Paper ID: 1373
Theme 2. Grassland production and utilization
Sub-theme 2.2. Integration of plant protection to optimise production

Physiological efficiency of some weeds species under hill farming systems of subtropical Meghalaya

D. P. Patel[1]*, Anup Das[2], G. C. Munda[2]
[1]ICAR-National Institute of Abiotic Stress Management, Baramati, Maharashtra, India
[2]ICAR Research Complex for NEH Region, Umiam, Meghalaya, India
*Corresponding author e-mail: pateldpp2001@yahoo.com

Keywords: Competition, Hill ecosystem, Photosynthesis, Resource use efficiency, Weed species

Introduction

Weeds are integral part of any farming system. Weeds are more aggressive in their ability to utilize limited moisture and nutrients in the soil relative to cultivated crops. Weeds grow more profusely in high rainfall areas such as subtropical Meghalaya owing to favourable climatic conditions which favours the growth of weeds particularly in uplands and limits the crop yields due to increased crop-weed competition for nutrients and light. The weed species such as *Ageratum conyzoides, Spilanthus acmella, Galinsoga parviflora, Bidens pilosa, Crassocephalum crepidioides, Polygonum capitatum, Alternanthera philoxeroides, Amaranthus spinosus and Mikania micrantha* are very common in most of the cultivated crops. These weeds are also very common in grazing lands, wastelands, agroforestry systems, abandoned fields etc. in northeast India and some of them are also consumed as green vegetables by the local inhabitants. Most of these weeds are also a menace in fodder cultivation and managing grasslands. A high rate of photosynthesis is always associated with higher productivity, unless sink capacity is limiting. However, studies on photosynthesis and its associated parameters in relation to crop-weed competition are limited. Therefore, an attempt was made to study the photosynthesis rate, transpiration rate, stomatal conductance and other associated parameters in major crops and the associated weed species under hill environment.

Materials and Methods

Observations on photosynthesis and its associated parameters were recorded from the several research experiments on various crops, i. e. Rice (*Oryza sativa* L.), Maize (*Zea mays* L.), Black gram (*Vigna mungo* L. Heeper), *Dolichos* bean (*Dolichos lablab* L.) Rice bean (*Vigna umbellata* Thumb.), Pole type French bean (*Phaseolus vulgaris* L.), Soybean (*Glycine max* L.), Groundnut (*Arachis hypogaea* L.), Turmeric (*Curcuma longa* L.) & Ginger (*Zingiber officinale* Rosc.) and major weed species (*Ageratum conyzoides* (L.), *Spilanthus acmella* (L.) Murr. *Galinsoga parviflora* (Cav.), *Bidens pilosa* (L.), *Crassocephalum crepidioides* (Benth.) S. Moore., *Polygonum capitatum* (Meissn.), *Alternanthera philoxeroides* (Mart.), *Amaranthus spinosus (*L.) *and Mikania micrantha* (H.B.K.) growing along with crop plants during *Kharif* season of 2010 and 2011 at the ICAR Research Complex for NEH Region, Umiam (950 m MSL), Meghalaya, India. The leaf photosynthesis rate (Pn; µ mole CO_2 m^{-2} s^{-1}), transpiration rate (TR; m mol m^{-2} s^{-1}, stomatal conductance (SC; m mol m^{-2} s^{-1}) and leaf temperature (^{0}C) were measured on fully developed leaf from top at flowering stage using portable photosynthesis system (Model CIRAS-2, U.K.). Leaf temperature depression (LTD) was calculated by subtracting the leaf temperature from atmospheric temperature. Ratio between rate of photosynthesis and transpiration (Pn/TR) was used to determine the water use efficiency (WUE) as described by Rosenberg and Kriiger (1993). Data obtained were analyzed by adopting standard statistical methods.

Results and Discussion

Observations on comparative photosynthesis rate and associated parameters of different weed species in subtropical Meghalaya showed significant variation in photosynthesis rate, transpiration rate, stomatal conductance, WUE and LTD in different weed species whereas variation in leaf temperature was insignificant (Table1).

Table 1: Comparative photosynthesis rate and associated parameters of different weed species under hill farming systems of subtropical Meghalaya

Sr. No.	Weed species	Transpiration Rate (m mol m^{-2} s^{-1})	Stomatal conductance (m mol m^{-2} s^{-1})	Leaf temperature (^{0}C)	Photosynthesis Rate (µ mol CO_2 m^{-2} s^{-1})	Water use efficiency (Pn/TR)	Leaf temperature Depression (^{0}C)
1	*Ageratum conyzoides* L.	9.64	554.2	27.3	26.5	2.75	3.7
2	*Spilanthus acmella* (L.) Murr.	8.83	503.0	27.4	26.6	3.02	3.1

3	*Galinsoga parviflora* (Cav.)	8.89	441.1	28.1	21.2	2.37	3.3
4	*Bidens pilosa* L.	8.65	430.8	27.6	27.7	3.22	3.2
5	*Crassocephalum crepidioides* (Benth.) S. Moore.	8.20	420.2	26.5	17.5	2.13	3.2
6	*Polygonum capitatum* (Messin.)	7.56	322.3	28.1	20.6	2.73	2.8
7	*Alternanthera philoxeroides* (Mart.)	7.10	356.2	26.8	32.3	4.56	2.5
8	*Amaranthus spinosus* L.	8.35	405.2	28.2	40.1	4.72	2.9
9	*Mikania micrantha* (H.B.K.)	9.80	512.5	28.1	26.1	2.70	3.8
Mean		*8.56*	*438.4*	*27.5*	*26.5*	*3.13*	*3.1*
C.D. at 5%		*0.77*	*63.10*	*NS*	*3.51*	*0.40*	*1.14*

The rate of photosynthesis in different weed species ranged between 17.5 to 40.1 µ mole CO_2 m^{-2} s^{-1}. The mean rate of photosynthesis was found to be highest in *Amaranthus spinosus* (40.1 µ mole CO_2 m^{-2} s^{-1}). A significant variation in rate of photosynthesis was observed amongst the different weed species studied. The transpiration rate and stomatal conductance recorded in weed species varied in the range between 7.10 to 9.80 and 322.5 to 554.2 m mol m^{-2} s^{-1}, respectively. Mean transpiration rate was found to be highest in *Mikania micrantha* (9.80 m mole m^{-2} s^{-1}) while mean stomatal conductance was higher in *Ageratum conyzoides* (554.2 m mole m^{-2} s^{-1}). The leaf temperature and LTD ranged between 26.5 to 28.2 and 2.5 to 3.8 ^{0}C, respectively. Mean leaf temperature was recorded highest in *Amaranthus spinosus* (28.2 ^{0}C) followed by *Mikania micrantha*, *Polygonum capitatum*, and *Galinsoga parviflora* while LTD was maximum in *Mikania micrantha* (3.8 ^{0}C) followed by *Ageratum conyzoides*. Water use efficiency estimated in different weed species ranged between 2.13 to 4.72. Mean WUE was estimated highest in the *Amaranthus spinosus* (4.72) followed by *Alternanthera philoxeroides* (4.56).

Observations on comparative photosynthesis rate and associated parameters of different cereals, pulses, oilseeds and spices crops in subtropical Meghalaya showed significant variation in terms of photosynthesis rate, transpiration rate, stomatal conductance, WUE, leaf temperature and LTD (Table 2).

Table 2: Comparative photosynthesis rate and associated parameters of cereals, pulses, oilseeds and spices crops under hill farming systems of subtropical Meghalaya

Sr. No.	**Crop species**	**Transpiration Rate (m mol m^{-2} s^{-1})**	**Stomatal conductance (m mol m^{-2} s^{-1})**	**Leaf temperature (^{0}C)**	**Photosynthesis Rate (µ mol CO_2 m^{-2} s^{-1})**	**Water use efficiency (Pn/TR)**	**Leaf temperature Depression (^{0}C)**
1	Rice (*Oryza sativa* L.)	7.65	501.7	26.0	17.5	2.29	2.2
2	Maize (*Zea mays* L.)	7.20	448.6	28.9	30.2	4.19	1.8
3	Black Garm (*Vigna mungo* L.)	6.21	236.7	29.1	18.6	2.99	1.7
4	Dolichos bean (*Dolichos lablab* L.)	8.40	438.7	27.5	29.9	3.55	3.2
5	Rice bean (*Vigna umbellata* Thumb.)	7.25	368.0	26.8	22.6	3.12	2.8
6	Frenchbean pole type (*Phaseolus vulgaris* L.)	7.18	288.7	29.5	17.7	2.47	2.5
7	Soybean (*Glycine max* L.)	7.94	431.0	27.3	28.2	3.55	2.8
8	Groundnut (*Arachis hypogaea* L.)	7.50	375.0	27.4	35.5	4.73	2.6
9	Turmeric (*Curcuma longa* L.)	6.65	241.7	29.7	13.5	2.03	1.9
10	Ginger (*Zingiber officinale* Rosc.)	5.60	306.4	28.2	13.6	2.43	2.7
Mean		*7.16*	*363.6*	*28.1*	*22.7*	*3.13*	*2.4*
C.D. at 5%		*1.47*	*164.4*	*1.52*	*5.67*	*0.504*	*0.78*

The mean photosynthesis rate in different crops under study ranged between 13.5 to 35.5 µ mole CO_2 m^{-2} s^{-1}. Mean rate of photosynthesis was found to be highest in groundnut (35.5 µ mole CO_2 m^{-2} s^{-1}). There was significant variation in the rate of photosynthesis among the different crops. Transpiration rate and stomatal conductance recorded in different crops were in the range between 5.6 to 8.4 and 236.7 to 501.7 m mole m^{-2} s^{-1}, respectively. Mean transpiration rate was found to be highest in *Dolichos* bean (8.4 m mole m^{-2} s^{-1}) while mean stomatal conductance was highest in rice (501.7 m mole m^{-2} s^{-1}).

Leaf temperature and LTD ranged between 26 to 29.7 ^{0}C and 1.7 to 3.2 ^{0}C, respectively. Mean leaf temperature was recorded highest in turmeric (29.7 ^{0}C) while LTD was maximum in Dolichos bean (3.2 ^{0}C). Water use efficiency estimated in different crop species ranged between 2.03 to 4.73. Mean WUE was estimated highest in groundnut (4.73) followed by maize (4.19). However, turmeric recorded lowest WUE (2.03).

The higher photosynthesis rate, transpiration rate, stomatal conductance, WUE and LTD in weed species compared to different crop species and lower leaf temperature in weed species compared to different crop species indicate that weeds are more competitive than crop plants and thus loss in crop yield is observed due to crop-weed competition. Patel *et al.* (2005) also reported higher physiological efficiency of weed species compared to crop plants. Weed species morpho-physiologically similar to the crop are usually the most competitive in comparison to those which differ greatly from the crops.

Conclusion

Due to higher physiological efficiency and aggressive nature of some weed species, they can become a menace in fodder cultivation and managing grasslands. Therefore, eco-friendly approaches and adequate policy measures are required for sustainable management of such obnoxious grasses which compete for natural resources such as sunlight, water, nutrient etc. and degrade quality of grass and make farming unsustainable.

References

Patel, D. P., Anup Das, Rajesh Kumar and G. C. Munda. 2005. Comparative study of photosynthesis and associated parameters in major crops and weed species in mid hills of Meghalaya. *Ann. Plant Physiol.* 19: 1-4.

Rosenberg, L. V. and G. H. J. Kriiger. 1993. Comparative analysis of differential drought stress induced suppression and recovery in carbon dioxide fixation, stomatal and non-stomatal limitation in *Nicotiana tabaccum*. *J. Plant Physiol.* 142: 296-306.