EFFECT OF GLYPHOSATE ON CHLOROPHYLL AND CAROTENOIDS IN WEED SPECIES (*Parthenium hysterophorus* L. and *Cyperus rotundus L.*)

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ABSTRACT

Photosynthetic effects of the Glyphosate (X-(Phosphonomethyl) glycine) on *Parthenium hysterophorus* L *and Cyperus rotundus* L. were studied. Glyphosate was diluted with distilled water (25ppm) for foliar application. The seedlings were maintained under natural photoperiod condition (about 2000 //E M'2 Sec" 400-700nm (PAR) at 12.00 noon with a light regime of approximately 11 hours at 34 to 40°C followed by 13 hours dark at 16-20°C. The experiment was carried out to analyze the effects of glyphosate by measuring chlorophyll ‘a’, chlorophyll ‘b’, total chlorophyll and carotenoid contents in weed species. The experimental plants were sprayed 20 days after emergence and control plants were maintained by a simultaneous spray of deionized water. Leaves of *Parthenium hysterophorus* L and *Cyperus rotundus* L weed species were collected at 5days interval following the foliar application of herbicide up to 15^{th} day. Results showed that Chlorophyll (Total chlorophyll, chlorophyll a and b) and carotenoid content was adversely affected as the duration and concentration of glyphosate increased

Key words: Glyphosate, Weed species *Parthenium hysterophorus* L., *Cyperus rotundus* L., Total chlorophyll, Carotenoids.

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INTRODUCTION

Glyphosate [N-(Phosphonomethyl) glycine)] is a relatively non-selective herbicide developed by Monsanto and is considered to be a very significant discovery (Stephen *et al*., 2012). Glyphosate [*N*-(phosphonomethyl) glycine] has become the most widely used herbicide in the world; in large part because of it use in transgenic, glyphosateresistant (GR) crops (Duke, 2012; Duke and Powles, 2008, 2009). It is particularly valuable for control of most annual and perennial weed species. It is applied to the foliage of vegetation to control. It is readily absorbed by leaves and translocated through the symplast (Sprankle *et al*., 1975). Since its introduction, glyphosate has been considered a toxicologically and environmentally safe pesticide, due to its low mammalian toxicity, relatively short environmental half-life, and extremely low activity in soil due to its binding to soil minerals (reviewed by Duke *et al*., 2012). Besides several competitive factors, weeds are also known to inhibit crop growth due to their allelopathic activity in the agro-ecosystems. Weeds often produce enormous biomass during their life cycle which upon decay can be phototoxic to other plants in the vicinity (Weston and Duke 2003; Batish et al. 2007). Glyphosate has several desirable properties that have contributed to its widespread use (Duke *et al*., 2008). Singh et al. (2005) concluded that Parthenium hysterphorus L. residues exert a negative influence on the early growth of Brassica crops by releasing water-soluble phenolics. Likewise, Batish et al. (2009) attributed the negative effect of Ageratum conyzoides residues on rice germination and early growth to the release of water soluble phenolic acids into the soil environment. During its several decades of use over vast areas, no significant adverse secondary effects of the herbicide have been established, other than the intense selection pressure that has resulted in the evolution of GR weeds. In fact, its use in GR crops has been associated with several environmental benefits (Cerdeira and Duke, 2006 and Garner and Nelson, 2008). The topic of evolution of GR weeds has been dealt with in detail in many research papers and reviews (Powles and Yu, 2010 and Shaner *et al*,. 2012).

Once glyphosate interacts with soil, whether applied directly to the soil surface, exuded from a plant root, or released from decomposing plant tissue, it is subject to various processes that control its environmental behavior and fate, including retention (sorption−desorption), transport, and degradation. Of these processes, sorption is arguably the most important as it controls the availability for degradation, plant uptake, and offsite transport. Sorption of glyphosate to soil has been extensively reviewed (Duke, 1988; Vereecken, 2005; Borggaard and Gimsing, 2008).

In the present investigation an attempt was made to study the comparative account of biological response of herbicide glyphosate in two weed species. Among herbicides used to control weeds glyphosate is one of the foliar applied herbicide.

MATERIAL AND METHODS

Pot culture experiment was conducted with freshly young seedlings of ***Parthenium hysterophorus* L** *(*Congress Grass**) and *Cyperus rotundus* L (**nut grass**).** Weed species are common and dominant in the vegetable crop fields in the surrounding area of Tirupati. Tirupati is located between 79°25' 1-ongitude and 3°58' Latitude and is situated in Chittoor District, Andhra Pradesh, India. The weed seeds were collected from the ground nut crop fields and seeds were soaked in the seed pan for 2 days to obtain maximum germination percentage. After 20 days, the plantlets were sown in the experimental pots containing red soil supplemented with farmyard manure in the ratio of 1:3. The seedlings were maintained under natural photoperiod condition (about 2000 //E M'^{2} Sec" 400-700nm (PAR) at 12.00 noon with a light regime of approximately 11 hours at 34 to 40°C followed by 13 hours dark at 16-20°C.

Herbicide Treatment

The herbicide used in the present study was (X-(Phosphonomethyl) glycine) marketed under trade name glyphosate and was obtained from Monsanto Company. Glyphosate diluted with distilled water (25ppm) was selected for foliar application. In the present study only 20-22 days old seedlings of ***Parthenium hysterophorus* L and *Cyperus rotundus* L** were treated with glyphosate using "Aspee" sprayer (Aspee, Bombay) to the drip point at 8.00 «LID without using any wetting agent. The control plants were maintained by a simultaneous spray of deionized water. Pot culture experiments were conducted in the Department of Environmental Science, Sri Venkateswara University, Tirupati, India.

Sampling

Leaves of ***Parthenium hysterophorus* L and *Cyperus rotundus* L** weed species were collected at 5days interval following the foliar application of herbicide upto 15th day. The leaves were thoroughly washed first with tap water followed by deionized water and were dried with filter paper. Fresh leaf material was used for the determination of chlorophyll and carotenoids. The chlorophyll content was estimated according to the method of Arnon (1949), Total carotenoids were determined as per the method of Jensen and Jensen (1971).

Data were expressed as Mean ± Standard deviation of mean (SD). Results were statistically analyzed by student's test (Pillai and Shinha 1968)

RESULTS AND DISCUSSION

The present work was undertaken to study the effect of glyphosate on chlorophyll fractions like chlorophyll 'a', chlorophyll 'b' and total chlorophyll were estimated in leaves of *Parthenium hysterophorus* L and *Cyperus rotundus* L. The results of this study showed that, the control plants chlorophyll 'a' content was more in *Parthenium hysterophorus* L and *Cyperus rotundus* L, but the glyphosate treatment caused decrease in all the plants up to 15th day over the control respectively in both the weed species. Thus, the chlorophyll 'a' content is decreased significantly in both the treated weed species (Tab.1, Fig.1). The treated plants showed that the gradual decrease in chlorophyll 'b' content in all the stages of experimental days. The maximum decrease was noticed in both the weed plants on 15th day, The decreased levels chlorophyll-b was observed in *Parthenium hysterophorus* L and *Cyperus rotundus* L (0.220; 0.186; 0.146; 0.125 and 0.218; 0.173;0.137; 0.118) on 5th-10th and 15th day respectively over the control (Tab.2, Fig.2). The results revealed that the total chlorophyll content was continuously decreased up to 15^{th} day in *Parthenium hysterophorus* L and *Cyperus rotundus* L over the control. The reduction in chlorophyll a, chlorophyll b and total chlorophyll contents in 15 days treated leaves is nearly 50% over control in both the cases. However, the weed species showed consistent decrease at all the experimental days. The result was similarly compared with several reporters (Luiz Henrique Saes Zobiole et al, 2012, Zobiole et al., 2010e). The content of total carotenoid was also reduced with effect of glyphosate caused gradual decreased carotenoid content in both the weed species up to 15^{th} day. In both cases the maximum declined was noticed on 15^{th} day only, The decreasing level of carotenoid content in *Parthenium hysterophorus* L and *Cyperus rotundus* L, (-0.746,-0.470,-0.315,-0.218; and -0.814,-0.513,-0.422,-0.132) (Tab.4, Fig.4) when compare to control. It was also resulted by the reports of Peter J. Ralph, 2000).

Table: 1. Effect of glyphosate on chlorophyll 'a'content on weed species (mg/g.fwt)

Name of the weed species	Days after treatment			
	Control	**5th day**	**10th day**	**15th day**
***Parthenium hysterophorus* L.**	0.360 ± 0.032	0.241 ± 0.028	0.205 ± 0.034	0.170 ± 0.021
***Cyperus rotundus* L.**	0.345 ±0.020	0.247 ±0.028	0.198 ± 0.031	0.160 ±0.040

= ± SD Values are mean of 5 replications

Table: 2. Effect of glyphosate on chlorophyll 'b' content on weed species (mg/g.fwt)

Name of the weed species	Days after treatment			
	Control	**5th day**	**10th day**	**15th day**
***Parthenium hysterophorus* L.**	0.220 ± 0.029	0.186 ± 0.021	0.146 ± 0.023	0.125 ± 0.092
***Cyperus rotundus* L.**	0.218 ±0.074	0.173 ±0.016	0.137 ± 0.013	0.118 ±0.060

= ± SD Values are mean of 5 replications

Table: 3. Effect of glyphosate on total chlorophyll content on weed species (mg/g.fwt)

Name of the weed species	Days after treatment			
	Control	**5th day**	**10th day**	**15th day**
***Parthenium hysterophorus* L.**	0.580 ± 0.027	0.399 ± 0.012	0.351 ± 0.019	0.295 ± 0.048
***Cyperus rotundus* L.**	0.392 ±0.023	0.337 ±0.019	0.278 ± 0.071	0.256 ±0.031

= ± SD Values are mean of 5 replications

Table: 4 Effect of glyphosate on carotenoid content in weed species (mg/g.fwt)

Name of the weed species	Days after treatment			
	Control	5th day	10th day	15th day
***Parthenium hysterophorus* L.**	0.746 ± 0.094	0.470 ± 0.147	0.315 ± 0.084	0.128 ± 0.0719
***Cyperus rotundus* L.**	0.814 ±0.024	0.513. ±0.019	0.422 ± 0.130	0.132 ±0.042

= ± SD Values are mean of 5 replications

Fig. 1 Effect of glyphosate on chlorophyll 'a'content on weed species (mg/g.fwt)

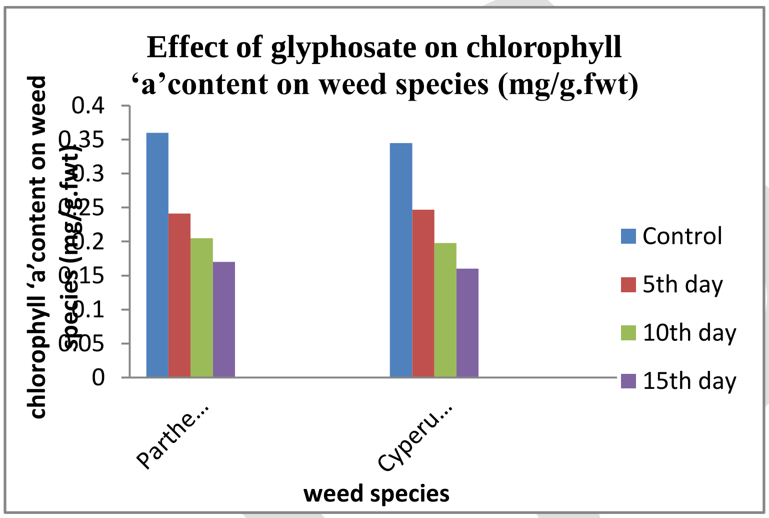


Fig. 2 Effect of glyphosate on chlorophyll 'b'content on weed species (mg/g.fwt)

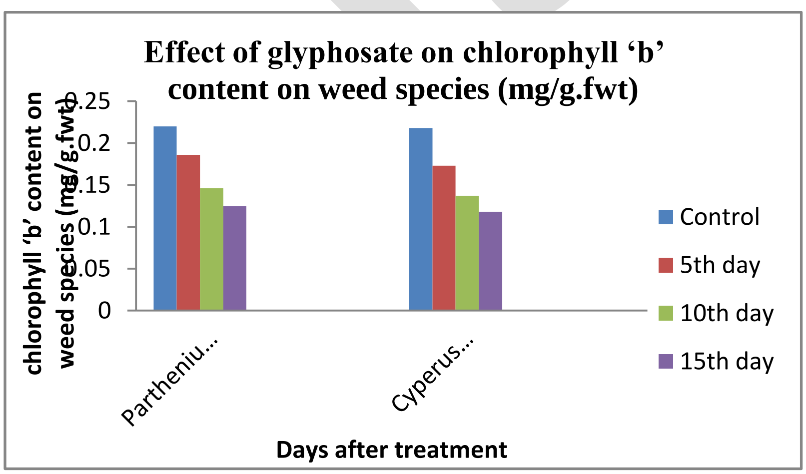


Fig. 3 Effect of glyphosate on total chlorophyll content on weed species (mg/g.fwt)

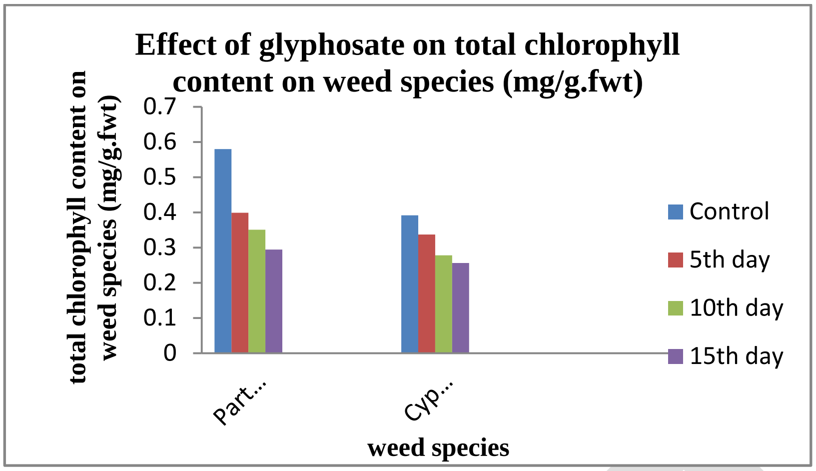
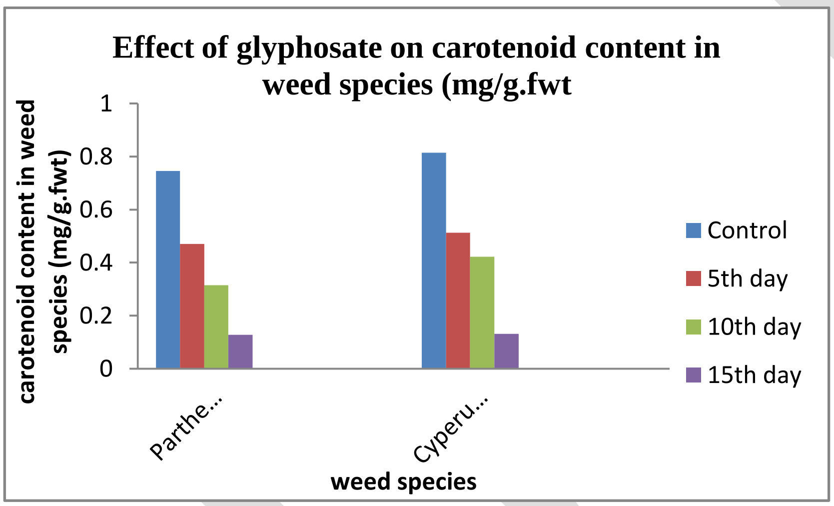


Fig.4 Effect of glyphosate on carotenoid content in weed species (mg/g.fwt)



CONCLUSION

The present investigation concluded that obviously from our results that the glyphosate has a strong effect on *Parthenium hysterophorus* L and *Cyperus rotundus* L. with the increase of glyphosate concentration applied to weeds, even at low dose (25 ppm) effects are directly related to changes in the total chlorophyll and carotenoid content. Similarly chlorophyll 'a' and chlorophyll 'b' contents were also decreased significantly in both the weeds upto 15th day. Carotenoid content was declined in both the weed species might have contributed to the photo oxidation of chlorophylls. The degradation of chlorophyll and carotenoid content in the present study testifies glyphosate action on photosynthetic activity.

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