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Estimating Population Density of Himalayan Rangeland Weed *Senecio chrysamthemoides* DC.

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Abstract

Unpalatable and unwanted native or invasive plants that have adverse impact on the forage in the grazing area are rangeland weed. Climate change, introduction of new species, disturbance and fragmentation of land are causative factors for spreading native or invasive weed infestation on rangelands. *Senecio chrysanthemoides* is a serious obnoxious weed on Himalayan rangeland area. It is densely populated on plain and left places of shed constructed area consequent rangeland degraded, displacing desirable species, degrading systems, decreasing productivity and increase management costs. To arrest infestation of weed, mechanical control measure was followed but unplanned mechanical control measure was inadequate. Up-rooting weed earlier flowering was more effective than other life form of weed.

***Key words*:** Control, Himalaya, population, rangeland, weed

Introduction

Plants which are unpalatable, unwanted and worthless native or invasive species that have adverse impact on the forage species in the grazing area are rangeland weed. Weed plants are mostly invasive species. These are nuisance in grazing land. Rangeland weed are poisonous and economically adverse. Invasive weed plant species negatively impact rangelands throughout the world by displacing desirable species, altering ecological processes, reducing wildlife habitat, degrading systems, decreasing productivity and increase management costs associated with herbicide application and pasture renovation (DiTomaso, 2000; Masters and Sheley, 2001). Many weeds are hosts of plant disease organisms. Climate change, introduction of new species, disturbance and fragmentation of land are causative factors for spreading native weed or invasive weed infestation on rangelands. Research in weed population dynamics is very important for the design of effective and environmentally friendly weed control strategies (Navas, 1991; Cousens and Mortimer, 1995; Liebman *et al*., 2001). Several works have studied the dynamics of weed populations and have tried to model those (Holst *et al*., 2007). Weed populations can show significant genetic differentiation between fields (Cavers, 1985), but will mostly occur as mixtures of genotypes within fields. Within a field, their distribution may be highly non-uniform (Rew *et al*., 1996), and their abundance may fluctuate markedly from year to year (Chancellor, 1985).

In Himalayan rangeland, the spread and dominance of weeds plant species has been identified as a serious threat to

rangeland biodiversity and ecosystem functioning. Intense grazing of grasslands often results in palatable species being replaced by less palatable species, which are often considered ‘‘less desirable or even worthless plants’’ (Vallentine, 1990). Rangeland weed identification and management on Himalayan rangeland has not addressed in Nepal (Limbu *et al*., 2012). We do not have the actual report of rangeland weed even checklist. 166 species of invasive weed (Tiwari *et al*., 2005) and 364 crop weed (Rajbhandari and Joshi, 1998) of temperate and tropical zone and 8 highly noxious high altitude rangeland weeds (Limbu *et al*., 2012) have been reported from Nepal.

Senecio chrysanthemoides is a serious invader on Himalayan rangeland area of Eastern Nepal. Morphologically, it is 2-4 feet tall compositae herb, lower leaves lyrate-pinnatifid with an auricled petiole, upper leaves sessile, bipinnatifid, base amplexicaul, surface white pubscent, numerous yellow flower head, flower head with 10-12 spreading ray florets, Ray floret few; disc florets many with shortly 5 fid tubular corollas. Achenes smooth. It is annual herb that becomes perennial under defoliation, flowering on August-September, locally called ‘Toriphule’. Usually, it occurs at 2400 to 3600 msl in Himalayan open rangeland area. It grows mostly fertile, plain land and heavily colonies on leaving places of temporary cows' sheds.

Over the last decades herdsmen of the Himalaya rangeland have been facing great infestation of *S. chrysanthemoides* on their pasturelands. Infestation area and population of the weed has been escalating since its introduction. It is unpalatable, broad leaves and fast growing invasive species. With having broad leaves, it sheds over grasses; other forbs plant could not compete for growing and nutrition. On other hand, it produces large number of seed at a time and dominates over the forage plant consequent degrade rangeland quality.

The objective of this paper is to estimate the population density of *Senecio chrysanthemoides* on rangeland area of Tinjure-Milke. Ultimately, this finding could lead to control and management of *S. chrysanthemoides*, especially for better rangeland management.

Materials and methods

Study area

The research work was conducted in Tinjure - Milke Mountain ridge, political border of three districts i.e. Taplejung, Tehrathum and Sankhuwasabha, (27°09'30.5" to 27°22'15"N and 87°26'09" to 87°34'14"E) of eastern Nepal (Fig. 1). The altitude of the study area

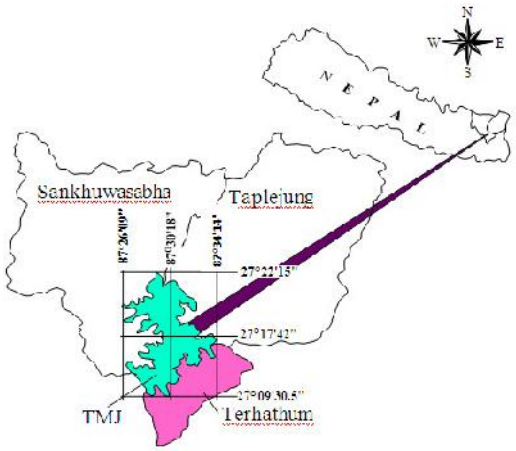

Figure 1. Map of the study area, TMJ

ranges from 2650 to 3400 msl and far from 225 km east of Kathmandu. Its climatic condition is average temperature 10-15°C and average annual rainfall 2250 mm. The

area is under heavy human and livestock (yak, cattle, buffaloes, sheep and goats) pressures (Oli, 2002). It serves as habitat corridor between Makalu-Barun Conse-rvation Area towards northwest and Kanchenjunga Conservation Area towards north-east, both of which touch the Qomolongma Biosphere Reserve in Tibet (Koirala, 2002).

The mountain ridge across Tinjure-Milke is the natural niches for dozens of rhododendron species. This is the capital of rhododendron of Nepal and home of 27 rhododendron species.

Experimental design

Study area was chosen Simkharka, Gupha pokhari, western aspect of Tinjure-Milke mountain ridge. We carried out observation data collection on September 2012. Landscape of the study area is diverse and left open space of cattle sheds. We interviewed 5 senior citizens, 10 senior herdsmen and 2 social activists for control measure of weed. Our questions were both open ended and close ended. We divided the study area into two broad categories a) use of the land for making temporary shed for cattle and b) slope of the land. Further, these both categories were divided into two alternative sub-categories. We classified use of the land as i) shed-constructed area (SA), where the emblems of shed construction remarked and ii) not shed-constructed area (NSA). The slope of the land was considered as i) highly sloped (HS), which bears 45° or more inclination and ii) gently sloped (GS), which had less than 45° inclinations. To quantify population density of *Senecio chrysanthemoides*, at least 38 quadrats of 2m × 2m (4 m^2) size were laid down randomly from shed-constructed and not constructed area. During the preliminary survey, 17 shed-constructed areas (spots) were identified in the study area. Among which 4 spots were on highly sloped (HS) land and 13 were on gently sloped (GS) land. For comparison of the population density of the *S. chrysanthemoids* plant, 21 spots were selected from not shed-constructed area (NSA), of which 7 were from the gently sloped (GS) and 14 from the highly sloped (HS) land. Entire *S. chrysanthemoides* plants of laid down quadrat were counted and recorded. The distribution of sample is given in the 2x2 contingency table (Tab. 1). The experimental data were analysed by using software SPSS-20 (2011).

Results and discussion

At first, the significance of the sample choice is tested using χ^2-test. The selection of sample area according to slope of the land and use of the land found to be significant, since, the computed chi-squared value (= 7.012) seemed significant with p-value (.008) < 0.01at 1 degrees of freedom (df).

Descriptive measures like range, mean and standard deviation of the population density are computed for each sample sub-categories. The estimated population density of the *Senecio chrysanthemoides* from all samples (spots) is 30.04 per metre square area with a standard deviation of 14.98. The population densities for SA, NSA, HS and GS are 44.32±10.97, 18.48±2.24, 21.88±7.12, 37.97±16.48 respectively. The 95% interval estimates of the population densities of the same sample sub-categories are obtained 38.69-49.96, 17.46-19.50, 18.33-25.42 and 29.68-45.10 per metre square area respectively (Tab. 2). The Box and whisker plot shows the distribution of population densities in the different

categories of the sample. The distribution of the population densities in highly sloped shed-constructed area and not shed-constructed area are symmetrical in nature. An outlier value of the population density is observed in the distribution of population density in gently sloped not shed-constructed area (Fig. 2).

The population density of the *Senecio* plant is highest for the shed-constructed area among all categories. For the gently sloped shed-constructed area, the population density (at 95% confidence interval) is estimated 40.9-53.9 plants per meter square area. The distribution is observed less dense on the highly sloped not shed-constructed area, the 95% interval estimate of which is 17.16-19.48 plants per metre square area (Tab. 3). The t-test is employed for testing the equality of means of the population densities (Senecio) in between the sub-categories SA and NSA, and HS and GS. Assuming equal variances, the independent sample t-test for testing equality of the means between NSA and SA reveals t = -10.568 for 36df. The population densities between shed-constructed area (SA) and not shed-constructed area (NSA) is observed significantly different, since p-value (=0.002)<0.1. Similarly, under the assumption of equal variances, the t-value on testing equality of the means between highly sloped (HS) and gently sloped (GS) land is obtained as -3.692. This confirms that the population densities over highly sloped and gently sloped lands are also significantly different, since p-value (= 0.001) < 0.1.

Population density of *Senecio chrysanthemoides* is escalating day by day since its infestation due to climate change and overgrazing of rangeland. Weed population density distribution is influenced by biotic and abiotic environment, landscape, rainfall, grazing intensity, rangeland management, fertilizer and herbicides treatment. Weed populations are dynamic in time, both within and between seasons, and in space, both within and between fields. Weed models should therefore ideally simulate the population dynamics along both these axes (Mortimer and Putwain, 1984; Van Groenendael, 1988; Colbach and Debaeke, 1998). Intra- and interspecific competitions are key processes in weed population dynamics (Blom, 1988) and ecophysiological models have been suggested as the most appropriate tool for exploring these interactions (Kropff *et al*., 1996).

Abandoned places after cattle's shed were very fertile land for growing and infestation to *S. chrysanthemoids* weed. Growth, development and infestation of *S. chrysanthemoids* were highly correlated to cattle excreta. These excreta might be good nutrient to the weed. The study area have various noxious rangeland weeds e.g. *Berberis erythroclada* Ahrendt, *Anaphalis contorta* (D. Don) Hook.f., *Potentilla lineata* Trev., *Euphorbia wallichii* Hook. f. and *Swertia pedicellata* Banerji. The population density of *Swertia pedicellata* Banerji was 126 individual/ m^2 (Limbu *et al*., 2012). Population density of *Senecio aquaticus* in grassland of Switzerland was 8-60 individual/ m^2 (Suter and Luscher, 2011). Highly slope areas (more than 45^o inclination) were not apt to construct cattle shed and excreta would not deposit. The weed, *S. chrysanthemoids*, was high competitor for growing at abandoned place of cattle shed after removing cattle sheds. It dominated over other forbs and grasses. Management of this weed, control measure, was not effective. Unplanned mechanical

Table 1. Number of sample area selected according to slope of the land and use of land

Use of the land	Slope of the land		Total
	Highly sloped (HS)	Gently sloped (GS)	
shed-constructed area (SA)	4	13	17
not shed-constructed area (NSA)	14	7	21
Total	18	20	38

Table 2. Descriptive measures and Confidence Intervals of population density

Sample Categories		No. of sample area	Population density				95% CI for mean
			Range	Mean	S. D.	S. E. of Mean	
Use of the land	shed-constructed area (SA)	17	47.00	44.32	10.964	2.659	38.69 - 49.96
	not shed-constructed area (NSA)	21	7.50	18.48	2.235	0.488	17.46 - 19.50
Slope of the land	highly sloped (HS)	18	21.50	21.88	7.120	1.678	18.33 - 25.42
	gently sloped (GS)	20	63.75	37.39	16.476	3.684	29.68 - 45.10
Total		38	63.75	30.04	14.977	2.430	25.12 – 34.96

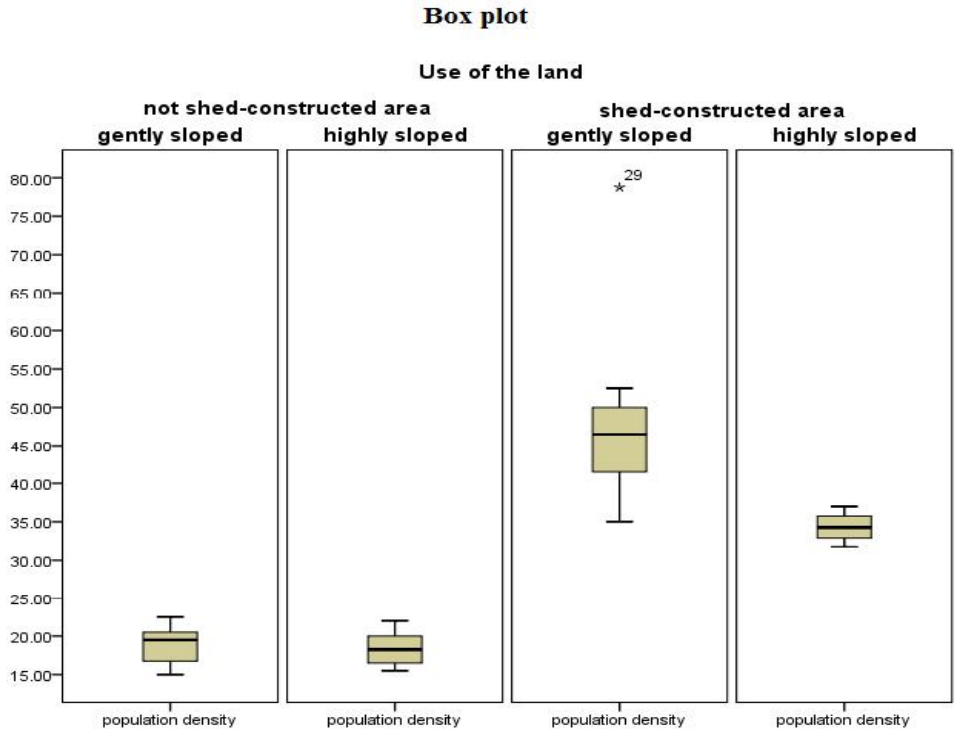

Figure 2. Distribution of population densities in different sample areas

Table 3. Descriptive measures and Confidence Intervals of population density for the cross categories

Slope of the land	Use of the land	No. of sample area	Population density			S. E. of Mean	95% CI for mean
			Range	Mean	S. D.		
Gently sloped (GS)	shed-constructed area (SA)	13	43.75	47.40	10.743	2.980	40.91-53.89
	not shed-constructed area (NSA)	7	7.50	18.79	2.782	1.051	16.22-21.36
Highly sloped (HS)	shed-constructed area(SA)	4	5.25	34.31	2.154	1.077	29.42-39.20
	not shed-constructed area (NSA)	14	6.50	18.32	2.008	0.537	17.16-19.48

control measure was inadequate for arresting its invasion. Up-rooting weed earlier flowering season was more effective than other life form of weed because plant would not get seed produce and regenerate more.

In conclusion, *S. chrysanthemoids* is highly obnoxious weed, continuously infesting on Himalayan rangeland. Its distribution is not homogeneous, dense populated in left place of shed constructed area. Mechanical weed control operation just before flowering season is effective for weed control. Population density estimation of weed determines appropriate control measure on Himalayan rangeland.

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