IRIS
Journal for Young Scientists
ISSN 2278 – 618X (Print)
ISSN 2278 – 6384 (Online)

http://www.patnawomenscollege.in/journal

Ant Induced Soil Modifications and its effects on Plant Growth

• **Umme Tahira Waris** • **Shalvika Nanda** • **Tanvi Sinha**
• **Reshma Sinha**

Received : November 2016
Accepted : March 2017
Corresponding Author : **Reshma Sinha**

Abstract : *A study was conducted to find out the soil fertility of ant mounds of Camponotus compressus and Solenopsis geminata. Ant mound soil samples were collected and nearby soil were also collected for the control setup. The physical compositions of the samples were tested. The plant, Vicia faba was planted in these samples and its growth was recorded for 15 days at an interval of 5 days. The results showed that the soil samples of Camponotus compressus was most fertile and showed maximum growth compared to the fertility and growth in Solenopsis geminata and control setup.*

Keywords: *Ant, Mound, Fertility, Growth.*

Umme Tahira Waris
B.Sc. III year, Zoology (Hons.),
Session : 2014-2017, Patna Women's College,
Patna University, Patna, Bihar, India

Shalvika Nanda
B.Sc. III year, Zoology (Hons.),
Session : 2014-2017, Patna Women's College,
Patna University, Patna, Bihar, India

Tanvi Sinha
B.Sc. III year, Zoology (Hons.),
Session : 2014-2017, Patna Women's College,
Patna University, Patna, Bihar, India

Reshma Sinha
Asst. Prof., Dept. of Zoology, Patna Women's College,
Bailey Road, Patna–800 001, Bihar, India
E-mail : sinha.reshma@rediffmail.com

Introduction :

Since their origin about 120 million years ago (mya), ants have evolved to become the most rich species and ecologically diverse group of social insects (Grimaldi and Engel 2005; Holldobler and Wilson 1990). Ants perform major ecological functions (predators, scavengers, soil turners, nutrient cyclers, pollinators) and are responsible for dispersal of numerous plant species (Del Toro et al. 2012,).

Ant nests contribute to soil nutrient heterogenecity in many ecosystems. The ant nest soils often contain higher concentrations of organic matter and mineral forms of nitrogen and phosphorous than soils collected off the nest mound (reviewed by Petal, 1978; Folgarait, 1998; MacMahon et al., 2000).

By building up their nests in soil and for their regular activities to attain the society, ants can modify the physical and chemical properties of soil. These modifications, in turn, exert effects on other living resources of soil also. Physical changes are concerned with the involvement of smaller particles of soil and organic matters both in vertical and horizontal directions by the activities of ants (Petal, 1977), thereby bringing about changes in the porosity, temperature, aeration and water holding capacity of the soil, which in turn influence the biotic activities in the soil itself. Chemical changes are somewhat related to the physical changes. These are due to the accumulation of organic matter in the nest and from decomposition processes. The potassium and phosphorus content of soil in ant nest is found higher than surrounding soils (Czerwinski et al., 1971; Gaspar, 1972).

Ant nests are known to enhance germination and seedling survival (Culver and Beattie, 1980), seed production (Rissing, 1986; Dean and Yeaton, 1993a) and plant growth (Dean and Yeaton, 1993b). Plant species associated with ant nests usually differ from species growing in adjacent areas (Culver and Beattie, 1983; Dean and Yeaton, 1993b).

The aim of the research was to compare the chemical compositions of ant mound soil and the growth of plant grown on those soil samples.

Materials and Methods :

The experiment was carried out in the campus of Patna Women's College, Patna where soil samples of two ant genera were collected and identified. Garden soil from nearby areas was also collected, that was taken as control sample. The soil samples were tested in the laboratory. *Vicia faba* (faba beans) were planted in these soil samples. The growth of these plants were observed for 15 days. Readings were taken at an interval of 5 days.

Results and Discussion :

Chemical composition of the soil samples: The concentration of Nitrogen (N), Phosphate (P) and Potassium (K) and the pH, carbon content and electrical conductivity in the respective soil samples show variable values as shown in Table 1.

Table 1. Showing the chemical composition of the soil samples

S. No.	Concentration in soil	Control	*Solenopsis geminata*	*Camponotus compressus*
1.	pH	7.595	7.390	6.963
2.	Electrical conductivity (ds/m)	0.164	0.140	0.502
3.	Organic carbon (%)	0.567	0.432	0.921
4.	Nitrogen (kg/ha)	381	242	593
5.	Phosphate (kg/ha)	44	87	23
6.	Potash (kg/ha)	621	546	154

Growth of plants in the soil samples: Comparison of the plants grown in the soil shows that the plants grown in soil collected from *Camponotus compressus* mounds had grown taller than those grown in control soil and *Solenopsis geminata* mounds soil.

Table 2. Average growth of plants in two different soil samples

S. No.	Number of days	Control (in cms)	*Solenopsis geminata* (in cms)	*Camponotus compressus* (in cms)
1.	5	10.2	7	10.5
2.	10	13.8	11.8	14.2
3.	15	15.7	15.5	19.3

This study is an effort to find the fertility of ant-mound soils of two ant genera, *Camponotus compressus* and *Solenopsis geminata*.

Two types of mounds can be built by species that construct conspicuous mounds. Type-I mounds are crater shaped, small in diameter and height, consist of mineral soil piled mainly as sand grains linked by a clay matrix, and are very susceptible to erosion. Type-II mounds are much larger, have elliptical shapes, persist for much longer, are sometimes covered by vegetation, and are made of reworked soil material (Paton et al., 1995).

Ant nests contribute to soil nutrient heterogenecity in many ecosystems. The soils near ant nests often contain higher concentrations of organic matter and mineral forms of nitrogen and phosphorus than soils collected off the nest mound (reviewed by Petal, 1978; Folgarait, 1998; MacMohan et al., 2000).

It was found that the pH of the ant mound soil was nearly neutral as compared to that of control soil as already suggested by Dlusskij, 1967 and Frouz et al., 2003 stating that the ants shift nest pH toward a neutral value i.e., ants increase pH in acidic soils and decrease it in basic soils.

The electrical conductivity is an indirect indication of the strength of nutrient solution (Samarakoon et al. 2006) as seen in the organic carbon and nitrogen content of *Camponotus compressus* mound soil which gave maximum growth also.

The chemical changes observed vary with soil characteristics or the species of ant involved (McGinley et al., 1994) as seen in the variable values obtained in the phosphate and potash content of the two ant mound soil samples.

An increase in the organic carbon and nitrogen is seen in *Camponotus compressus* mounds in comparison to control soil sample (Salem and Hole, 1968; Czerwinsky et al., 1996; Petal, 1978; Mandel and Sorenson, 1982) which could be possibly due to its foraging and nest building activities.

Ants change physical and chemical parameters of the soil by bioturbation and by accumulation of organic material. Due to the building of below-ground galleries, mounding and material mixing, the soil of ant nests is characterized by the impeded formation of soil horizons, increased porosity, drainage and aeration, reduced bulk density and modified texture and structure. Increased content of organic matter, phosphorus, nitrogen and potassium in the nests is due to food storage, aphid cultivation, and accumulation of faeces and ant remains (Paton et al., 1995; Folgarait, 1998).

It was also found that the growth of plant in soil sample of *Camponotus compressus* mound was highest. Ant nests are known to enhance germination and seedling survival (Culver and Beattie, 1983), seed production (Rissing, 1986; Dean and Yeaton, 1993a) and plant growth (Dean and Yeaton, 1993b).

Seedlings grow faster and produce more biomass in soil from nests of various ant species than in soil from the surrounding area (Lafleur et al., 2005).

Ultimately, soil abiotic and biotic changes generated by ants have an effect on the performance and diversity of vascular plants (Culver and Beattie, 1983; Rissing, 1986).

Conclusion :

From the above results we can conclude that the mound soil sample of *Camponotus compressus* was most fertile and shows maximum plant growth than the fertility and plant growth of *Solenopsis geminata* mound soil sample and control soil sample.

Acknowledgements :

We express our sincere thanks to our respected Principal, Dr. Sister Marie Jessie A.C. for giving us this wonderful opportunity to undertake the project. Our sincere thanks to Dr. Shahla Yasmin, HOD, Department of Zoology for her support. We are also thankful to the Central Soil Testing Laboratory for helping us in soil testing. Finally, we are grateful to the Research Committee for providing the facilities and financial support.

References :

Culver DC, Beattie AJ (1980). The fate of *Viola* seeds dispersed by ants. *Am. J. Bot.* 67:710–714.

Culver DC, Beattie AJ (1983). Effect of ant mounds on soil chemistry and vegetation patterns in a Colorado montane meadow. *Ecology* 64:485–492.

Czerwinski Z, Jakubczyk H, Petal J (1971). Influence of Ant hills on the Meadow Soils. *Pedobiologia,* 11: 277-285.

Czerwinski Z, Jakubczyk H, Petal J (1996). The influence of ants of the genus Myrmica on the physico-chemical and microbiological properties of soil within the compass of ant hills in Strzeleckie Meadows. *Polish J. Soil Sci.* 3:51-58.

Dean WRJ, Yeaton RI (1993a). The effects of harvester ant *Messor capensis* nest-mounds on the physical and chemical properties of soils in the southern Karoo. *South Afr. J. Arid Environ*. 25:249–260.

Dean WRJ, Yeaton RI (1993b). The influence of harvester ant *Messor capensis* nest-mounds on the productivity and distribution of some plant species in the southern Karoo. South Africa. *Vegetation* 106:21–35.

Del Toro I., Ribbons RR , Pelini SL (2012). The little things that run the world revisited: a review of ant-mediated ecosystem services and disservices (Hymenoptera: Formicidae). 406 *Myrmecological News*, 17:133–146.

Dlusskij GM (1967). Ants of Formica. Hymenoptera, Formicidae, G. Formica, Moscow, p.236.

Folgarait PJ (1998). Ant biodiversity and its relationship to ecosystem functioning a review. *Biodiversity and Conservation*, 7: 1221-1224.

Frouz J, Holec M, Kalcik J (2003). The effect of *Lasius niger* (Hymenoptera, Formicidae) ant nests on selected soil chemical properties. –*Pedobiologia.* 47: 205-212.

Gasper CH (1972). Study of ant-population in various grassland. *Ekol. Pol.,* 20: 145-152.

Grimaldi, Engel MS (2005). Evolution of the Insects. Cambridge University Press, Cambridge, p.755.

Hölldobler B, Wilson EO (1990). The Ants. Harvard University Press, Cambridge, p.732.

Lafleur B, Hooper-Bui LM, Mumma EP, Geaghan JP (2005). Soil fertility and plant growth in soils from pine forests and plantations: effect of invasive red imported fire ants *Solenopsis invicta* Buren. – *Pedobiologia* 49: 415-423.

MacMohan JA, Mull JF, Crist TO (2000). Harvester Ants (*Pogonomyrmex* spp.): their community and ecosystem influences. *Annu. Rev. Ecol. Syst.* 11: 119-161.

Mandel RD, Sorenson CJ (1982). The role of harvester ant (*Pogonomyrmex occidentalis*) in soil formation. *Soil Sci. Soc. Am. J.* 46: 785-788.

McGinley MA, Dhillion SS, Neumann JC (1994). Environmental heterogeneity and seeding establishment: ant-plant-microbe interactions. *Funct. Ecol.* 8: 607-615.

Paton TR, Humphreys G.S., Mitchell PB (1995). Soils: a new global view. New Haven: Yale University Press.

Petal J (1977). The role of ants in ecosystems. In: *Production Ecology of Ants and Termites* (Ed. Brian, M.V.), IBP. 13, Cambridge Univ. Press. 293-325.

Petal J (1978). The role of ants in ecosystems. In Brian, M.V. (Ed.), Production Ecology of Ants and Termites (International Biology Programme, no. 13). Cambridge University Press, New York. 293-325.

Rissing SW (1986). Indirect effects of granivory by harvester ants: plant species composition and reproductive increase near ant nests. *Oecologia* 68: 231–234.

Samarakoon, Weerasinghe, Weerakkody (2006). Effect of electrical conductivity of the nutrient solution on nutrient uptake, growth and yield of leaf lettuce in stationary culture. *Tropical Agriculture Research* 18: 13-21.

Salem M, Hole F (1968). Ant (*Formica exectoides*) Pedoturbation in a Forest *Soil. Soil Sci.Soc. Amer.* 32: 563-567.