SOIL SEED BANK STATUS OF PARTHENIUM HYSTEROPHORUS L. INVADED FALLOWLAND OF CHAPRA, BIHAR

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***Abstract*: *Parthenium hysterophorus* L. an invasive alien species has invaded all states of India. The estimation of the soil seed banks of *Parthenium* invaded sites is important to know the degree of seriousness of the invasion of this weed. A study was conducted in the Jai Prakash University Chapra, campus which is established in about 240ha of land which was earlier a cropland to estimate the soil seed bank status in two season in April and July 2017. The soil samples were collected from 0-10cm depth from ten locations invaded with *Parthenium*. The composite soil samples were placed in earthen pots having five replicates. The emerged seedlings of different species were counted and identified. The number of seedlings were lower in soil samples collected in April 2017 compared to July 2017. The number of seedlings of *Parthenium* was 17.2/pot in April 2017 and 6.2/pot in July 2017.**

***Keywords*: *Parthenium hysterophorus*, Fallowland, Seed bank, seedlings**

1. Introduction

Parthenium hysterophorus L. a member of Asteraceae family is a noxious invasive alien species was introduced in India with wheat grains imported from Mexico during PL 480 scheme. It has spread in all states of India. It has affected the agroecosystem, natural vegetation, environment, human and animal health (Parthasarathi et al. 2012; Devi et al. 2014). The size of seeds of ranges from 2 to 205mm (Patil 2013; Kaur et al. 2014). The dormancy period of seeds in soil may be till ten years (Masum et al. 2013; Kaur et al. 2014). Kaur et al. (2014) have reported that a single plant of *Parthenium* can produced 25000 to 100000 seeds. Adesina et al. (2012) and Ayele et al. (2013) have estimate decrease in number of seeds with increase in soil depth. About 81.5% decrease in soil seed banks was reported from 0-3cm depth to 6-9cm depth by Adesina et al. (2012) and Ayele et al. (2013). The seeds of *Parthenium* can remain upto 15cm soil depth (Karim et al. 2017b) to 20cm depth (Nguyen et al. 2010). The dispersal of seeds is affected by wind flow, vehicles, human activities, water etc. The distribution of soil seed bank is related to the soil condition like soil structure and soil chemistry (Gomaa 2012). Karim et al. (2018) have reported 2.78 thousand seeds per m^2 in 0-5cm soil depth. Buhler et al. (2009) have reported around 60% of total seeds of *Parthenium* in 0-5 cm soil depth. Price et al. (2010), yang and Li (2013), and Karim et al. (2017b) have reported higher number of seeds on 0-5 cm soil depth. Navie et al. (1996) reported that the presence of 3200 to 5100 seeds/m^2 in Australia was considered as danger for environment. The vertical distribution of seeds in soil profile depends on the type of tillage (Menalled 2008). In no tillage condition most of the seeds remain on soil surface while in reduced tillage field 80-90% of seeds remain in 0-10cm soil profile.

All living seeds present in a soil profile, soil surface, dispersal inits, seeds or fruits include soil seed banks, soil seed banks vary according to seed proximity, seed persistence and physiological state (Saatkamp et al. 2014). Living seeds have been recorded in or on the soil for different durations, different seasons, at different depths, in different quantities, in different states of dormancy or procession to germination (Soatkamp et al. 2014). The study of dynamic and quantitative aspects of seed banks should be considered if we want to predict the role of seed banks. Soil seed banks are a dynamic part of plant populations. Climate, herbivory and disturbances vary in any ecosystem which directly changes the year to year in soil seed bank density and spatial heterogeneity.

The soil seed bank is the natural storage of seeds, often dormant, within the soil of most ecosystems. Weed seed bank have been studied intensively in agricultural science because of their important economic impacts, other fields interested in soil seed banks include forest regeneration and restoration ecology (Martins and Silva 1994).

Species with seeds that remain viable in the soil longer than five years form the long-term persistent seed bank, while species whose seeds generally germinate or die within one to five years are called short-term persistent. The

mortality of seeds in the soil is one of the key factors for the persistence and density fluctuations of plant populations, especially for annual plants. There are indications that mutations are more important for species forming persistent seed bank compared to those with only transient seeds. The increase of species richness in plant community due to a species richness and abundant soil seed bank is known as the storage effect. In addition to seeds, perennial plants have vegetative propagules to facilitate forming new plants, migration into new ground, or reestablishment after being top-killed. These propagules are collectively called "soil bud bank" and include dormant and adventitious buds or stolons, rhizomes and bulbs.

Roberts (1981) has defined the term soil seed bank has been used to designate the viable seed reservoir present in a soil. All the viable seeds present in the soil or mixed to soil debris constitute the soil seed bank (Simpson et al. 1989).

Voll et al. (1996) stated that knowledge of the emergence rate of the different species from a soil seed bank can be used for the adequacy of soil and crop management programs, which can result in a rational use of herbicides. The success of survival of weeds is due to their persistence capacity in certain areas. This capacity is due to production of large number of seeds, long-term viability and continuous germination, phenotypic and genotypic plasticity (Freitas 1990; [Fernandez-Quintanilla and Saavedra 1991]. Carvalho and Favoretto (1995) stated that the success of a seed bank depends on the seed density ready to germinate. The longevity of seeds represents a major mechanism of survival of certain weed species and which leads to a continuous source of emergency. The longevity of seeds in the soil varies among species, characteristics of the seeds, burial depth and climatic conditions (Carmona 1992).

The dormancy represents the main mechanism of species preservation in the seed bank, distributing the germination through the year. Dormancy can guarantee the seed survival in the form of seeds under adverse conditions, even when the population of plants is completely eliminated (Carmona 1992). In agro-ecosystems where the soil is disturbed frequently, the soil seed bank acts to stabilize and ensure species survival (Roberts 1981).

The seed bank reflects the historical process of the plant life cycle from its establishment in the environment to the distribution in time and space. The degree of seriousness of the invasion of *Parthenium* weed can be predicted from the condition of weed seed bank in the soil. A weed seed bank is a reserve of viable weed seeds that are present on the soil surface and in soil profile which indicates the past history of weed vegetation. Whyte (1994) reported that *Parthenium* weed seeds remain viable in the soil seed bank for 4 to 6 years. Tamado et al. (2002) stated that *Parthenium* seeds were buried in the soil for 26 months and observed that the viability of seeds was more than 50% and the 'half-life' of seeds in soil was 3 to 4 years. The weed seed bank in the soil is an indication of the possibility of future infestation. Destryoing weed seeds from the soil seed bank is an important aspect of weed management. Information on the weed seed bank in an area helps in predicting the degree to which crop-weed competition or environmental degradation may occur in that area. Data on the soil seed bank can also be used to calculate new plant recruitment in the area. Knowledge about seed banks is therefore, important as it provides valuable data for developing weed management strategy (Golafshan and Yasari 2012). In order to development alternative to weed system, it is essential to have information about the seed bank biology.

The present study was conducted to estimate the soil seed bank of *Parthenium hysterophorus* infested fallowland of J.P.University Chapra campus.

2. *Materials and Methods*:

The determination of seed banks of soils is very difficult through the techniques that are used because they demand a lot of work and sometimes distruct seed viability (Buhler and Maxwell 1993). The best way to determine the presence and amount the seed in soil is to observe the seedlings emergence at the site. The most frequently used technique involves the determination of the number of seeds placing soil samples for germination in appropriate places or physical separation of seeds from the soil. The methods of emergence of seedlings is simple and has the advantage of the easy identification of the species however the results are influenced by the seed dormancy (Buhler and Maxwell 1993). Several chemicals are used for seed separation.

For the soil seed bank study soil samples were collected from the ten randomly placed quadrates of 30cm × 30cm size in the study site invaded with *Parthenium* in two seasons in the months of April and July 2017. From each quadrate soil samples were collected from upper 0-10cm soil depths. Composite soil samples were prepared and were placed in earthen pots with five replicates. Water was applied to each pot whenever it was needed to maintain the soil moisture at approximately field capacity. The readily identifiable emerging seedlings were counted, recorded and discarded every week. Those species that were difficult to identify at the seedling stage were counted, labelled and allowed to grow until identification was possible. At weekly intervals after removing of seedlings the soil samples were stirred to stimulate further germination. The experiment was run over a three month period to enable all species within the soil sample to be identified. The emergence values that were found were reported as pot wise.

3. *Results and Discussion*:

During the month of April 2017 the mean value of soil seed bank of *P.hysterophorus* was 17.2/pot whereas for other species such as *Oxalis corniculata* was maximum 31.8/pot, *Cynodon dactylon* 1.61/pot and *Croton sparciflorus* 29.4/pot. Only the seedlings of four species emerged from the soil samples collected in the month of April 2017. From the soil samples collected in the month of July 2017 seedlings of eight species emerged. The maximum number of seedlings tiller was for *C.dactylon* 83.8/pot and minimum 0.4/pot for *P.niruri*. The seedlings of *P.hysterophorus* were only 6.2/pot. Thus in the rainy season the number of seedlings of *Parthenium* decreased compared to summer season.

Nigatu et al. (2010) while studying the soil seed bank of *P.hysterophorus* infested sites in Ethiopia have reported that the largest *P.hysterophorus* soil seed bank was under its own high infestation level. Navie et al. (1996) have reported several aspects of ecology of *Parthenium* such as its high seed production, long-term viability of the buried seed, an innate dormancy mechanism and rapid germination and seedling establishment which allow it to create large monospecific seed banks would lead to a decline in the diversity and abundance of other species. Nigatu et al. (2010) observed that seed bank in the medium-and high-infested sites had 65 and 87% *P.hysterophorus* densities as compared to just 25% at the low-infested site. The presence of *P.hysterophorus* reduces the diversity of the soil seed bank and therefore, the ability of many native species to regenerate. Karim et al. (2017) while estimating the soil seed banks of *Parthenium* infested sites in Malaysia from four depths, 0-5cm, 5-10cm, 10-15cm and 15-20cm in different sites reported that weed seed bank significantly differed between the different sites. They have reported 0.99 million/ha, 1.79 million/ha, 5.4 million/ha and 11.08 million/ha seeds in the soil in different locations. Around 60% of the total number of seeds were recorded in 0-5cm soil depth; with the number of seeds decreased logarithmically with soil depth. The total number of seeds in the soil depth of 15cm was 8300 seeds/m^2 or 83.0 million/ha (Karim et al. 2 017b). Monitoring of weed seeds over a long period of time is required to make sure that all the seeds are removed from the soil. Shabbir (2015) reported that the domination of *Parthenium* weed of the seed banks indicated that the weed had a substantial negative impact on the ecology of plant communities. *Parthenium* weed can significantly reduce the plant diversity in the belowground species present in the form of seed banks. Nguyen (2011) found that the diversity of a pasture plant community in Queensland was significantly reduced by the presence of *Parthenium* even when the weed was present in relatively low density (i.e. 2 plants/m^2) and this trend was seen both the above ground plant community and the soil seed bank. In the present study the seedlings of *Parthenium* decreased in the month of July compared to April 2017. In the month of April the seedlings of only four species emerged whereas in the month of July seedlings of eight species emerged. In the month of July *C.dactylon* was dominant whereas in the month of April *O.corniculata* was the dominant species.

The present study indicated the seed bank of different species varied in soil in April and July i.e. in different season; and the number of seedlings of *Parthenium* were higher in April 2017 to July 2017 i.e. seed bank of *Parthenium* also varied in different season.

Table 1. Soil seed bank status of different species in soil samples collected in the month of April 2017.

Sl. No.	Name of Species	Pot 1	Pot 2	Pot 3	Pot 4	Pot 5	Mean
1	***Parthenium hysterophorus***	14	21	17	24	10	**17.2**
2	***Croton sparciflorus***	20	22	25	41	39	**29.4**
3	***Oxalis corniculata***	35	60	20	18	26	**31.8**
4	***Cynodon dactylon***	2	6	0	0	0	**1.6**

Table 2. Soil seed bank status of different species in soil samples collected in the month of July 2017.

Sl. No.	Name of Species	Pot 1	Pot 2	Pot 3	Pot 4	Pot 5	Mean
1	***Parthenium hysterophorus***	6	8	5	7	5	**6.2**
2	***Cynodon dactylon***	80	106	71	85	77	**83.8**
3	***Oxalis corniculata***	2	4	2	0	0	**1.6**
4	***Dactyloctenium aegyptium***	0	8	2	13	8	**6.2**
5	***Tridax procumbens***	0	2	0	3	2	**1.4**
6	***Cyperus rotandus***	0	2	0	3	4	**1.8**
7	***Digitaria setigera***	0	0	0	0	2	**2.4**
8	***Phyllanthus niruri***	0	0	0	0	2	**0.4**

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