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Germination Potential and Growth Behaviour of *Eclipta alba*

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ABSTRACT

Laboratory experiments were conducted to determine dormancy in *Eclipta alba* seeds. The effects of light, temperature, age of the seeds, simulated moisture stress, salt stress and variable pH were also studied. It was observed that the seeds germinated immediately after harvest and showed no dormancy. These possessed an absolute requirement of light for germination. 25ºC was seen to be the optimal temperature for germination. These did not germinate beyond a water stress of –0.4 MPa. Low levels of salinity (0-120 mM NaCl) did not affect germination. Acidic pH completely inhibited germination. Only seeds at the surface layers of soil germinated. Those at a depth of even 2.5 cm did not germinate. Seed rain/m^2 was observed to be 13, 63, 534. The results have been discussed in the light of literature available.

INTRODUCTION

Eclipta alba L. Hassk (*Eclipta prostrata*) is a dicot annual weed belonging to the family Compositeae (Asteraceae). It is variously called as '*Yerba de Tago'*, '*White daisy'*,'*Bhringraj'* and '*Bhangra'*. The weed grows commonly in moist places and is considered to be one of the world's major weeds. While in India it is considered as a nuisance in rice crop, in other countries it is known to cause problem in other crops like soybean and peanut. The weed may grow erect or prostrate often rooting at the nodes with opposite, sessile and oblong leaves (2.5 x 7.5 cm). The leaves possess white appressed hair. Floral heads are solitary, white homogenous capitula without differentiation into ray or disc florets, and 6-8 mm in diameter.

Weed emergence can be variable in the fields and is dependent upon innate as well as environmental factors. Seed dormancy/viability would determine the time of germination. Some weeds remain viable in the soil for longer periods as compared to others. This would be further affected by prevailing environmental conditions like light, moisture, temperature, soil pH, etc. Sound weed management practices require an integrated approach. Ability to predict weed seed germination in response to environmental conditions is essential for better timing of mechanical, chemical as well as biological treatments. Invasion and establishment into other areas can also be predicted from the environmental factors essential for its germination and growth.

Though abundantly found as weed, some of the farmers have attempted to cultivate it for its medicinal properties. Its micropropagation, has also been attempted because of its demand in national and international markets (Dhaka and Kothari, 2005). A study on the physiology of germination and growth behaviour of this herb gains importance from its cultivation point of view also.

The main objective of the present investigation was therefore (1) to determine the viability/dormancy of the weed seeds, (2) to study the effect of light, temperature and age of the seeds on germination, (3) To determine the effect of moisture stress, salt stress and variable pH on germination of the weed, (4) to study emergence of the weed seedlings from various depths and (5) to study the vegetative and reproductive growth behaviour of the weed.

MATERIALS AND METHODS

Seeds of *Eclipta alba* were collected in the month of October in 2004, 2005 and 2006 from farm fields of Haryana Agricultural University, Regional Research Station, Uchani, Karnal. These were stored in glass bottles. For testing dormancy/viability 20 seeds in three replicates were subjected to a germination test in Petriplates lined with filter papers at room temperatures immediately after harvest. The filter paper was moistened with distilled water. Germination was determined by visible radicle protrusion one week after soaking. Germination was tested at room temperatures at monthly intervals also for the next six months. To study the effect of temperature on germination, the germination test was performed at 15, 20, 25 and 30^{O}C in an incubator maintained at these temperatures. Germination count was taken 1, 2, 3 and 4 weeks after soaking. To study the effect of light Petridishes were wrapped in aluminium foil and opened only to record the germination count. To study the effect of age, freshly harvested seeds, one and two years old seeds were tested at 25ºC in continuous light. Studies on the effect of pH, salt and moisture stress were also conducted at 25ºC in light. To study the effect of moisture stress, aqueous solutions with osmotic potential 0, -0.02, -0.05, -0.2 and -0.4 mPa (mega Pascals) were prepared by dissolving appropriate amounts of polyethylene glycol (PEG, 8000) in deionized water (Burlyn and Kaufmann, 1973). Sodium chloride solutions of 0, 40, 80, 120 and 160 mM were prepared to study the influence of salt stress. Effect of pH on germination was studied using buffer solutions of pH 4-10. Unbuffered distilled water was used as control. To study emergence from various depths, 20 seeds in three replicates were placed in earthen pots at surface, 2.5 and 5.0 cm depths. Seedling emergence was recorded. All experiments were repeated twice. Regression analysis of the data on osmotic potential and salt stress was performed.

To study the growth behaviour, seeds were allowed to germinate in pots (9 cm dia.) filled with sandy loam soil in July 2005. Two plants per pot were maintained in three replicates to study the growth behaviour. Data on plant height, leaf number/plant, number of flowers and fruits/plant were recorded at periodic intervals. Number of plants infesting rice field/m^2 was also recorded. Number of flowers/plant, number of seeds per capitula for 20 capitula and 1000-seed weight of the seeds were also recorded. Seed rain/ m^2 was calculated by multiplying the average number of seeds per plant with number of plants per square metre.

RESULTS AND DISCUSSION

The weed seeds germinated when tested in the month of October immediately after harvest. Germination percentage was near 100% within three days indicating lack of dormancy in the weed. This also indicated that all the seeds produced were viable. Germination tests conducted at monthly intervals at room temperatures in the laboratory revealed higher germination in the months of October and November which declined in the months of December and January indicating inhibition of germination at lower temperatures (Table 1).

Table 1. Germination response of *Eclipta alba* seeds at monthly intervals for six months after harvest

Month	Temperature ºC (Max./Min.)	Per cent germination after one week
October	29/13	99±0 .9
November	27/13	81±0.7
December	17/8	13±0.1
January	18/10	20±0.18
February	25/9	90±0.88
March	34/16	75±0.68

Germination test conducted at different continuous temperatures revealed 100% germination within 15 days at 25ºC. Germination declined with increase in temperature to 30ºC. Decline in germination was also seen at temperatures lower than 25ºC. At 15ºC, germination was completely inhibited. Germination was inhibited in the set maintained in continuous dark (Table 2). The results on inhibition of germination in dark are in conformity with the findings of Altom and Murray (1995). However, in contrast to the ecotype from Oklahoma U. S. which showed optimal germination at

Table 2. Germination of *Eclipta alba* seeds at varying temperatures under light and dark conditions

Temperature	Light condition	Germination percentage			
		1 week	2 weeks	3 weeks	4 weeks
15ºC	Light	0	0	0	0
	Dark	0	0	0	0
20ºC	Light	6.5±1.0	6.5±1.0	6.5±1.0	6.5±1.0
	Dark	0	0	0	0
25ºC	Light	85±0.9	100±0	100±0	100±0
	Dark	0	0	0	0
30ºC	Light	55±0.7	65±0.2	65±0.2	65±0.2
	Dark	0	0	0	0

35°C, the ecotype from Haryana, India showed optimal germination at 25°C. Freshly harvested seeds as well as one-year old seeds showed 100% germination. Two-year old seeds showed significant loss of germination (Table 3). Seeds sown in pots in the surface soil layer showed 95% emergence one week after sowing and 100% emergence after two weeks, while those at a depth of 2.5 cm or more did not emerge. This may be due to inhibition of germination in the dark.

Eclipta germination declined with the lowering in osmotic potential. While it was 80% in control, it declined to 45% at -0.2 MPa and to 6 % at -0.4 MPa (Fig. 1). The seeds did not germinate at a water potential lesser than -0.4 MPa. An increase in salt concentration in the solution affected germination only beyond 120 mM NaCl. Only at 160 mM the germination percentage

Table 3. Germination response of *Eclipta alba* seeds as affected by age of the seeds at 25°C in light

Age (Years)	Germination percentage			
	1 week	2 weeks	3 weeks	4 weeks
Freshly harvested, 0	85±1.6	100±0	100±0	100±0
1 year	95±0.4	95±0.2	95±0.2	95±0.2
2 years	10±0.8	15±1.1	15±1.2	15±1.2

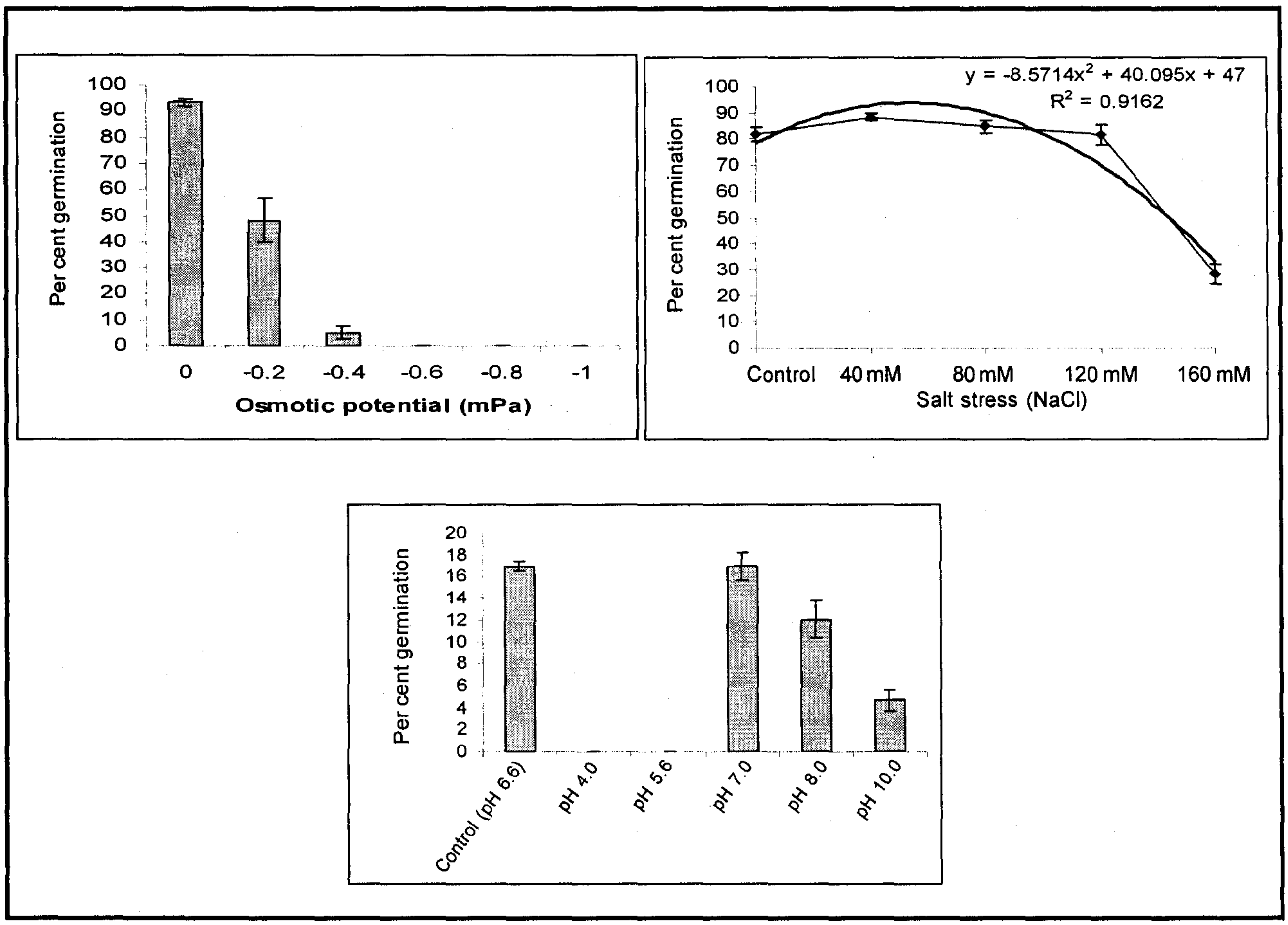

Fig. 1. Germination percentage of *Eclipta alba* as affected by moisture stress (A), salt stress (B) and solution pH (C). Bars indicate standard error of mean of three replicates. Regression analysis of data on salt stress indicates a decline in germination percentage after 100 mM NaCl.

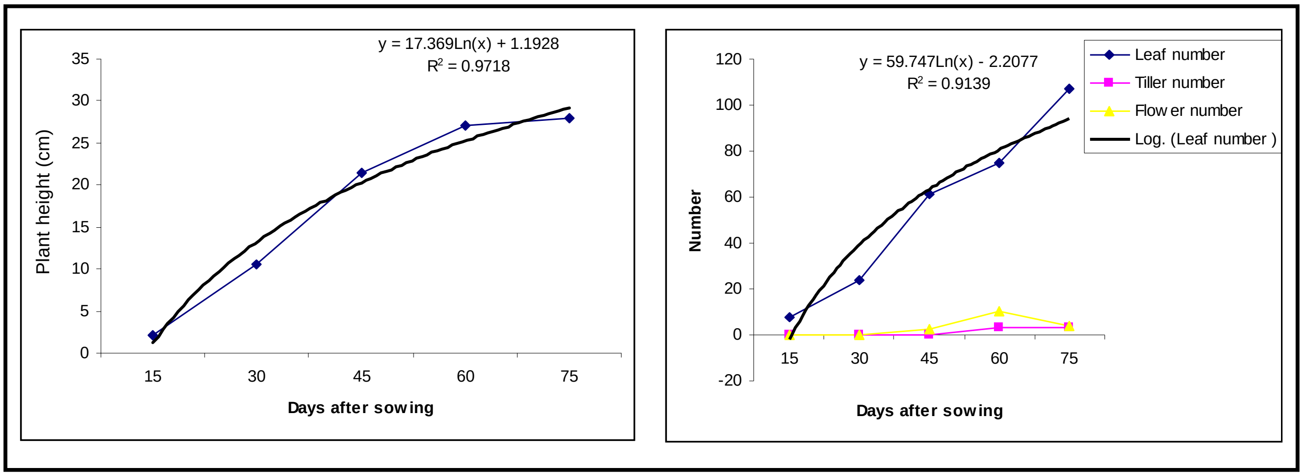

Fig. 2. Periodic changes in growth parameters of *Eclipta alba*.

declined to 30% of the control. A solution pH of 7.0 and 8.0 allowed 60-80% germination. Twenty three per cent seeds germinated at pH 10.0 but died when kept in this medium for more than a week (Fig. 1). None of the seeds germinated at pH 4.0 and 5.6. The germination of the ecotype from Haryana, India at pH 10.0 is in contrast to the response seen in the ecotype from Oklahoma U. S. (Altom and Murray, 1995). This could be due to the ecotypic adaptation in different geographical niches.

The data on morphological parameters indicate that the plant gains a length of 8-10 cm within 15 days and develops 8-10 leaves (Fig. 2). These start to flower 45 days after sowing and a maximum of 18-20 flowers per plant could be observed. The flowers may mature and produce seeds within 15 days. Old capitula shed seeds, while new flowers keep emerging. The plants show tillering at 60 days after sowing and 3-4 tillers are produced per plant. The plants from the fields are seen to bear 20-100 flowers with 4-10 tillers/plant. Average number of seeds produced per plant is 3000 with a range of 840-7000. Seed rain/m^2 in rice fields is 13, 63, 534 + 343506. 1000-seed weight is 376 + 2 mg.

With no dormancy in *E. alba* seeds and 100% viability of the seeds produced by this weed a severe competition is expected immediately after shedding. This is particularly so if the seed is shed in wetter areas. It is evident from the inhibition of germination at a water stress of -0.2 mPa that the weed is moisture loving and can invade only wet areas. The weed may also invade areas with low levels of salinity. Invasion can also take place in alkaline soils but establishment may be difficult. Acidic soils would restrict its invasion. The loss of germination in two-year old seeds as also no dormancy in the seeds is an indicator of the fact that it may not contribute much to the soil seed bank. However, since the plants do not flower and shed seeds at one time the period of seed shedding becomes broad. Also ability to germinate immediately after harvest would require management of the weed over a rather broad period. A herbicide that would have sufficient residual effect would be needed to manage the weed. More than one applications of post-emergence herbicides could also be considered for the management of the weed.

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