Flood Tolerant Hollies: Qualifiers for Quagmires

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Nature of Work: Hollies (Ilex spp.) represent one the most commercially important groups of landscape plants in the United States. Within this genus, there are species native to a diversity of climates and habitats that range from arid alpine conditions to warm wetlands (3). Landscape sites are often characterized as having compacted, clay soils resulting in poor drainage and low aeration that subsequently limit plant growth and survival. The objective of this study was to evaluate and compare relative tolerance to root-zone inundation among a diverse collection of holly taxa.

The taxa used in this study included: Ilex rugosa, Ilex x meserveae (rugosa x aquifolium) 'Blue Princess', I. aquifolium 'Sparkler', I. crenata 'Convexa', I. opaca 'Satyr Hill', I. rugosa x cornuta 'China Girl', I. x attenuata (opaca x cassine) 'Foster's #2', I. aquifolium x cornuta 'Nellie R. Stevens', I. cassine, I. cornuta 13urfordii', I. decidua 'Warren Red', I. verticillata 'Winter Red', I. vomitoria 'Stokes', and I. glabra. Plants were propagated from stem cuttings in 1993 and potted into two quart pots in a composted pine bark mix. In September 1994 plants were placed into twenty randomized complete blocks with each block containing one control and one flooded plant from each taxa. The flooded plants were placed in one-gallon plastic buckets and the water level was maintained one inch above the root crown. Photosynthetic rates were measured biweekly using a portable gas exchange system (LI-COR, Model LI-6200, Lincoln, Neb.). After eight weeks of flooding and two weeks after draining visual evaluations of root and leaf appearance were made. An l l point, pretransforrned rating scale was used that corresponded to the percent of root ball having live roots, with zero being no live roots and ten being 100% covered (1). A similar scale was used for evaluating shoots with zero indicating no leaf drop or discoloration and ten indicating that all of the leaves showed discoloration or had abscised. In mid-November the hollies were placed into a walk-in cooler kept at 40°F with an 8-hour photoperiod for over-wintering. In mid-March the plants were placed back into the greenhouse to conduct survival ratings.

Results and Discusslons: Photosynthesis is often found to be a sensitive indicator of plant response to stress, and the capacity to maintain photosynthesis during flooding is an effective measure of a plant's tolerance to flooding (2). Following eight weeks of flooding, net photosynthetic rates of flooded plants ranged from 60% of the control for I. cornuta 'Burfordii' to 6% of the control for I. rugosa (Table I). Two weeks after the flooded plants were drained, photosynthetic rates recovered for some plants and ranged from l 37% of the control for I. cassine to -5% of the control for I. aquifolium ' Sparkler' . Visual ratings for root systems following flooding ranged from 92% of the control for l. cornuta 'Burfordii' to 60% of the control for I. crenata 'Convexa'. Visual ratings of the shoots (flooded-control) ranged from 0% deterioration for I. cornuta 'Burfordii' to 93% deterioration for I. rugosa Survival of flooded plants, measured the following Spring, ranged from 100% for eight of the taxa to 6% for I. rugosa. Overall, four of the taxa: I. cornuta 'Burfordii', I. x 'Nellie R. Stevens', I. cassine, and I. x attenuata 'Foster's #2'

performed remarkably well during and after flooding with photosynthetic rates greater than 40% of the controls after eight weeks of flooding, root ratings greater than 75% of the controls, less than 5% of the foliage showing deterioration, and 100% survival. At the other end of the spectrum I. crenata 'Convexa', Ilex x meserveae 'Blue Princess', 1. rugosa and 1. aquifolium 'Sparkler' did not tolerate flooding well as indicated by severely depressed photosynthetic rates, deterioration of foliage and roots, and decreased survival. The remaining taxa, I. x 'China Girl', I. glabra, 1. verticillata 'Winter Red', I. decidua 'Warren's Red', I. vomitoria 'Stokes', and I. opaca 'Satyr Hill' were intermediate but still relatively tolerant of the flooding stress as indicated by survival rates of 95-100%.

Significance to the Industry: This study demonstrates considerable variation in tolerance to root-zone flooding arnong different hollies. When selecting hollies for poorly drained conditions, consideration should be given to their relative tolerance to inundation and appropriate taxa should be utilized. The considerable variation in tolerance to inundation also suggests the potential for enhancing adaptability through selective breeding or use of more adaptable taxa for rootstocks in grafted plants.

Literature Cited

I . Little, T.M. and F.J. Hills. 1978. Agricultural experimentation: design and analysis. Wiley, New York.

2. Ranney, T.G. and R.E. Bir. 1994. Comparative flood tolerance of birch rootstocks. J. Amer. Soc. Hort. Sci. I I 9: 43-48.

3. The Royal Horticultural Society. 1992. The new royal horticultural society dictionary of gardening. Macsillan Press, N.Y.

Table 1. Comparison of net photosynethesis (µmol•m-2•s-1) among flooded and control treated plants of 14 taxa following 8 weeks of treatment at 2 weeks after the flooding treatments were ceased.

	8 weeks of Treatment			2 Weeks Following Treatment		
Taxa	Control	Flooded	% of Control	Control	Flooded	% of Control
Burfordii'	10.2	6.1	60	10.3	10.3	100
'Nellie R. Stevens'	11.5	6.2	53	8.8	6.6	75
cassine	4.4	2.2	50	3.8	5.2	137
'Foster's #2'	7.2	3.1	43	9.4	5.5	59
'China Girl'	11.1	4.0	36	10.8	1 1.4	105
glabra	12.5	4.4	35	13.6	12.7	93
'Winter Red'	7.4	2.6	35	11.5	11.0	96
'Warren's Red'	12.0	2.3	19	8.1	2.1	25
'Stokes'	10.5	3.5	33	8.3	7.1	85
'Satyr Hill'	7.7	2.9	37	7.3	4.2	58
'Convexa'	14.2	2.6	18	14.3	2.5	17
'Blue Princess'	6.2	1.3	21	6.3	0.9	15
rugosa	3.2	0.2	6	3.0	0.3	10
'Sparkler'	12.3	1.5	12	10.2	-0.6	-5
Statistical Analysis[Z]						
Taxa		**		**		**
Treatment		**		NA	**	NA
Taxa x Treatrnent		**		NA	**	NA
LSDo05		2.4		20	2.7	30

[Z] NS, *, and ** indicate that treatments were not significant or significan at P=0.05 and P=0.01, respectively.

Table 2: Visual ratings of root and shoot quality following 8 weeks of treatment and survial after overwintering.

	Root Rating[W]			Shoot Rating [X]			Survival (%)	
Taxa	Control	Flooded	% of Cont.[Y]	Control	Flooded	Flood-Control[Y]	Control	Flooded
'Burfordii'	25	20	89	0	0	0	100	100
'Nellie R. Stevens'	44	35	87	0	1	1	100	100
cassine	12	6	67	2	11	4	100	100
'Foster's #2'	21	10	67	0	0	0	100	100
'China Girl'	44	29	78	0	4	4	100	100
glabra	39	18	64	0	37	37	100	100
'Winter Red'	81	55	75	8	18	2	100	100
'Warren's Red'	29	16	74	2	55	41	100	100
'Stokes'	38	25	79	0	1	1	100	95
'Satyr Hill'	43	19	64	0	4	4	100	95
'Convexa'	19	4	46	0	21	16	100	90
'Blue Princess'	11	4	59	0	67	65	100	40
rugosa	10	4	57	0	93	93	100	15
'Sparkler'	3	1	55	0	91	91	100	6
Statistical Analysis[Z]								
Taxa		**	*		**	**		**
Treatment		**	**		**	**		**
Taxa x Treatment		**	*		**	**		**
$LSD_{0.05}$		25.0	12.3		3.0	3.0		9.5

[W] % of root ball covered with live roots (values were backtransformed to percentages following statisitics).
[X] % of foliage area that were dead, discolored or abscised (values were backtransformed to percentages following statisitics).
[Y] Values were calculated on from original data and thus will not equal the percent or difference of means.
[Z] NS, *, and ** indicate that treatments were not significant or significan at P=0.05 and P=0.01, respectively.