

# INFLUENCE OF PATHOGENS ON THE PHOTOSYNTHESIS PARAMETERS OF VARIOUS CANNA CULTIVARS

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### INTRODUCTION

Canna (family *Cannaceae*) is globally important for its ornamental as well agricultural aplications. The beauty of cannas is spoiled by many soil-borne and air-borne pathogens. Necrotic lesions on roots, stems and leaves and wilt are the most common symptoms of the diseases. The most important factors responsible for these symptoms are the fungal diseases like grey mould and fusariosis. Among the diseases *Alternaria* leaf blight caused by *Alternaria* alternata is one of the most destructive disease, commonly prevailing in all cannas. Recommended fungicides are often effective but not allowed in urban area. The severity of pathogens does not always manifest itself in the form of necrosis or wilting, especially at early stages of plant growth, but can affect the process of photosynthesis.

The photosynthesis process is closely linked to plant species or even cultivar, and is modified in considerable degree by environmental conditions, such as temperature, precipitation and its distribution during the growing season, and many other factors. It is known that leaves diseases may have destructive effect on the photosynthesis and gas exchange and may dramatically decrease photosynthesis in various crop plants. Pathogens cause morphological, physiological and biochemical changes, as well as the significant decrease the amount of photosynthetic pigments, and therefore limit the photosynthesis rate which resulted in reducing the capacity of assimilation apparatus. As a result of plant tissues infestation, many pathogens may impair photosynthesis even in the initial stage of infection when no symptoms are visible.

The aim of investigations was the estimation of relationship between the infection of selected varieties of canna by pathogenic fungi and intensity of photosynthesis and gas exchange.

#### RESULTS

Performed studies shown that the predominating species were *Alternaria alternata* and *Fusarium* spp.. From stems 2000 fungal colonies belonging to 18 species and from leaves 2306 fungal colonies belonging to 17 species were isolated. *A. alternata*, *Fusarium* spp. and *S. sclerotiorum* predominated among fungi which are regarded as pathogenic. *F. culmorum* was isolated frequently from all plants especially from cv. 'America', 'Robert Kemp' and 'La Boheme'. Numerous colonies of *F. avenaceum* were obtained every year especially from stems of canna cv. 'America', 'Botanica' and 'Lucifer'. *A. alternata* occurred on all plants but more frequently on stems and leaves especially in 2016 on cv. 'Picasso'. *S. sclerotiorum* colonised frequently leaves and stems. Also three other fungi: *Cylindrocarpon obtusisporum*, *Thanatheporus cucumeris* and *Botrytis cinerea* were isolated frequently. *C. destructans*, *Truncatella truncata* and *Phoma exigua* colonised the plants very rarely.

In the first year of performed studies, the lowest photosynthetic intensity was noted at cultivars: 'Picasso'. Similar low results were reported at cultivars 'Cherry Red' and 'President'. The analogous trend was observed in the second year of studies. The lowest level of photosynthesis was carried out at 'Picasso' and 'La Boheme'. However, the highest values of photosynthesis intensity were recorded in 'Botanica', 'Wyoming' and 'Lucifer' cultivars. The investigated cultivars differed also in transpiration rate (E), stomatal conductance (Gs) and concentration of substomatal carbon dioxide (Ci).

Year	E			Total								
Ke	Fungus species	Ai	Am	Bo	Ch	Lb	Lu	Pi	Pr	Rk	Wy	(%)
	Alternaria alternata (Fr.) Keiss.	13	14	6	23	14	8	4	9	IXK	15	106(17)
	Botrytis cinerea Pers. ex Fries.	10		v				5			10	5(1)
	Chaetomium cochlioides							2				2(0)
	Epicoccum nigrum Link						19	-			4	23(4)
	Fusarium avenaceum (Corda ex											
	Fries)Sacc.	16	2	20	12	4	4	14	16	12		100(16)
4	Fusarium culmorum (Smith) Sacc.	26	43	10	15	30	22	24	42	46	47	305(48)
7014	Fusarium oxysporum Schlecht.	2	7	4	7	2	13	1	2	6	4	48(7)
	Gliocladium catenulatum Gill. et Abb			5								5(1)
	Penicillium expansum Link ex S.F.Gray			2					2			4(1)
	Truncalella truncata (Lev.)Steyaert							5				5(1)
	Rhizopus stolonifer (Ehrenb.) Vuill.					4					40	4(1)
	Trichoderma harzianum Rifai					20						20(3)
	Trichoderma koningii Oud.							2				2(0)
	Total	57	66	47	57	74	66	57	71	64	70	629
	Alternaria alternata (Fr.) Keiss.	7	14	18	26	2	2	18	25	6	13	131(18
	Botrytis cinerea Pers. ex Fries.		20								_	20(3)
	Chaetomium cochlioides		2	3							2	7(1)
	Cylindrocarpon destructans (Cooke&Hark.)					2					2	4(1)
	Epicoccum nigrum Link	4					6					10(1)
	Fusarium avenaceum (Corda ex			2	10		21	11		10	9	<i>(5</i> (0))
C107	Fries)Sacc.			2	10		21	11		12	9	65(9)
7	Fusarium culmorum (Smith) Sacc.	36	4	41	26	42	11	4	30	40	16	250(35)
	Fusarium equiseti (Corda) Sacc.	9	2			13					2	26(4)
	Fusarium oxysporum Schlecht.	5	21			27	7	11	13	7	9	100(14)
	Fusarium solani (Mart.)Sacc.									2		2(0)
	Penicillium expansum Link ex S.F.Gray	3		4		5		2			3	17(2)
	Thanatheporus cucumeris Kühn						4			9	2	15(2)
	Trichoderma koningii Oud.	3	3	18	11			20	8	5		68(10)
	Total	67	66	86	73	78	64	66	78	79	58	715
2016	Alternaria alternata (Fr.) Keiss.	19	15	6		10	28	15	19	15	2	129(20
	Botrytis cinerea Pers. ex Fries.						19	4	2			25(4)
	Chaetomium cochlioides		2	2								4(0)
	Epicoccum nigrum Link		2			8		2	3	2		17(3)
	Fusarium avenaceum (Corda ex Fries)		18			10						28(4)
	Sacc.											
	Fusarium culmorum (Smith) Sacc.		24	17	21	12	3	3	2	19	12	113(17)
i	Fusarium equiseti (Corda) Sacc.					2	1	4	17			24(4)
	Fusarium oxysporum Schlecht.		14	32	26	17	27	23	15	37	38	229(34)
	Penicillium notatum Westl.			9		11			2	2		24(4)
	Truncalella truncata (Lev.)Steyaert								11			11(2)
	Phoma exigua Desm.										14	14(2)
	Sclerotinia slerotiorum (Lib.) de By										6	6(1)
	Trichoderma koningii Oud.					20		27			3	32(5)

# CONCLUSIONS

- 1. Canna plants were colonized by pathogenic fungi especially *Fusarium* spp., *Sclerotinia sclerotiorum* and *Alternaria alternata* and frequently antagonistic fungi like *Trichoderma* sp., *Chaetomium* sp. and *Epicoccum nigrum*. The best health status and the lowest number of colonies were noticed for plants of cv. 'Botanica'.
- 2. The conducted studies indicate the negative effect of pathogens infecting canna on photosynthesis intensity and gas exchange. 'La Boheme', 'Picasso', 'Cherry Red' and 'President' cultivars, more infected by pathogens conducted photosynthesis and gas exchange on significantly lower level than less infested cultivars as 'Botanica' and 'Wyoming'.
- 3. The damage to the photosystem was more severe than external disease symptoms indicated, suggesting that intensity and gas exchange measurements might be helpful in early evaluation of diseases severity.

## MATERIAL AND METHODS

The experiment was conducted in a randomized complete blocks design with four replicates where block was the random effect. The observations were conducted in 2014–2016 at the Botanical Garden in Lublin. The objects of study was ten cultivars of canna plants: 'Aida'- Ai, 'America' - Am, 'Botanica' - Bo, 'Cherry Red' -Ch, 'La Boheme' Lb, 'Lucifer' Lu, 'Picasso' - Pi, 'Robert Kemp' - Rk, 'President' – Pr and 'Wyoming' -Wy. The plants were planted in the pots in March and placed in the soil in May.

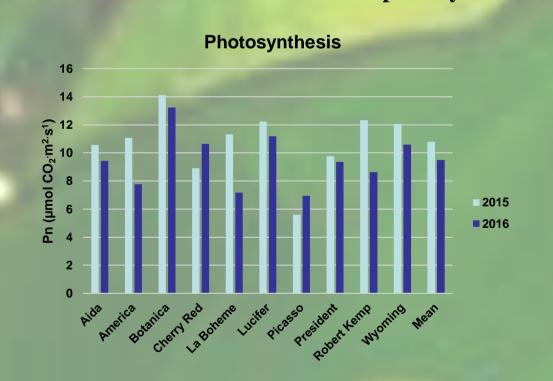
At the first decade of October selected diseased plants were sampled from field. The plants (leaves and stems) were analysed in laboratory. Plant material was cleaned. Next, fragments plants were placed on mineral medium in Petri dishes. The obtained fungal colonies were transferred to potato dextrose medium (PDA, Difco) and identified to the species with the available monographs.

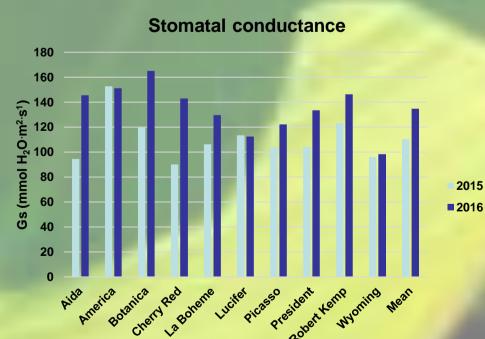
The measurements of photosynthetic activity of plants were performed in two growing seasons. In every season the measurements were carried out in the first decade of July and the first decade of September. The following parameters of gas exchange were measured: intensity of photosynthesis (Pn) ( $\mu$ mol CO<sub>2</sub>·m<sup>2</sup>·s<sup>-1</sup>), transpiration (E) (mmol H<sub>2</sub>O·m<sup>2</sup>·s<sup>-1</sup>), stomatal conductance (Gs) (mmol H<sub>2</sub>O·m<sup>2</sup>·s<sup>-1</sup>) and substomatal CO<sub>2</sub> concentration (Ci) ( $\mu$ mol CO<sub>2</sub>·m<sup>2</sup>·s<sup>-1</sup>). They were performed using portable infrared gas exchange analyser, type CIRAS-2 Portable Photosynthesis System (Hitchin, Herts., UK).

#### Fungi colonizing leaves of canna

Year	Fungus species	Cultivars										
×		Ai	Am	Bo	Ch	Lb	Lu	Pi	Pr	Rk	Wy	(%)
	Alternaria alternata (Fr.) Keiss.	14	21	11	15	20	20	17	11	9	11	149(23)
	Cylindrocarpon obtusisporum							4				4(1)
	Epicoccum nigrum Link						16					16(2)
	Fusarium avenaceum (Corda ex Fries)Sacc.	10	2	16	11	7	8	23	13	10	2	102(15)
_	Fusarium culmorum (Smith) Sacc.	9	43	23	19	35	15	23	29	47	42	285(43)
2014	Fusarium equiseti (Corda) Sacc.		2									2(0)
7	Fusarium oxysporum Schlecht.	3	4	2	12	11	15		2	10	8	67(10)
	Geotrichum candidum Link.	17										17(3)
	Gliocladium catenulatum Gill. et Abb			6					2			8(1)
	Penicillium expansum Link ex S.F.Gray		2		2							4(1)
	Trichoderma harzianum Rifai					2		4				6(1)
	Total	53	74	58	59	75	74	71	57	76	63	660
	Alternaria alternata (Fr.) Keiss.	16	18	39	36	27	34	23	35	36	21	285(37)
	Botrytis cinerea Pers. ex Fries.								4			4(1)
	Chaetomium cochlioides	5		17	2					2		26(3)
	Epicoccum nigrum Link	3	21	15		20	9	9	13	15	15	120(16)
	Fusarium avenaceum (Corda ex Fries) Sacc.				2							2(0)
16	Fusarium culmorum (Smith) Sacc.	13	11	7	29	5	16	20	19	16	2	138(18)
2015	Fusarium equiseti (Corda) Sacc.					17		2				19(3)
7	Fusarium oxysporum Schlecht.	9	10	2	2	6		2		4		42(6)
	Fusarium solani (Mart.)Sacc.							2				2(0)
	Penicillium expansum Link ex S.F. Gray	2						11	3		10	26(3)
	Sclerotinia slerotiorum (Lib.) de By					4						4(1)
	Trichoderma harzianum Rifai										2	2(0)
	Trichoderma koningii Oud.	6			3		10	14	10	12	14	69(9)
	Total	55	62	80	82	81	76	85	87	84	75	764
	Alternaria alternata (Fr.) Keiss.	8	66	82	40	71	83	89	86	62	83	670(76)
	Botrytis cinerea Pers. ex Fries.			1			11			13		25(3)
	Epicoccum nigrum Link			1		13		4	4			22(2)
,,	Fusarium avenaceum (Corda ex Fries) Sacc.			13		6				12	6	37(4)
2016	Fusarium culmorum (Smith) Sacc.		18		6	4	8	6	4	2	4	52(6)
2	Fusarium equiseti (Corda) Sacc.		4	3		2			2	6		17(2)
	Fusarium oxysporum Schlecht.		6		6	3	4		8	13	2	42(5)
	Penicillium nigricans (Bain.) Thom			4				4				8(1)
	Trichoderma koningii Oud.						5	4				9(1)
	Total	8	94	104	52	99	111	107	104	108	95	882

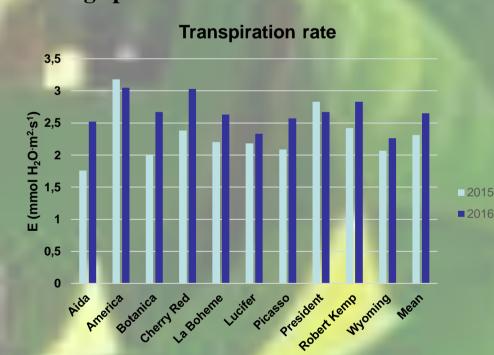
The values of photosynthesis intensity and gas exchange parameters

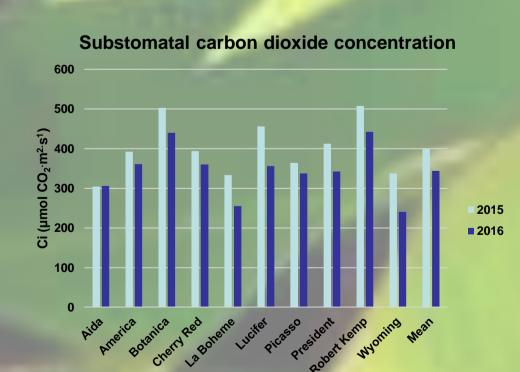






Yellowing and spots on leaves of canna cv. 'Botanic'







Necrotic spots on leaves of canna cv. 'Cherry Red'

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