

## Original Research Article

### Physiological efficiency of weeds in rice fallow fields

#### ABSTRACT

Photosynthetic rate, Transpiration rate and Stomatal Conductance is measured in different weeds during July 2020 in rice fallows using IRGA- Photosynthesis system model Lci- T. We have chosen all the weeds at flowering to maturity phase and observed the data. Among the weeds analysed *Partheniumhysterophorus* has recorded very high Photosynthetic rate ( $\mu \text{ molm}^{-2} \text{ Sec}^{-1}$ ) and there was difference with stage also, Flowering stage (165.28) has recorded a higher photosynthetic rate followed by vegetative (123.2) and maturity phase (118.72) and found that transpiration rate also followed the same trend. Even this has recorded more than the C4 crop photosynthetic rate for example *Trianthemaportulacastrum* which has recorded a photosynthetic rate of 21.98, which was the next highest photosynthetic rate among the weeds recorded and as well as over C4 crops too. Among the grasses *Paspalum* sp., *Echinochloacolona* ( $7.81\mu \text{ molm}^{-2} \text{ Sec}^{-1}$ ) and *Cynodondactylon* ( $4.2\mu \text{ molm}^{-2} \text{ Sec}^{-1}$ ) has recorded higher photosynthetic rate. *Cyperus* and *Cyanodon* has recorded with lesser stomatal conductance and transpiration rate but has recorded higher photosynthetic rate which can thrive better in rainfeds also. *Echinochloa* has more transpiration rate and stomatal conductance among grasses and this might be due to their water loving nature. *Boerhaviadiffusa*, *Euphorbiahirta* and *Ruellatuberosa* are recorded with lesser stomatal conductance. On critically analysing the weeds, it was observed that some weeds like Parthenium are reported with higher photosynthetic rate with lesser transpiration rate and stomatal conductance over better photosynthetic efficiency crop like maize and also this has resulted in the better withstanding ability to the water stress. Correlation analysis showed that photosynthesis and Transpiration rate are positively correlated but weak ( $r=0.28$ ) and the regression equation is ( $Y=4.98+4.32(x)$ ), photosynthetic rate and stomatal conductance are also positively correlated but weak ( $r=0.20$ ) and the regression equation is  $Y=20.36+17.04(X)$ . Transpiration and Stomatal Conductance is positively and strongly correlated ( $r=0.57$ ) and regression equation is  $Y=3.92+2.51(x)$ .

Keywords: Major Weeds – Physiological efficiency – Documentation

#### Introduction

Adaptation of weeds to adverse climate is with high plasticity and even succeeds their generation against the efforts forced by man to control these plants. Rising carbon dioxide ( $\text{CO}_2$ ) concentrations and associated changes in global temperature and precipitation are major concerns for future weed management and crop production (Aruna Varanasi et al) [1]. Weed cause 36% yield loss in groundnut, 31% in Soybean, 25% in maize and sorghum and 19% in wheat Gharde et al. [2]. Physiological efficiency of the weeds changes among species and environment in which it grows. For instance Caroline Hernke Thie et al. [3] found that Alexander grass (*Urochloaplantaginea*) relies on the superior control of stomatal opening and high water use efficiency. Hairy beggarticks (*Bidens pilosa*) efficiency in competition lies on its ability to remove water from soil to levels when the other surrounding plant species would undergo stress. We wish to document the physiological efficiency of the weeds available in current fallows without any crop competition. All the physiological parameters like photosynthetic rate, transpiration rate and stomatal conductance are documented using Infrared Gas Analyzer (IRGA) model Lci T. By assessing this we can identify the most efficient weed and we can take measures to manage this weed and its spread

especially invasive weeds. We have categorised the weeds in to Grasses, Sedges and Broad-Leaved weeds and as well as their photosynthetic pathway C3, C4 and C3- C4. It is necessary to know the photosynthetic rate of the weeds to design our weed management practices. We can identify the noxious weed to control and better weed for domestication.

## Materials and Methods

All the physiological parameters like photosynthetic rate, transpiration rate and stomatal conductance are documented using Infrared Gas Analyzer (IRGA) model LCi T and this was recorded in the rice fallow fields of D block, Agricultural College and Research Institute, Madurai. The stage of the weed also recorded mostly we have taken at the flowering stage of the available weeds and as well as some field crops for comparison. During the observation, the moisture remains same and we have observed the data between 10.30-12.30 am on 31.7.2020 as we have confirmed with the 3 plants for a single species at the same stage. The instrument is precise and easy to record.

## Results and Discussion

Among the weeds analysed *Partheniumhysterophorus* has recorded very high Photosynthetic rate and there was difference with stage also, Flowering stage ( $165.28\mu\text{ molm}^{-2}\text{ Sec}^{-1}$ ) has recorded a higher photosynthetic rate followed by vegetative ( $123.2\mu\text{ molm}^{-2}\text{ Sec}^{-1}$ ) and maturity phase ( $118.72\mu\text{ molm}^{-2}\text{ Sec}^{-1}$ ) and found that transpiration rate also followed the same trend. At maturity the *Sorghum arundinaceum* presents higher values of transpiration rate, stomatal conductance and non-photochemical quenching coefficient was reported by Deborah Amorim Martins *et al*[4]. Even this Parthenium has recorded more than the C4 crop photosynthetic rate for example *Trianthemaportulacastrum* has recorded a photosynthetic rate of  $21.98\mu\text{ molm}^{-2}\text{ Sec}^{-1}$ , which was the next highest photosynthetic rate. Among the grasses *Paspalum sp.*, *Echinochloacolona* ( $7.81\mu\text{ molm}^{-2}\text{ Sec}^{-1}$ ) and *Cynodondactylon*( $4.2\mu\text{ molm}^{-2}\text{ Sec}^{-1}$ ) has recorded higher photosynthetic rate. *Cyperus* and *Cyanodon*has recorded with lesser stomatal conductance and transpiration rate has recorded higher photosynthetic rate which can thrive better in rainfeds also. Alexander grass (*Urochloaplantaginea*) presented better stomatal control ability to avoid water loss and at the same time high efficiency in the use of the available CO<sub>2</sub>, being able to maintain high photosynthetic rates even with greater periods of stomatal closure, which results in higher WUE (Aspiazúetal[5]; Caroline HernkeThielet *al*[6]). Some common annual weeds growing with crops transpires about four times more water than a crop plant and use up to three times as much water to produce a pound of dry matter as do the crops [7]. *Echinochloa* has more transpiration rate and stomatal conductance among grasses and this might be due to their water loving nature. *Boerhaviadiffusa*, *Euphorbiahirta* and *Ruellatuberosa* are recorded with lesser stomatal conductance.

**Table 1. Photosynthetic efficiency of weeds**

### Grasses

Sl.No	Name of the weed	Stage of the weed	Photosynthetic rate $\mu\text{ molm}^{-2}\text{ Sec}^{-1}$	Transpiration rate $\text{m mol m}^{-2}\text{ Sec}^{-1}$	Stomatal Conductance $\text{mol sec}^{-1}$
1.	<i>Paspalum sp.</i>	Seed	10.08	5.67	0.18

		formation			
2.	<i>Echinochloacolona</i>	Seed formation	7.81	5.71	0.13
3.	<i>Cynodondactylon</i>	Well mat	4.69	2.36	0.03
4.	<i>Cynodondactylon</i>	Well mat	4.20	1.19	0.02
5.	<i>Brachiariareptans</i>	Flowering	3.04	3.26	0.07
7.	<i>Cenchrus ciliaris</i>	Flowering	3.32	1.18	0.03
8.	<i>Chloris barbata</i>	Flowering	6.49	1.68	0.14

### Sedges

SI.No	Name of the weed	Stage of the weed	Photosynthetic rate $\mu \text{ mol m}^{-2} \text{ Sec}^{-1}$	Transpiration rate $\text{m mol m}^{-2} \text{ Sec}^{-1}$	Stomatal Conductance $\text{mol sec}^{-1}$
1.	<i>Cyperus iria</i>	Flowering	6.13	2.21	0.04
2.	<i>Cyperus esculentus</i>	Flowering	2.45	2.04	0.05

### Broad leaved weeds

SI.No	Name of the weed	Stage of the weed	Photosynthetic rate $\mu \text{ mol m}^{-2} \text{ Sec}^{-1}$	Transpiration rate $\text{m mol m}^{-2} \text{ Sec}^{-1}$	Stomatal Conductance $\text{mol sec}^{-1}$
1.	<i>Parthenium hysterophorus</i>	Flowering	165.28	7.05	0.23
2.	<i>Parthenium hysterophorus</i>	Matured	118.72	2.98	0.05
3.	<i>Parthenium</i>	Vegetative	123.2	6.43	0.16
5.	<i>Trianthemaportulacastrum</i>	Seed formation	21.8	7.4	0.26
6.	<i>Corchorus olitorius</i>	Flowering	11.18	8.13	0.60
7.	<i>Cleome chelidoni</i>	Flowering	15.26	10.49	0.33

8.	<i>Passiflora foetida</i>	Small twine	65.71	7.5	2.6
		Flowering	9.68	3.45	0.10
9.	<i>Sida cordifolia</i>	Flowering	13.47	9.6	0.50
10.	<i>Convolvulus arvensis</i>	Flowering	11.41	4.84	0.21
11.	<i>Hibiscus vitifolius</i>	flowering	5.95	2.64	0.04
12.	<i>Heliotropium indicum</i>	Seed formation	5.55	5.48	0.11
13.	<i>Chrozaphorarottleri</i>	Seed formation	3.53	4.99	0.09
14.	<i>Malvastrumcoromandelianum</i>	Flowering	2.60	6.55	0.47
15.	<i>Ruella tuberosa</i>	Flowering	2.37	0.4	0.01
16.	<i>Boerhaviadiffusa</i>	Flowering	2.03	1.81	0.08
17.	<i>Tridax procumbens</i>	Flowering	2.06	2.43	0.13
18.	<i>Euphorbia hirta</i>	Seed formation	1.47	1.28	0.03
19.	<i>Commelinabenghalensis</i>	Flowering	3.48	3.28	0.18
20.	<i>Eclipta alba</i>	Flowering	8.27	3.88	0.15
21.	<i>Acalypha indica</i>	Flowering	4.81	2.10	0.13

### Crops

Crop	Stage	Photosynthetic rate $\mu \text{ mol m}^{-2} \text{ Sec}^{-1}$	Transpiration rate $\text{m mol m}^{-2} \text{ Sec}^{-1}$	Stomatal conductance $\text{mol sec}^{-1}$
Maize	Cob formation Stage	12.92	6.82	0.16
Cumbu Napier Hybrid grass	At harvest stage	20.85	4.27	0.21
Cowpea	Vegetative	8.27	3.88	0.15

### C3 weeds

Sl.No	Name of the weed	Stage of the weed	Photosynthetic rate $\mu \text{ mol m}^{-2} \text{ Sec}^{-1}$	Transpiration rate $\text{m mol m}^{-2} \text{ Sec}^{-1}$	Stomatal Conductance $\text{mol sec}^{-1}$
1.	<i>Corchorus olitorius</i>	Flowering	11.18	8.13	0.60
2.	<i>Passiflora foetida</i>	Small twine	65.71	7.5	2.60
3.	<i>Sida cordifolia</i>	Flowering	13.47	9.6	0.50
4.	<i>Hibiscus vitifolius</i>	flowering	5.95	2.64	0.04
5.	<i>Heliotropium indicum</i>	Seed formation	5.55	5.48	0.11
6.	<i>Chrozaphora rotleri</i>	Seed formation	3.53	4.99	0.09
7.	<i>Malvastrum coromandelianum</i>	flowering	2.60	6.55	0.47
8.	<i>Ruella tuberosa</i>	Flowering	2.37	0.4	0.01
9.	<i>Tridax procumbens</i>	Flowering	2.06	2.43	0.13
10.	<i>Convolvulus arvensis</i>	Flowering	11.41	4.84	0.21
<b>Mean</b>			<b>12.383</b>	<b>5.256</b>	<b>0.476</b>

#### C4 weeds

Sl.No	Name of the weed	Stage of the weed	Photosynthetic rate $\mu \text{ mol m}^{-2} \text{ Sec}^{-1}$	Transpiration rate $\text{m mol m}^{-2} \text{ Sec}^{-1}$	Stomatal Conductance $\text{mol sec}^{-1}$

1.	<i>Paspalum sp.</i>	Seed formation	10.08	5.67	0.18
2.	<i>Echinochloacolona</i>	Seed formation	7.81	5.71	0.13
3.	<i>Cynodondactylon</i>	Well mat	4.69	2.36	0.03
4.	<i>Cynodondactylon</i>	Well spreaded	4.20	1.19	0.02
5.	<i>Brachiariareptans</i>	Flowering	3.04	3.26	0.07
6.	<i>Cenchrus ciliaris</i>	Flowering	3.32	1.18	0.03
7.	<i>Cyperus iria</i>	Flowering	6.13	2.21	0.04
8.	<i>Trianthemaportulacastrum</i>	Seed formation	21.8	7.4	0.26
9.	<i>Boerhaviadiffusa</i>	Flowering	2.03	1.81	0.08
10.	<i>Euphorbia hirta</i>	seed formation	1.47	1.28	0.03
11.	<i>Cleome chelidoni</i>	Flowering	15.26	10.49	0.33
<b>Mean</b>			<b>7.26</b>	<b>3.87</b>	<b>0.11</b>

### C3-C4 intermediate weed

Sl.No	Name of the weed	Stage of the weed	Photosynthetic rate $\mu \text{ mol m}^{-2} \text{ Sec}^{-1}$	Transpiration rate $\text{m mol m}^{-2} \text{ Sec}^{-1}$	Stomatal Conductance $\text{mol sec}^{-1}$
1.	<i>Parthenium hysterophorus</i>	Flowering	165.28	7.05	0.23
2	<i>Parthenium hysterophorus</i>	Vegetative	123.2	6.43	0.16
3.	<i>Parthenium hysterophorus</i>	Matured	118.7	2.98	0.05
<b>Mean</b>			<b>135.73</b>	<b>5.49</b>	<b>0.15</b>

On averaging the photosynthetic efficiency of weeds it was observed that some C3 like *Passiflorafoetida* also with better photosynthetic efficiency over C4 weed and crops. However *Parthenium* has recorded a very high photosynthetic rate which is of C3- C4

intermediate Photorespiration is thought to be reduced through a CO<sub>2</sub> concentrating mechanism by limited C<sub>4</sub>-type of photosynthesis in the C<sub>3</sub>-C<sub>4</sub> intermediate Flaveria species (GedupudiRajendrudu, [8]). Rising temperature, elevated CO<sub>2</sub> and changing rainfall pattern are the important aspects of changing climate with pronounced impacts on agriculture ecosystems in general and weed species specifically (Dinesh Jingeretal[9]).

### Correlation and Regression

Correlation analysis showed that photosynthesis and Transpiration rate are positively correlated but weak ( $r=0.28$ ) and the regression equation is ( $Y=4.98+4.32(x)$ ), photosynthetic rate and stomatal conductance are also positively correlated but weak ( $r=0.20$ ) and the regression equation is  $Y= 20.36+17.04(X)$ . Transpiration and Stomatal Conductance is positively and strongly correlated ( $r=0.57$ ) and regression equation is  $Y=3.92+2.51(x)$ .

Table 2 :

Variables	Photosynthetic rate with Transpiration rate	Photosynthetic rate with stomatal conductance	Transpiration with Stomatal Conductance
Correlation	$r=0.28$	$r=0.20$	$r=0.57$
Regression equation	$Y=4.98+4.32(x)$	$Y= 20.36+17.04(X)$	$Y=3.92+2.51(x)$
$r^2$	0.07	0.20	0.46

### Conclusion

*Partheniumhysterophorus* has recorded very high photosynthetic rate and there was difference with stage also, Flowering stage (165.28) has recorded a higher photosynthetic rate( $\mu \text{ mol/m}^2 \text{ /Sec}$ ) followed by vegetative (123.2) and maturity phase (118.72) and found that transpiration rate also followed the same trend. Even this has recorded more than the C<sub>4</sub> crop photosynthetic rate for example *Trianthemaportulacastrum* which has recorded a photosynthetic rate of 21.98, which was the next highest photosynthetic rate among the weeds recorded and as well as over C<sub>4</sub> crops too. Among the grasses *Paspalum* sp., *Echinochloacolona* ( $7.81\mu \text{ molm}^{-2} \text{ Sec}^{-1}$ ) and *Cynodondactylon*( $4.2\mu \text{ molm}^{-2} \text{ Sec}^{-1}$ ) has recorded higher photosynthetic rate. *Cyperus* and *Cyanodon*has recorded with lesser stomatal conductance and transpiration rate but has recorded higher photosynthetic rate which can thrive better in rainfed also. *Echinochloa* has more transpiration rate and stomatal conductance among grasses and this might be due to their water loving nature.

### References

1. Aruna Varanasi, Vara Prasad, P.V. Mithila Jugulam, Chapter Three - Impact of Climate Change Factors on Weeds and Herbicide Efficacy, Editor(s): Donald L. Sparks, Advances in Agronomy, Academic Press, 2016 Volume 135;107-146.
2. Gharde Y. Singh, P.K., Dubey, R.P and Gupta P.K. Assessment of yield and economic losses in agriculture due to weeds in India. Crop Prot. 2018.107:12-18
3. Caroline Hernke Thie , Felipe Adelio de David , Leandro Galon , Sidnei Deuner , Cesar Tiago Forte , Gismael Francisco Perin , Paula Rochelly de David , Altemir José

- Mossi , André Andres & Germani Concenço. Physiology of Weeds in Intraspecific Competition *Journal of Agricultural Science*; 2018, 10 (6);334-340
4. Deborah Amorim Martins, Adriano Jakelaitis, Isabella Sichierski Cardoso, Alan Carlos Costa and Juliana de Fátima Sales, Growth and physiological characteristics of the weed false johnsongrass (*Sorghum arundinaceum*(Desv.) Stapf *Rev. Ceres* 2016;63 (1): 16-24.
  5. Aspiazú, I., Sedyama, T., Ribeiro Jr., J. I., Silva, A. A., Concenço, G., Ferreira, E. A and Araujo, W. F. Water use efficiency of cassava plants under competition conditions. *Planta Daninha*, 2010;28(4), 699-703. <https://doi.org/10.1590/S0100-83582010000400001>.
  6. Caroline HernkeThiel , Felipe Adelio de David , Leandro Galon , SidneiDeuner , Cesar Tiago Forte , Gismael Francisco Perin , Paula Rochelly de David , Altemir José Mossi , André Andres &GermaniConcenço, Physiology of Weeds in Intraspecific Competition. *Journal of Agricultural Science*; 2018; 10 (6); 334-340.
  7. Hussein FawzyAbouziena , Hamed Mohamed El-Saeid and AboBakr Ahmed El-Said Amin. Water loss by weeds: a review. *International Journal of Chem Tech Research*2015;7(1): 323-336.
  8. GedupudiRajendrudu, Jasty Prasad S.R.andRamadas, V.S. C3-C4 intermediate species in *Alternanthera* (Amaranthaceae). *Plant Physiol.* 1986;80: 409-414.
  9. Dinesh Jinger, Ramanjit Kaur, Navneet Kaur and Anchal Das, Weed dynamics under changing climatic scenario: A Review. *Int. J.Curr. Microbiol. App.Sci.* 2017;6(3):2376-2388