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Phenotypic plasticity among *Parthenium hysterophorus* L. populations in response to altered climatic condition in Maharashtra, India

Allapure RB and Nagpurne VS

Department of Botany, Maharashtra Udayagiri Mahavidyalaya, Udgir, Dist. Latur.
Corresponding author: vinaynagpurne@gmail.com

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ABSTRACT

Plant shows phenotypic plasticity in response to the altered environmental conditions and geographic locations. This is one of the key for the speciation and diversity in the population of a particular species. In the present studies there is an attempt to assess the phonological plasticity in *Parthenium hysterophorus* to environmental stress. We found change in habit and morphological characters and it's an adaption and acclimatization for that environmental condition. Plants show greater biomass and flowers as compared to other plants grown in barren land.

Keywords: phenotypic plasticity , *Parthenium hysterophorus,* Speciation , Ecotypes , Ecads.

INTRODUCTION

Populations of a particularly widely distributed species often show geographic variation in morphological characters in response to environmental stress and climate change. Such morphological character as ecotypic variations is the result of different adaptive mechanisms, including genetically based differentiation, phenotypic plasticity or a combination of both.

Darwin himself, based on examples on acclimatization of domestic animals and plants, was convinced that "species in nature are closely limited in their ranges by the competition of other organic beings quite as much as, or more than, by adaptation to particular climates" Even though the pattern of climate change over long periods of time is complex, some conclusions can still be drawn between changes in species morphology and global climate change. Lesson from the fossil record is that species have the capacity to evolve in the face of unordered environmental change. However, the extent and rate of

current climatic trends may be unprecedented, and we may discover that some species will reach early to their limit to adaptation in given environmental settings. This limit is in theory set by the amount of genetic variability of individuals within populations, and little is known about the extent of genetic variability and the evolvability (or evolutionary potential) of most species.

Species have to evolve quickly enough to adapt to their new environmental conditions and track the rapidly changing climate. For many species, it may be difficult to predict the effect of climate change on morphology. For a few species (e.g. *Parthenium*), much is known about their ecology, morphology,physiology and genetics. With this accumulated knowledge, we may be able to predict the responses of these taxa to future environmental fluctuations. However, these species may be the exception, and for most species, only a part of the relevant information is known, and predictions on their response to climate change may be less accurate, Sultan S.E. 1995. Moreover, there may be several evolutionary solutions for a given species to adapt to its new environment. The consistent patterns of ecotypic variation observed across the *Parthenium* species in Marathwada area of Maharashtra, India. *Parthenium* probably entered India before 1910 (through contaminated cereal grain), but remain obscure until 1956. Since 1956, the weed has spread like wildfire throughout India and covered entire country. Most of the Indian states are currently under threat by *Parthenium*. It occupies over 5 million ha of land in the country. *Parthenium* grows luxuriantly in practically everywhere Drought, and subsequent reduced pasture cover, creates the ideal situation for *Parthenium* to establish.

Infestation by *Parthenium* degrades natural ecosystems. It aggressively colonizes disturbed sites and reduces pasture growth and depresses forage production. In human, the pollen grains can cause allergy-type responses like hay fever, photodermatitis, asthma, skin rashes, peeling skin, puffy eyes, excessive water loss, swelling and itching of mouth and nose, constant cough, running nose and eczema. *Parthenium* offers a big challenge to all attempts of control because of its production of huge amount of seeds, high germination capacity of seed and extreme adaptability to a wide range of ecosystems.

Marathwada is a drought prone area of Maharashtra state in India with extreme climatic regime and since last two decades rainfall is scanty and this would be due to climatic changes that occurred continuously. In this study, we assessed ecotypic variations and phenological plasticity to unordered environmental conditions particularly drought in populations of *Parthenium hysterophorus*, an alien invasive weed which growing luxuriantly to the barren lands and fields too.

MATERIAL AND METHOD

Study species and population sampling

In natural conditions, *P. hysterophorus* it occurs in all environmental conditions, including cultivated areas, barren land, roadsides and abandoned croplands, inhabiting well drained, acid or neutral soils. Populations of the species were selected in two geographically and climatically contrasting regions Distance between selected populations was 300 km. Long-term climatic data for each population site indicate difference in annual precipitation levels across populations and differences in annual temperature. We measured plant height in all plants, flowering periods, overall growth pattern finally, and seeds formation. We compared phenotypic responses of Parthenium in varius regions in response to rainfall.

RESULTS AND CONCLUSION

We measured different morphological traits related to growth, morphology, phenology and reproduction. Plants in the drought area grew less, had lower leaf chlorophyll content and rosette habit, and reproduced faster. We also found significant differences between regions that likely reflect adaptation to climatically distinct environments, with populations from the heavy rainfall showing a faster growth with profuse branching, as compared to plants of drier conditions. Phenotypic expression of all functional characters was significantly affected by the drought conditions in *Parthenium*. *Kaur* et al., 2019 also studied the invasive alien species. Plants from all populations grew more, in terms of height and Final above-ground biomass, in the high rainfall than plants in the drought areas.

Plants populations from drought area showed the decreased leaflet area (2-fold reduction), curly leaves,

and change in colour of the leaves from green to pale yellow and typical rosette formation is common. Furthermore, in drought area, plants from all populations increased leaflet thickness compared heavy rainfall. On average, plants from the drought populations showed early flower buds and advanced fruiting, but produced number of seeds.

Ecotypic differentiation in *P. hysterophorus* has also been reported by Berger *et al*. 2017, who compared several cultivars and wild collections from diverse habitats across the species' range. Our results, they found that ecotypes from drought-prone environments showed earlier phenology, change in total leaf morphology than populations from high-rainfall, moist sites these results also see by Milla *et al*. 2009; Moncalvillo *et al*. 2019.

Adaptive plasticity in *P.hysterophorus* populations may be exclusive mechanisms contributing to plant adaptation to environmental variation and climate change Moncalvillo *et al*. 2019. The expression of genetic variation is *P. hysterophorus* is environment-dependent. Therefore, it may be possible that the observed patterns of population differentiation were slightly affected by the unordered environmental conditions. Arnold *et al*., 2019 showed the temperature as one of the factor for the ecotypic plasticity in different plants.

Plasticity to drought was in most cases in the same direction as quantitative genetic variations, also studied by Kim E and Donohue K. 2013. Species is more adaptive value to unordered environment and climate change. Our results indicate that both genetic differentiation and plasticity can generate adaptive phenotypic variation in *P.hysterophorus*, and help to make suitable control strategy for farmers similar results were observed by Sai-Chun Tang 2010.

Yadav and Garg (2011) studied the management of invasive alien species by vermicomposting. *Parthenium hysterophous* weed was used for vemicompost formation.A future experiment needs to be conducted with different years and using the same genetic material which would confirm whether such patterns of genetic variation are consistent across the time.

Conflicts of Interest: The authors declare no conflict of interest.

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