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CHEMICAL CONTROL OF *Parthenium hysterophorus* L.

Asad Shabbir[1]

ABSTRACT

Parthenium hysterophorus weed is an alien invasive weed species spreading very fast in Pakistan and in many other parts of the world. In this present study, we investigated the chemical control of P. hysterophorus using two herbicides, glyphosate and isoproturon at different doses (at ¾ and ½ of the recommended), tested first under glasshouse conditions and then under field conditions in Islamabad. Under glasshouse conditions, the recommended doses of both the herbicides resulted in 100% mortality of the weed 21 days after spray (DAS). The ½ and ¾ doses of glyphosate resulted in 60% and 90% mortality of P. hysterophorus plants, respectively 21 DAS. Under field conditions, ½ and ¾ of the recommended doses of glyphosate resulted in 100%, 80% and 30% mortality of P. hysterophorus plants, respectively 21 DAS. However, the most effective dose for isoproturon was the recommended dose that resulted in 80% mortality of the weed plants 21 DAS. This study concluded that both of these selective herbicides, glyphosate and isoproturon are effective in killing of P. hysterophorus but glyphosate is comparatively more effective as compared to isoproturon.

Keywords: Parthenium weed, herbicide, glyphosate, isoproturon, Islamabad

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INTRODUCTION

Parthenium hysterophorus L. commonly known as parthenium weed is an alien invasive weed of global significance. This noxious weed has serious negative impacts upon crop and pasture production, human and animal health and native plant biodiversity (Shabbir and Bajwa, 2006; Adkins and Shabbir, 2014). In Pakistan, *P.hysterophorus* was first reported in 1990s in the Gujarat district in the Punjab Province and since then it is spreading at alarming rate in most parts of the country, especially in central Punjab and Khyber Pakhtunkhwa

[1] Institute of Agricultural Sciences, University of the Punjab, Quaid-e-Azam campus, Lahore 54590 Punjab Pakistan
*Corresponding author's email: asad.iags@pu.edu.pk

(Shabbir *et al.*, 2012) and more recently in Azad Jammu Kashmir (A. Shabbir Personal comm.). *Parthenium hysterophorus* is very common in disturbed habitats, for example, along roadsides, canal and watercourses, in unmanaged lawns, around the buildings and wastelands from where it spreads into the agricultural fields (Adkins and Shabbir, 2014).This weed is also reported from the protected areas and national parks around the world.

Parthenium hysterophorus can invade a wide range of crops, such as rice (*Oryzasativa* L.), wheat (*Triticumaestivum* L.), maize (*Zea mays* L.), teff (*Eragrostis* Tef Zucc. Trotter) and sorghum (*Sorghum bicolour* L.) in different parts of the world (Tamado *et al*., 2002; Shabbir, 2006). In these crops, *P. hysterophorus* has been shown to reduce yields by as much as 40% in India (Khosla and Saboti, 1979) or by 28% in Ethiopia (Tefera, 2002). In Pakistan, this weed is very common in crops that grown on ridges for example in sugarcane (*Saccharum officinarum* L.), maize and onion (*Allium cepa* L.) (Shabbir *et al*., 2012). Contamination of rice and wheat seeds with this quarantinable weed species seed may havesevere consequences for the export of these crops.

The chemical control is a quick and effective option for the management of *P. hysterophorus*. A range of herbicides including atrazine, dicamba, 2,4-D, picloram and glyphosate, are all applied at high volume, have been found useful to manage this weed overseas (Haseler, 1976) but little information is available from the Pakistan, especially from the Punjab province where the weed has its core infestation and spreading very fast.

The present study was therefore designed to investigate the efficacy of different doses of two commonherbicides, glyphosate and isoproturon for chemical management of *P. hysterophorus* first under glasshouse and then field conditions.

MATERIALS AND METHODS

Glasshouse experiment

Seeds of *P. hysterophorus* were collected from the *Changa Manga* forest plantations during a field visit in the winter season. The viability of seeds wastested in the laboratory where seeds were set to germinate on moistened double folded filter paper in pre-sterilized Petri plates placed in an incubator (30/18^{o}C). The seeds of *P. hysterophorus* showed 90% germination within a week. Twenty four clay pots (30 cm diameter; height of 35 cm) were filled with approximately 5 kg of sandy loam soil were placed in a glasshouse 30/18 ±2 (day/night) with 60% relative humidity. Five seeds of *P.hysterophorus*were sown in each pot at about 2 cm depth and watered regularly at field capacity. Fourteen days after sowing when

the maximum germination had been attained, the number of plants was reduced to onepot^{-1} to have a uniform density.

Two herbicides, commercially registered against the broad leaved weeds, were selected for the chemical control of *P. hysterophorus.* The selected herbicides with their trade and generic namesand recommended doses were Glyphosate(Round-up)at 500 mL ha^{-1} andIsoproturon 5WP (Isoproturon)at 2 Kg ha^{-1}.These herbicides were obtained from the Weed Science Unit of the National Agricultural Research Centre, Islamabad.Three doses of each of the twoherbicides were formulated*viz*, the recommended dose (hereafter as full dose), ¾ and ½ of the fulldose. Each treatment was replicated three times. The quantity of each herbicide required for a single pot was estimated by calculating the area of the pot used.The required amount of each herbicide was applied to all pots except the control on three-week old *P. hysterophorus*plants. A simple hand sprayer was used for the herbicides applicationearly in the morning during bright day light. The plant foliage was sprayed sufficiently so that it is completely wet with the herbicide. A similar amount of distilled water applied on plant in the control treatment. The experiment was carefully watched on daily basis for the development of any symptoms (necrosis or wilting) and data were recorded on plant height and mortality rate at an interval of 7, 14 and 21 days after the herbicide application.

Field experiment

A suitablefield site (5m × 10m) with high and even density of *P. hysterophorus* was selected for the chemical control. This site was a typical wasteland near the National University of Modern Languages (NUML), Sector H-9, Islamabad. At this site, *P. hysterophorus* had formed a typical monoculture and most plants were at the rosette stage (Plate 1). Within the selected site, nine plots (1 × 1m) were created and marked with the help of wire tags.

The full, ¾ and ½ doses of isoproturon and glyphosate formulated as described in a previous section and weretested for the field experiment. A surfactant was added (1mL 1L^{-1}) to enhance dispersion, penetration of the herbicides, and to promote residual effects on the *P. hysterophorus* plants. The formulated doses of both herbicides were applied on *P. hysterophorus* plants, using a 5L manual pump sprayerearly in the morning on a clear day. The plants were carefully observed throughout the course of the experiment and data on mortality of the plants were taken at an interval of 7, 14 and 21 days after spray (DAS).Mortality rate (%) was calculated on the basis of the number of the weed plant kill at 7, 14 and 21 DAS. A visual criterion was developed to assign mortality rate (%) in selected plots in field. For example if 1/5 of the plot area is dead 20% mortality was assigned and if ½ is dead, 50% isassigned and so on. Due to large

number of plants present plot^{-1} and time constraints, the number of individual plant plot^{-1} was not counted.

Experimental design and data analysis

Both pot and field experiments were laid out in a completely randomized design. Data onplant height (cm) and mortality rate (%) of *P. hysterophorus* were analysed statistically using Assistat statistical software package. A pairwise comparison among various treatments was also made.To identify significant differences between means, a LSDtest (Steel and Torrie, 1980) was performed.

RESULTS AND DISCUSSION

Chemical control underglasshouse conditions

Plant height

After14 days of glyphosate application, a significant height reduction of *P. hysterophorus* plants was seen in all three doses of the herbicide as compared to the control treatment ($P< 0.05$; Fig. 1a). A similar effect of treatments was observed 21 DAS but the full dose had a greater suppressive effect upon the plant height reducing itto 68% as compared to control (Fig. 1a). A similar trend was observed when isoproturon was applied, 14 and 21 DAS and the height was significantly suppressed in all three doses as compared to control (Fig. 2a). The full dose of isoproturon resulted in the maximum height suppression (62%) 14 DAS. It was interesting to note that the suppressive effect of both herbicides on height was the same in full dose and ¾ of the full doses of glyphosate and isoproturon (Fig. 1a & 2a).

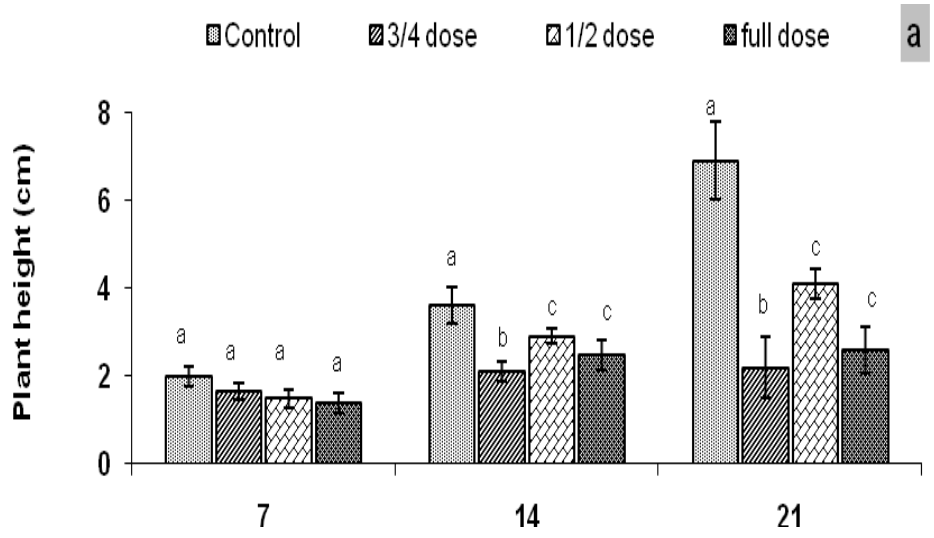
Mortality rate

Wilting and necrosis of leaves started after few days of herbicides application but mortality was only seen after 14 DAS. Glyphosate resulted in 40and 90% mortality in ¾ and full dose of glyphosate, respectively however it was increased to 100% in both treatments 21 DAS (Fig. 1b). No mortality was seen in any other treatment except in the full dose of isoproturon where 70% plants died 14 DAS (Fig. 2b) however, all *P. hysterophorus* plants survived in ½ dosebut ¾ and full dose of isoproturon resulted in 80 and 100% mortality 21 DAS. In earlier studies, bromoxynil + MCPA was the most effective as post-emergence treatments (Javaid, 2007) while Imazethapyr is particularly effective as a pre-emergence treatment in green gram (Tewari *et al*., 2004).

Chemical control underfield conditions

Soon after the application of glyphosate, leaf tip and leaf margin necrosis developed as early symptoms which gradually intensified with the progression of experiment. After 14days spray70, 40 and 20%mortality was achieved in full, ¾ and ½ doses of

glyphosate, respectively as compared to control (Fig. 3a; Plates 1). The mortality was increased to 100 90 and 30% in full, ¾ and ½ doses, respectively 21 DAS of glyphosate. When isoproturon was applied, 100% mortality was achieved in full dose and only in 21 DAS (Fig. 3b). However, all other doses showed only up to 50% control after 21 DAS in the field. Glyphosate was more effective in controlling *P. hysterophorus* and showed better results as compared to isoproturon in achieving an early killing of weed plants. This effect was seen both under glasshouse and field conditions.Some of the newer herbicides, such as imazapyr, oxadiazon, oxyfluorfen, pendimethalin and thiobencarb, have also been reported to be highly effective against *P. hysterophorus* (Parsons and Cuthbertson, 1992).It was interesting to note that ¾ dose of isoproturon was very effective under glasshouse but not under the field conditions. The probable reason for this difference in efficacy may be due to the fact that plant under field conditions were exposed to natural climatic conditions as compared to the semi controlled conditions in the glasshouse. In contrast, ¾ dose of glyphosate was equally effective under both the glasshouse and field conditions where 100 and 90 % control of *P. hysterophorus* was achieved, respectively 21 DAS. The low rates of glyphosate have already proven to be effective in controlling *P. hysterophorus* in coffee (*Coffea arabica* L.) plantations in Kenya (Njoroge, 1991).



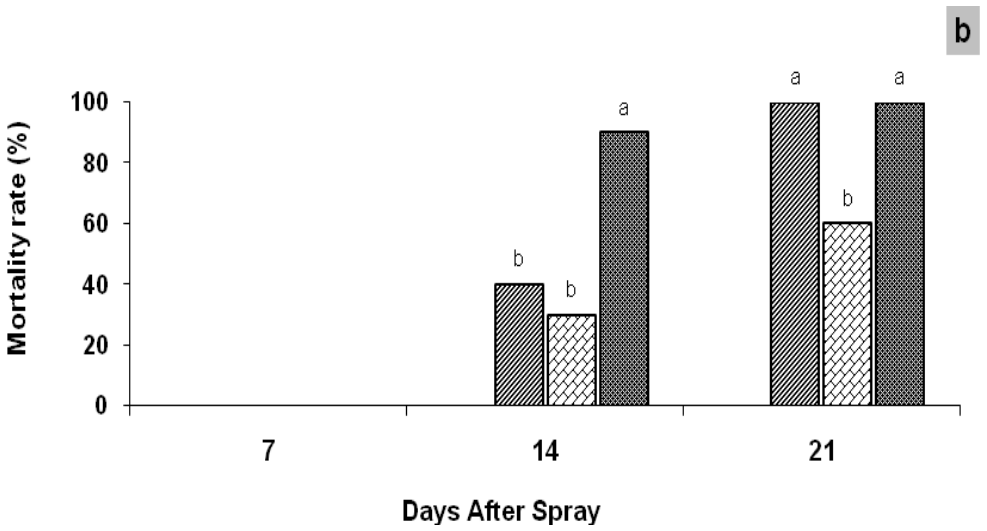
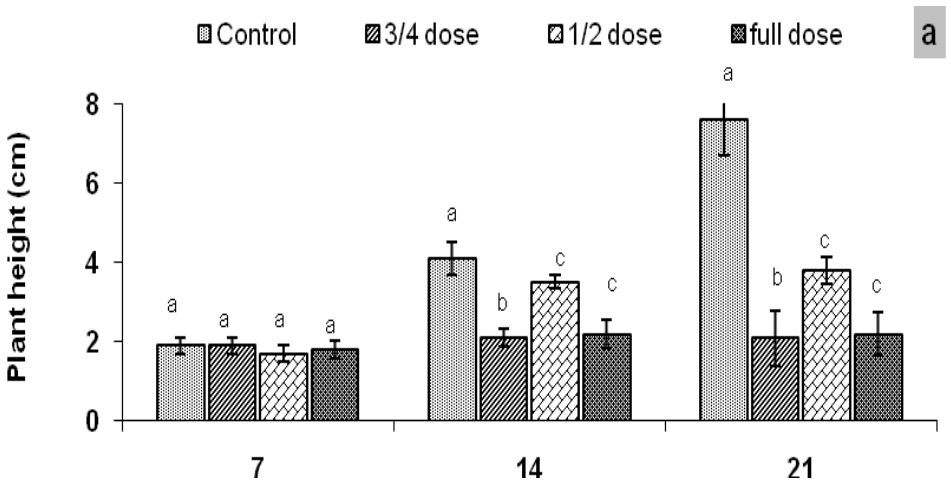


Figure 1. Effect of glyphosate on (a) plant height (cm)and (b) mortality rate (%)of *P. hysterophorus*7, 14 and 21 DAS. Values with different letters show significant differences ($p<0.05$). Vertical bars show ±SE of the mean from three replicates.



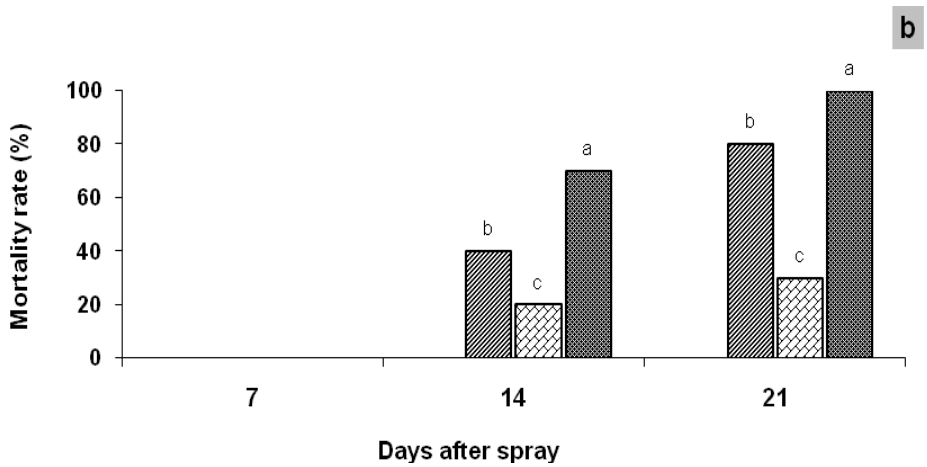
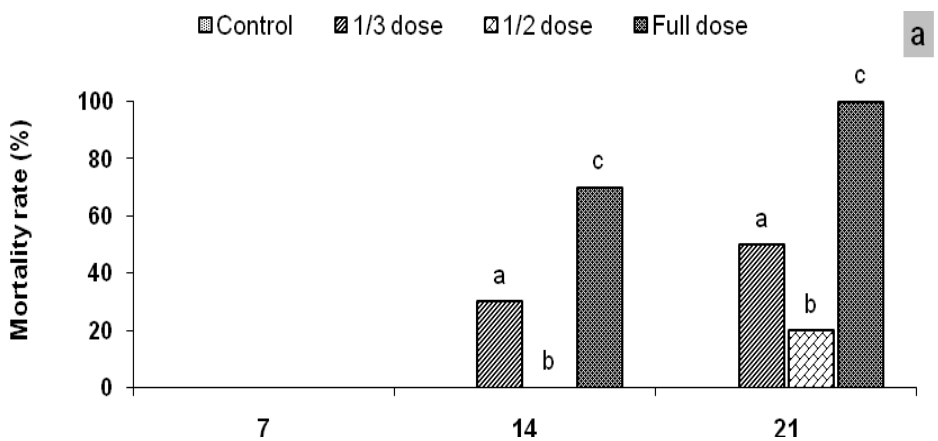


Figure 2. Effect of isoproturon on (a) plant height (cm) and (b) mortality rate (%)of *P. hysterophorus*7, 14 and 21 DAS. Values with different letters show significant differences ($p < 0.05$). Vertical bars show ±SE of the mean from three replicates.



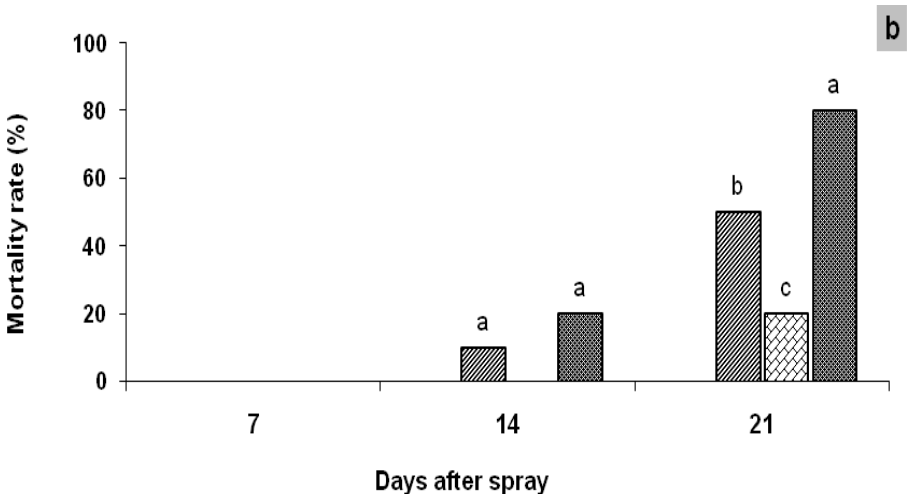


Figure 3.Effect of glyphosate (a) and isoproturon (b) on mortality rate (%) of *P. hysterophorus* 7, 14 and 21 DAS in the field. Values with different letters show significant differences ($p < 0.05$).

Plate 1. *Parthenium hysterophorus* in rosette stage growing in a control plot (at the left side) complete mortality in a typical plot treated with full dose of glyphosate 21 DAS (at the right side).

CONCLUSION

Under glasshouse conditions, the recommended doses of both glyphosate and isoproturon have 100% mortality of the weed at 21 days after spray (DAS). The ½ and ¾ doses of glyphosate has 60% and 90% mortality of *P. hysterophorus*, respectively. Under field conditions, ½ and ¾ of the recommended doses of glyphosate give 100%, 80% and 30% mortality of *P. hysterophorus* plants, respectively. However, the most effective dose for isoproturon was the recommended dose that resulted in 80% mortality of the weed plants. Thus both of these selective herbicides, glyphosate and isoproturon are effective in killing of *P. hysterophorus* but glyphosate is comparatively more effective as compared to isoproturon.

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