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Demographic studies on Alien invasive *Conyza canadensis* L. in Kashmir Himalaya

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ABSTRACT

Conyza canadensis is an invasive weed of increasing importance in subtropical and warm-temperate regions worldwide, both in non-agricultural habitats and in annual and perennial crops. To gain insights on basic life cycle processes determining the demographic success of *C. canadensis*, we studied for this species during two season's seedling emergence patterns, survival to the adult stage and fecundity in a Kashmir Himalaya habitat in which *C. canadensis* was a component of the plant community. Present study reveals the demography of alien invasive Conyza canadensis. During the present study it was observed that large seedling recruitment occurs in autumn season and small seedling recruitment occurs in summer season. The species is transient colonizer as the population was not stable in time and space. During the present study it was also observed that after the emergence of seedlings mostly they remain in rosette form and starts getting elongated from spring season. Survivorship curve in Conyza canadensis resembled Deevey III type indicates highest mortality during the seedling stage. The bolting starts to occur in late spring and flowering occurs in late summer. The life history component like fecundity is contributed by the large seedling recruitment of autumn season while survival of species occurs by the small seedling recruitment of spring season.

Key Words: Conyza canadensis, demography, Kashmir Himalaya, Asteraceae, mortality, population turnover.

I INTRODUCTION

Plant invasions dramatically affect the distribution, abundance and reproduction of many native species (Sala et al., 1999). Because of these ecological effects alien species can influence the evolution of native exposed to novel interactions with invaders (Parker et al., 1999).Many factors are known to influence plant invasions, but syntheses of how and under what circumstances particular factors drive or limit invasions are only beginning to emerge (e.g. Davis et al., 2000; Bluemental, 2006; Hallet, 2006; Alexander et al., 2011). The spread of a species in a new range is limited by propagule pressure, abiotic factors and biotic interactions with competitors, enemies and mutualists, and all these factors may vary along environmental gradients, such as latitude and altitude (Dietz and Edwards, 2006;

Hallet, 2006). Species responses to changing conditions along these gradients can be characterised by high phenotypic plasticity (Parker et al., 2003; Richards et al., 2006) or local adaptation (e.g. Lacey, 1988; Weber and Schmid, 1998).

Conyza canadensis is a weedy winter annual member of the Asteraceae family. Common names include Canada fleabane, horseweed, and mare's tail, with a previous scientific name of *Erigeron canadensis* (Weaver 2001). Native to North America, *Conyza canadensis* has become fully naturalized internationally, especially in Europe (Frankton and Mulligan 1987). The life history of facultative winter annual weeds is important for determining weediness, adaptiveness, recruitment, and management approaches in species like *Conyza canadensis*. Knowledge of weed recruitment biology can be used to influence management practices, such as herbicide application timing (Hacault and Van Acker 2006). Emergence periods for this species group can vary substantively among species within the group, increasing the importance of understanding emergence timing in relation to management. Facultative winter annual weeds can recruit mostly in the fall, mostly in the spring, or equally in both seasons (Cici and Van Acker 2009). *Conyza canadensis* is a surface-germinating ruderal species with non-dormant seeds that germinate in either fall or spring. These inherent properties make this species an ideal model plant to study factors affecting germination and emergence (recruitment) timing. As a ruderal species, *Conyza canadensis* relies heavily on large amounts of seed dispersal to increase the chances of recruitment. Previous studies have shown that microsite conditions do indeed play a large role in seed germination for this species (Regehr and Bazzaz 1979; Nandula et al. 2006; Main et al. 2006). For *Conyza canadensis* populations, disturbance can create a variety of microsites that are suitable for germination. Nandula et al. (2006) conducted a large study on the effects of different treatments on the germination of *Conyza canadensis*

II MATERIALS AND METHODS:

The valley of Kashmir often referred to as the paradise on earth for its diverse rationale is situated in the northern fringe of Indian subcontinent between 33◦ 20` and 34◦ 50` N latitude and 73◦ 55` and 75◦ 35` E longitudes covering an area of about 16000sq.km. The valley is formed by girdling chain of Himalayan mountains namely the pir Panjal range of the Lesser Himalaya in the south and Zanskar range of the Greater Himalaya in the southeast to northeast and the west. It is believed that the Kashmir Himalaya was once a large lake called Satisar

The present study was conducted in Kashmir University. For demographic study five quadrants were of one meter were laid. The quadrants were surveyed after an interval of 15 days from the seedling recruitment to maturation i.e., from September 2016 to July 2017 except during February when the entire study area was covered by snow. During the present study it was observed that seedling after attaining

distinctive appearance were marked using colour paint following Khushwaha et al., (1981). The marked seedlings were again counted on the subsequent census to record mortality, new recruits and survival of individuals. During the present study it was observed that the seedlings without colour marking on each sampling date constituted the new recruits which after counting were marked with the colour paint in permanent quadrants to distinguish between already recruited and new recruits on the successive sampling dates. The commulative gains and losses in the population were obtained on the basis of data on new recruits and mortality at different census dates. For survivorship curve the survival of all the plants present on a given census date in the multi aged population was plotted against time axis(Harper. 1977).The data on population size new recruits and mortality are expressed as individuals per square meter For survival

III OBSERVATION

Data on population size, recruitment pattern and mortality are presented in table I. Maximum population size was observed before winter in the month of September followed by decline till March. The number of individuals were again increased in April with onset of favourable conditions but followed again by decline. Population size closely followed the recruitment pattern which occurred in two pulses. The major peak in recruitment was recorded in September and minor peak in March after the end of winter when favourable climate conditions prevailed.

Mortality showed an irregular pattern but highest number of deaths was recorded only in autumn immediately after mass recruitment of the seedlings. Thereafter mortality declined but remained more or less uniform till December. Significant mortality was also recorded in April after second wave of recruitment, after which the population size remained more or less stable.

Table I.

Recruitment pattern, mortality and population size of Conyza canadensis. (Mean and Standard deviation based in data drawn from five quadrants)

Date of Sampling	Population size	New Recruits	Mortality
2-9-2016	4520.34 ± 425.15	___	___
16-9-2016	2375.46 ± 250.95	645.86 ± 171.98	2375.67 ± 245.78
1-10-2016	1835.43 ± 71.70	426.98 ± 133.71	1055.33 ± 221.56

15-10-2016	1673.23 ± 201.18	415.65 ± 98.73	650.32 ± 57.46
1-11-2016	1567.73 ± 357.28	388.78 ± 87.54	630.76 ± 45.87
15-11-2016	1365.49 ± 279.45	330.45 ± 71.90	665.73 ± 98.78
30-11-2017	1105.54 ± 223.56	_____	530.59 ± 156.83
15-12-2016	998.56 ± 199.67	_____	453.98 ± 130.56
30-12-2016	913.45 ± 220.76	_____	285.90 ± 75.69
2-01-2017	813.63 ± 198.98	_____	130.78 ± 35.89
16-1-2017	428.65 ± 134.56	_____	125.45 ± 32.76
3-2-2017	SNOW FALL	snowfall	snowfall
17-2-2017	SNOW FALL	snowfall	snowfall
1-3-2017	470.76 ± 148.87	_____	90.45 ± 31.87
15-3-2017	790.65 ± 201.45	442.45 ± 117.89	75.87 ± 47.36
1-4-2017	876.93 ± 214.27	490.69 ±	285.98 ± 130.94
15-4-2017	413.74 ± 130.76		367.75 ± 151.98
1-5-2017	388.80 ± 98.45	53.89 ± 25.98	180.76 ± 78.95
15-5-2017	320.65 ± 55.57	45.98 ± 20.78	130.49 ± 63.51
1-6-2017	245.46 ± 43.76	___	90.49 ± 51.98
15-6-2017	221.35 ± 39.76	__	120.90 ± 41.78
1-7-2017	188.43 ± 32.87	____	135.87 ± 77.92

(-) Means Not Recorded

Population turn over points out that Conyza canadensis never attains population size that is stable in time; instead both new and old recruits contribute to the population.

During the present study it was observed that heavy seedling mortality was observed in early spring. However with the onset of favourable conditions in the spring, additional seedlings were recruited which survived without experiencing extreme mortality till senescence phase Survivorship(Fig.1.) curve of Conyza canadensis resembles Deevey's (1947), Type III curve, indicative of heavy seedling mortality up to early spring. However with the onset of favourable conditions in the spring, additional seedlings were recruited which survived without experiencing extreme mortality till senescence phase

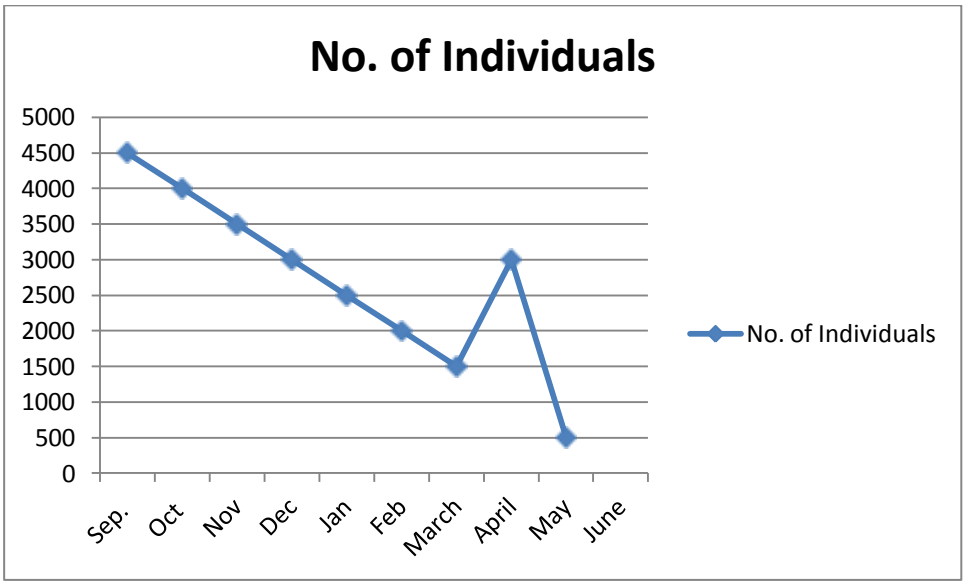

Fig.1. Survivorship curve of *Conyza canadensis*

(In the survivorship graph horizontal months shows the time and in vertical number shows the number of individuals)

IV DISCUSSION

During the present study it was observed that recruitment of Conyza occurs in two pulses. Major pulse of recruitment was recorded in autumn before winter and minor pulse occurs in spring. Similar pattern of recruitment was observed by Kay, (1998). The species experiences considerable mortality during winter which in other winter annuals has been attributed to frost heaving of soil (Regehar and Bazzaz, 1979; Mack and Pyke, 1983). Apart from frost heaving the mortality in Conyza canadensis may be due to strong intraspecific competition between the seedlings as the seedling density was very high during the initial stages (Fig.1). On the other hand Mack (1976), and

Watkinson and Harper, (1978) observed that population of the winter annuals that do not form rosettes suffer almost no mortality due to intraspecific competition until the time of senescence because of low temperature potential. During the present study it was observed that Conyza canadensis is transient colonizer and never attains a population size that is stable in time and space. Such an observation draws support from the studies carried out by Regehar and Bazzaz, (1979), on Erigeron canadensis which like Conyza canadensis is also a winter annual species.

Mass recruitment of Conyza canadensis seedlings during autumn is favoured by a variety of factors such as moisture availability due to rains, optimum temperature which has experimentally determined (Allaie, 2003) and senescence of summer vegetation. Thus Conyza canadensis has fine tuned its life history strategy to the prevailing habitat conditions which helps in the mass recruitment and colonization.

Results of present study clearly demonstrate temporal variability in germination time and thereby recruitment. Similar results were obtained by Gonzalez-Astorga and Nunez- Farfan, (2000) in Tagetes micrantha. Furthermore an ecological trade of between survival and fecundity was detected in relation to seedling emergence time, as striking differences in survivorship and fecundity among pre and post winter populations were observed (Allaie, 2003). This phenotypic variation in the life history trait of emergence time is ecologically and evolutionarily important due to its effect in determining species fitness (Baskin and Baskin, 1972; Abul- Fatih and Bazzaz, 1979; Marks and Price, 1981; Watkinson, 1981; Leon, 1985; Phillipi, 1993; Venable, et al. 1987). The variation in emergence time has been reported to be the result of both genetic variation and phenotypic plasticity (Schlichting and pigliucci, 1993). In conyza canadensis environmental control of emergence seems evident but the existence of genetic variation in emergence time needs to be determined. In tagetes micrantha variation in emergence time has been reported to controlled both by environmental (Dominguez and Dirzo, 1995) as well as genetic variation (Gonzalez- Astorga and Nunez- Farfan, 2000). The results of the present study clearly indicates that variation in plant emergence time in conyza canadensis produces a life history trade off with early emergence favouring the fecundity component of fitness and late emergence favouring the survival component.

In conclusion it can be stated that invasion of native ruderal habitats of Kashmir himalaya by Conyza canadensis is due to the fine tuning of its life history strategy to the prevailing environmental conditions. Protracted recruitment pattern aided by habitat disturbance and favourable moisture, temperature , light and nutrient regimes and high population size even after seedling mortality are the key demographic attributes contributing to the establishment and spread of this species.

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