nectar secretion coincides with anther dehiscence in both types of cyathia. In *Euphorbia* spp. nectar is fructose, glucose and sucrose rich (Papp, 2004). Ants are considered as a common floral visitor, some floral compounds are especially attractive to ants (Koptur and Truong, 1998) but their effect on reproductive success has least attracted the pollination biologists. Most of the studies on ant-plant association revealed that ants lower the reproductive fitness which is attributed to the secretions from their bodies that lower pollen viability (Beattie *et al.,* 1984, 1986; Hull and Beattie, 1988; Wagner, 2000). However, the vulnerability of pollen to ant secretions depends upon the species involved and duration of attachment (Sanderson and Wright, 1989). Few studies have demonstrated the role of ants as pollinators (Hickman, 1974; Galen, 1982; Gomez and Zamora, 1992; Ramsay, 1995; Gomez *et al*., 1996; Raju and Ezardanam, 2002, Sharma *et al.,* 2009). The ant (*Camponotus compressus*) as floral visitor of many species has been reported from different regions of India (Raju and Ezardanam, 2002; Agarwal and Rastogi, 2008, Sharma *et al.,* 2009). In the present study the consequences of ant-plant interaction have been discussed.

MATERIALS AND METHODS

The studies were carried out at three sites in North West Himalaya along a transect of 252 km. from subtropical to temperate regions (Jammu -74º 55´ E., 32º 45´ N, Rajouri -

74º 45´ E., 33 º 10´ N and Poonch -73º 58´ E and 33º 25´ N). from 2005-2008 during June to September

For quantification of visitor's frequency, visual observations were recorded from 0800-1800 hours at Jammu and Poonch, 0800-1500 hours at Rajouri on three sunny days. Besides census (15 days, n = 150 plants) for ant visitation were conducted evenly through morning till evening during flowering period(June-September) to determine their effectiveness as visitors where one minute observation for number of ants per plant, time spent on one cyathia and distance traveled in between the cyathia of same plant was also recorded. Pollen load on ants (n = 24) was assessed by counting the number of pollen grain attached with their body parts by scrubbing over with a piece of petroleum jelly and then melting it on glass slide (Beattie 1971). In order to determine the effect of secretions of ants on pollen viability, ants were kept in a container with cyathia in male phase for 8 hours along with control treatment (cyathia during male phase with dehisced anthers were kept in container for 8 hours). The pollen grains were removed from ants and control treatment thus viability was determined by tetrazolium (TTC 1%) solution. The role of visitors on seed set was assessed by (a) emasculating and bagging individual cyathium (n = 30), (b) cyathia were bagged collectively for geitonogamy (n = 20), (c) ants were excluded but open to flying insects (n = 20) and (d) open pollination (ants + flying insects, n = 20).

RESULTS AND DISCUSSION

Out of the total insect catch at Jammu (n = 515), Hymenopterans (n = 324) comprised the largest order followed by Lepidopetarns (n = 151) and Dipterans (n = 40). Of the Hymenopterans, necterivorus ant (*Camponotus compressus*) is a frequent visitor, (Fig. 1) it comprised 52.6 % of total insect visitors and the peak period of activity occurs between 1000 -1700 hrs (88.75%). However at Rajouri and Poonch, the species is visited only by *Camponotus compressus* and in some areas *Meramoplus bicolor* also visit the cyathia.

Figure 1: Camponotus compressus foraging cyathia of *Euphorbia geniculata*

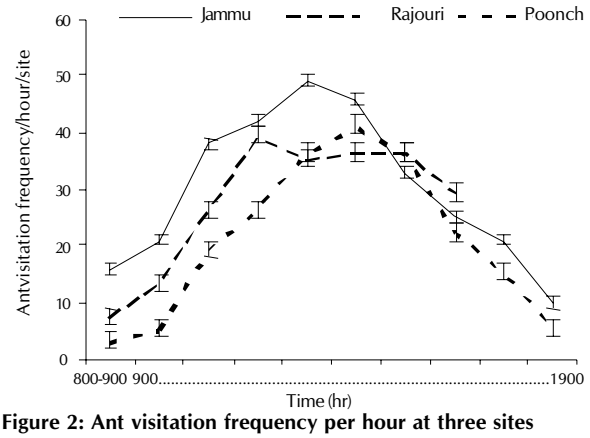

Figure 2: Ant visitation frequency per hour at three sites

The abundance of ants per plant is 4.46 ± 0.2 (Mean ± SE). In one cluster of cyathia, individual ant foraged 9.07 ± 0.3 cyathia and the distance travelled in between the cyathia of same group averages 2.7 ± 0.08 cm. On an average, an ant spends 5.9 ± 0.3 seconds on one cyathium. Pollen load per ant is 48.91 ± 6.26. Pollen exposed to ants revealed no significant reduction in viability (ANOVA; $F = 0.83$ $P = 0.37$).

Pollination experiments revealed that seed set occurs even after emasculation and bagging of individual cyathium (32.2 ± 8.22 %). Exclusion of ants only (57.9 ± 2.77%) and all insects (44.1 ± 4.33%) result in low seed set, whereas seed set in plants open to all visitors (78.21 ± 2.09%) is higher Fig. 3.

In *Euphorbia geniculata,* the ant represents predominant or exclusive visitor group. Being social insects, ants regularly visit the foraging site as long as they are rewarded (Hölldobler and Wilson, 1990) and the interactions are characterized by low expenditure of energy by both ant and plant (Hickman, 1974). Present observations revealed that ants foraging on the floral heads transport pollen within few minutes because of the quick movement between aggregated cyathia at different developmental stages. The ants are rewarded in form of copious nectar available throughout flowering period. The number of cyathia visited per plant remains fairly large throughout blooming which make them potent pollinators, at least for geitonogamy. Moreover, pollen viability is not affected possibly due to lack of metapleural glands in genus

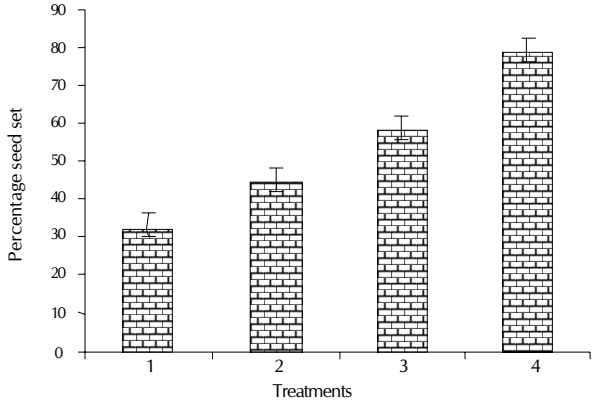

Figure 3: Seed set after experimental manipulations with cyathia (Treatments, 1-emasulated + bagged; 2-Cyathia groups bagged for geitonogamy; 3-ant exclusion; 4- open to flying insects + ants)

Camponotus (Hölldobler and Engel-Siegel, 1984; Gomez, *et al*., 1995). This mutualistic association with ants is obligatory for invasive weeds to colonize new areas as flying insects are least attracted due to lack of visual attractants.

ACKNOWLEDGEMENT

Mohd. Araf acknowledges the fellowship (SRF) received from CSIR, New Delhi.

REFERENCES

Agarwal, M.V. and Rastogi, N. 2008. Role of repellents in the regulations of flower visits of extrafloral nectary-visiting in an Indian crop plant. *Ecological Entomology*. **33:** 59-65.

Beattie, A. J. 1977. A technique for study of insect borne pollen. *Pan Pacific Entomologist*. **47:** 82.

Beattie, A. J., Turnbull, C., Knox, R. B. and Williams, E. G. 1984. Ant inhibition of pollen function: a possible reason why ant pollination is rare. *Amer. J. Botany*. **71:** 421-426.

Beattie, A. J., Turnbull, C., Hough, T. and Knox, R. B. 1986. Antibiotic production for possible function for the metapleural glands of ants (Hymenoptera: Formicidae). *Annals of the Entomological Society of America*. **79:** 448-450.

Dafni, A and Karneili, E. 1979. Observation on the life cycle of Euphorbia geniculata. *Israel Weed Science conference*. **7:** 11-12.

Galen, C. 1982. The effect of nectar thieving ants on seed set in floral scent morphs of *Polemonium viscosum*. *Oikos* **41:** 245-249.

Gomez, J. M. and Zamora, R. 1992. Pollination by ants: consequences of quantitative effects on a mutualistic system. *Oecologia*. **91:** 410-418.

Gomez, J. M., Zamora, R., Hodar, J. A. and Gracia, D. 1996. Experimental study of pollination by ants in Mediterranean high mountain arid habitats. *Oecologia*. **105:** 236-242.

Hickman, J. C. 1974. Pollination by ants; a low energy system. *Science*. **184:** 1290-1292.

Hölldobler, B. and Engel-Siegel, H. 1984. On the metapleural gland of ants. *Psyche. Cambridge*. **91(3/4):** 201-224

Hölldobler, B. and Wilson, E.O. 1990. Ants. Haward University Press, Cambridge.

Hull, D. A. and Beattie, A.J. 1988. Adverse effect on pollen exposed to *Atta texana* and other North American ants: implication for ant pollination. *Oecologia* **7:** 153-155.

Jesse, L.C., Moloney, K .A. and Obrycki, J. J. 2006. Insect visitors of invasive plant *Rosa multiflora* (Rosaceae), In Lowa, USA. *Weed Biology and Management*. **6:** 235-340.

Kigel, J., Lior, E. Zamir, L. and Rubin, B. 1992. Biology of reproduction in the annual summer weed Euphorbia geniculata Ortega. *Weed Research*. **32:** 317-328.

Koptur, S. and Truong, N. 1998. Facultative ant-plant interaction: Nectar sugar preference of introduced pest ant species in South Florida. *Biotropica*. **30:** 179-189.

Mayurnanthan, P. V. 1934. On the introduction and spread of *Euphorbia geniculata*. Orteg. In India. *Current Science*. **3:** 254.

Mishra, J. S. and Singh, V. P. 2003. Interference of *Euphorbia geniculata* in soybean-chickpea cropping system. *Indian J. Weed Sci*. ***35*:** 225-227.

Mishra, J. S., Singh, V. P. and Yaduraju, N.T. 2003. Biology of *Euphorbia geniculata* in relation to date of sowing and seeding depth. Proceedings of Nineteenth Asian Pacific-Weed Science Society Conference, 17-21 March, 2003, Manila, *Philippines*. **1:** 399-403.

Mishra, J. S. and Singh, V. P. 2000. *Euphorbia geniculata*: An emerging problem weed of soybean. *Weed Science News Letter*. **4:** 2-4.

Morale, C. L. and Aizen, M. A. 2006. Invasive mutualism and the structure of plant- pollinators interaction in temperate forest of north-west Patagonia, Argentina. *J. Ecology*. **94:** 171-180.

Morale, C. L. and Aizen, M. A. 2002. Does invasion of exotic plants promote invasion of exotic flower visitors? A case study from temperate forests of southern Andes. *Biological invasions*. **4:** 87-100.

Parker, I. M. 1997. Pollinator limitation of *Cytisus scoparius* (scotch broom), an invasive exotic shrub. *Ecology*. **78:**1457–1470.

Papp, N. 2004. Nectar and nectary studies on seven *Euphorbia* species. *Acta Botanica Hunagrica*. **46:** 225-234.

Raju, A. J. and Ezardanam, V. 2002. Pollination ecology and fruiting behaviour in a monoecious species, *Jatropa curcus* L. (Euphorbiaceae). *Current Science*. **83:** 1395-1398.

Ramsey, M. 1995. Ant pollination of perennial herb *Blandifordia grandiflora* (Liliaceae). *Oikos*. **74:** 265-272.

Richardson, D. M., Allsopp, N., D'antonio, C. M., Milton, S. J. and Rejmánek, M. 2000. Plant invasion-the role of plant mutualism. *Biological Reviews*. **75:** 65-93.

Sanderson, T. and Wright, P. J. 1989. Inhibition of pollen germination by ant secretion. *Actas coll. Insectes. Soc*. **5:** 25-30.

Sharma, I., Sharma, N. and Kour, H. 2009. Studies on the role of ants in reproductive efficiency of three species of *Phyllanthus* L. *Curr. Sci*. **96(2):**

Wagner, D. 2000. Pollen viability reduction as a potential cost of ant association for *Acacia constricta* (Fabaceae). *Amer. J. Botany*. **87:** 711-715.

Zimmerman, M. 1988. Nectar production, flowering phenology, and strategies for pollination. In: Lovett dost. J., Lovett Dost, L (Eds.), Plant reproductive ecology: Patterns and strategies. Oxford University Press, New York, USA. pp.157-178.