

Wheat scenario

S. Strack, D Galeriu, S Diabate, A Melintescu

L. Patryl, H. Nagai

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S. Strack, S. Diabaté

Consequences of atmospheric exposure of wheat plants with Tritium: Experimental observations and dynamic model predictions
Dynamics of organically bound Tritium in wheat plants after short-term atmospheric HTO release: Experimental observations and model predictions

Abstract:

One of the interesting results of the “HTO Release Scenario: Spring Wheat Day and Night, V3.0” during the BIOMOVS II study was the experimental observation and the model predictions of the organically bound Tritium (OBT) formation after the “night” exposure. Most of the predictions from the night scenario show significant underestimation of the experimental observations. Obviously most problems due to modelling the final Tritium concentrations in the grains were connected with the night conditions. One reason can be seen in the fact that the exposure of the tritium plants during the dark period is not a pure ‘night’ exposure. The atmospheric Tritium concentration was still enhanced, when the dark period was finished. At that time additional OBT can be formed due to photosynthetic activities, i.e. the total OBT in the grains is a product from both processes: non-photosynthetically and photosynthetically. A complete overview of all chamber experiments performed in 1993 show a clear reduction of the final OBT concentration in the grains if the exposure has been performed before or after the grain filling period. During the grain filling period in all experiments the final OBT concentrations in the grains are close to the mean value of 0.62 % of the TWT concentration in the leaves at the end of exposure. No difference could be observed

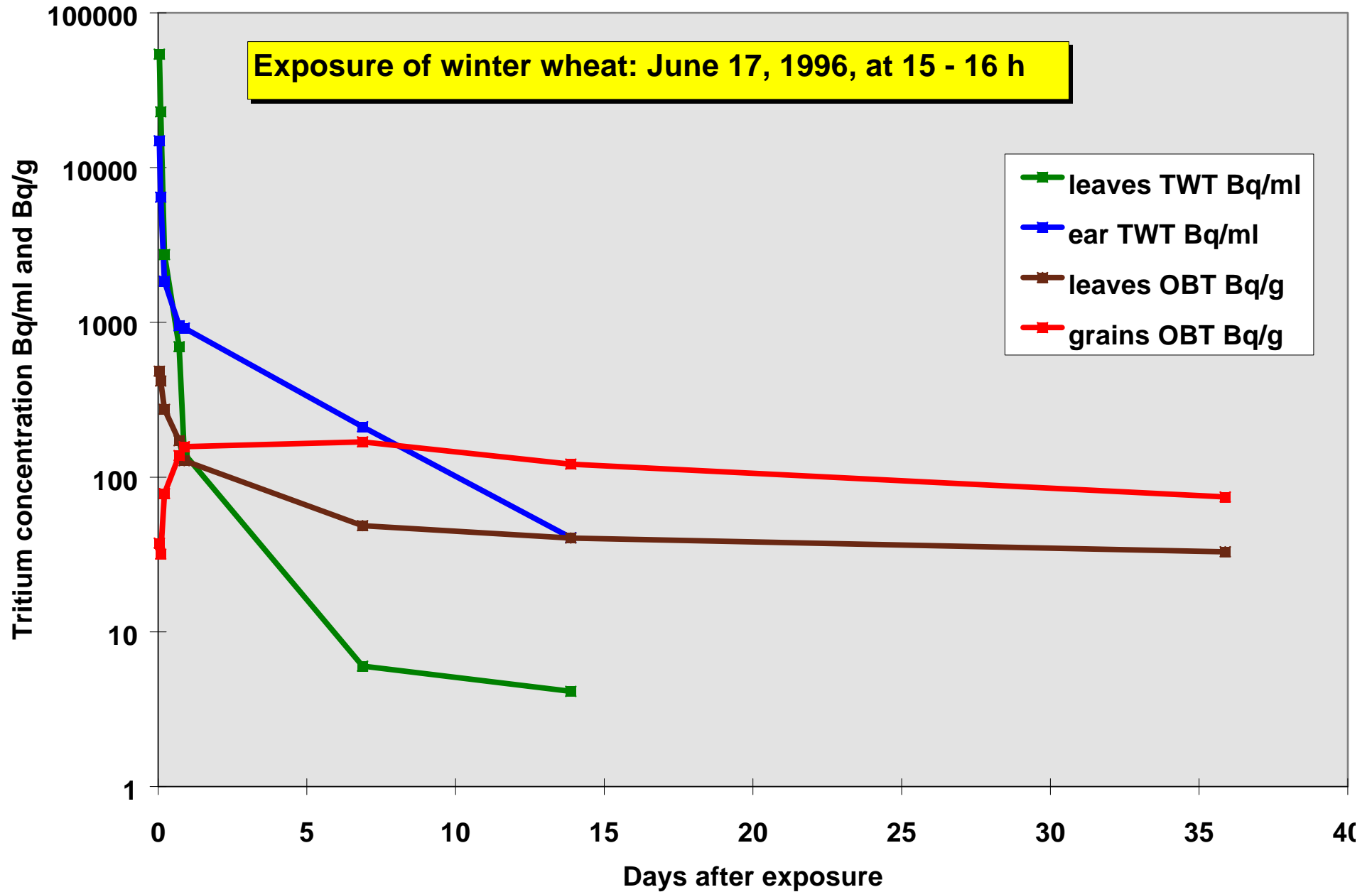




TABLE 1Dry Weights of Plant Parts (mean \pm 1 SD, n=3-7) at the Beginning of Anthesis and at Harvest of Winter Wheat Plants (cv. Contra).

	1994 Rural field dry weights g per plant	1995 FZK field dry weights g per plant	1996 FZK field dry weights g per plant
<u>Beginning of anthesis</u>	<u>3 June 1994</u>	<u>4 June 1995</u>	<u>5 June 1996</u>
Leaves	0.45 \pm 0.13	0.25 \pm 0.04	0.14 \pm 0.02
Stems	1.69 \pm 0.47	0.98 \pm 0.31	0.86 \pm 0.15
Ears	0.50 \pm 0.05	0.43 \pm 0.02	0.40 \pm 0.02
<u>Harvest</u>	<u>End of July 1994</u>	<u>21 July 1995</u>	<u>23 July 1996</u>
Yield of grains	1.89 \pm 0.3	1.69 \pm 0.28	1.47 \pm 0.31

TABLE 2
Meteorological Conditions and Rates of Net Photosynthesis of the Flag Leaf during
Exposure to Atmospheric HTO (1 h Means of Single Exposures)

Category of exp.	Numb. of exp.	Time start of exposure	Temp. box (°C)	Rel. humidity box (%)	Global irradiation (W m ²)	PPFD (μmol m ⁻² s ⁻¹)	net photo-synthesis (μmol CO ₂ m ⁻² s ⁻¹)
Dawn	3	7:00-8:00	11-26	76-93	92-171	160-370	5.3-6.7
Day	7	9:00-15:00	26-36	63-75	410-810	620-1830	12.8-16.7
Dusk	2	20:00	15-24	84-89	26-38	54-86	0.8-1.5
Night	2	23:00	12-17	89-93	0	0	-0.7

TABLE 3

Uptake of Atmospheric HTO into TWT of Wheat Plants in Dependence on the Time of Exposure. The TWT Concentrations at the End of 1 h Exposure are Related to the

Average HTO Concentration in Atmospheric Water during the Exposure

Relative TWT concentrations^a at the end of 1 h exposure to HTO (%)

Plant parts	Exposure at dawn (3 exp.)	Exposure at day-time (7 exp.)	Exposure at dusk (2 exp.)	Exposure at night (2 exp.)
Leaves	26-74	53-105	20-26	18-19
Stems	4-12	10-24	3-5	3
Ears	9-15	14-25	6-10	6
Total plant	10-21	20-34	6-11	7

TABLE 4

Half-Lives of TWT Concentration in Wheat within 1 h after the End of Exposure to HTO

TWT half-lives (min)

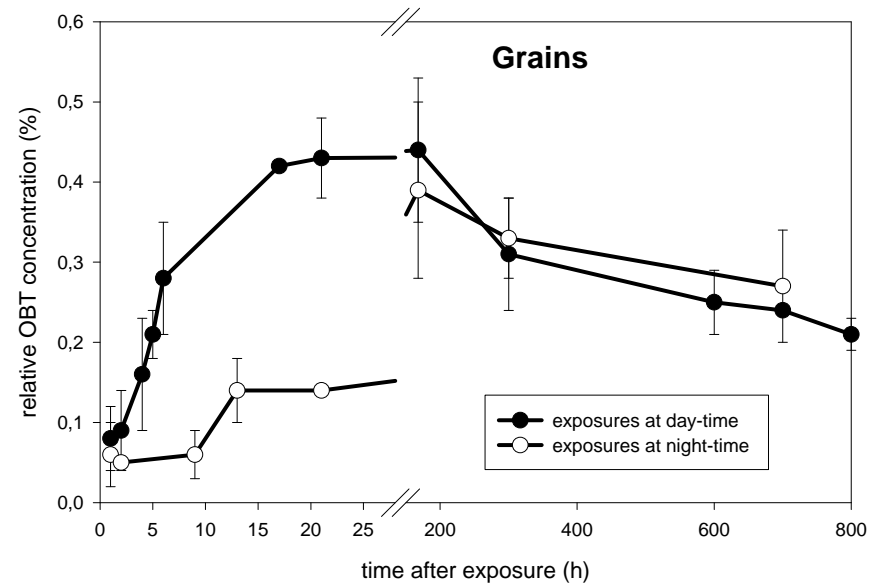
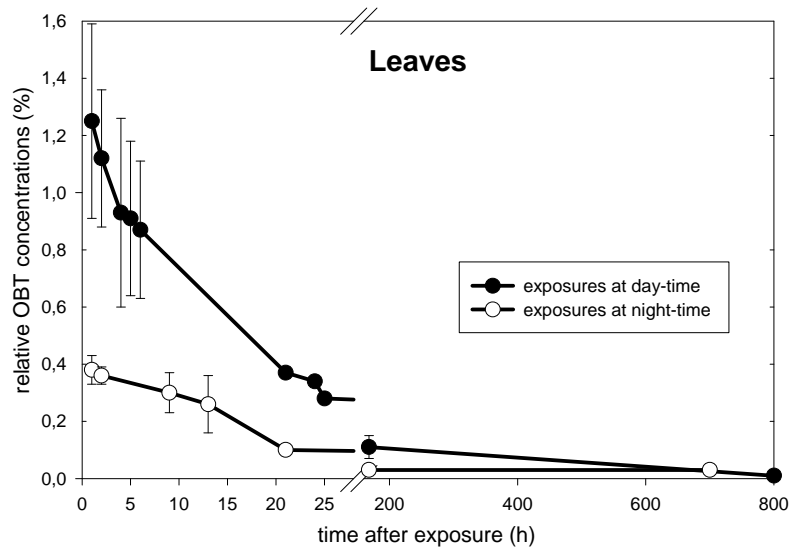
Plant parts	Exposure at dawn (3 exp.)	Exposure at day-time (6 exp.)	Exposure at dusk (2 exp.)	Exposure at night (2 exp.)
Leaves	40-60	25-49	230-660	110-170
Stems	45-49	20-26	130-320	60-190
Ears	79-91	50-126	210-330	150-920
Total plant	50-72	27-60	220-340	100-250

TABLE 5

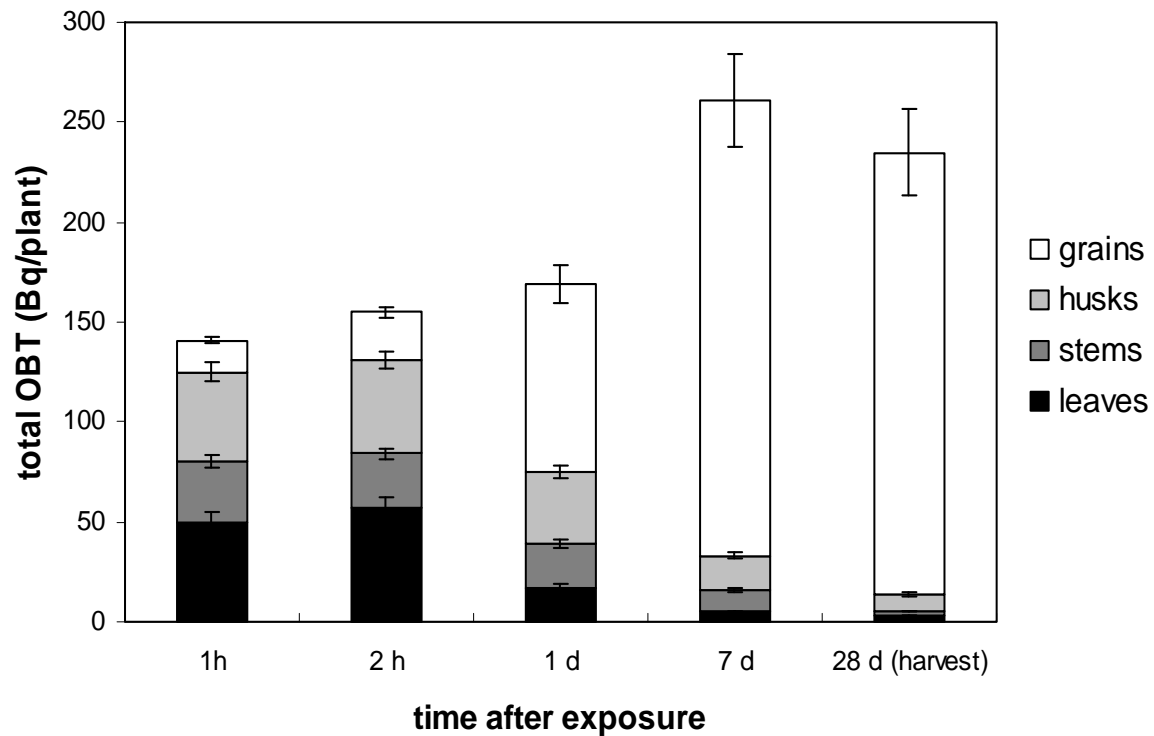
Initial OBT Formation in Wheat in Dependence on the Time of Exposure (mean \pm 1SD). The OBT

Concentrations are Related to the TWT Concentration in Leaves at the End of Exposure to HTO. ■

	Relative OBT concentration at the end of 1h exposure (%)			
Plant parts	Exposure at Dawn (3 exp.)	Exposure at Day-time (7 exp.)	Exposure at Dusk (2 exp.)	Exposure at Night (2 exp.)
Leaves	0.63 \pm 0.15	1.25 \pm 0.34	0.46 \pm 0.04	0.38 \pm 0.05
Stems	0.09 \pm 0.03	0.17 \pm 0.03	0.08 \pm 0.02	0.08 \pm 0.01
Ears	0.12 \pm 0.07	0.17 \pm 0.08	0.16 \pm 0.07	0.10 \pm 0.05
Total plant	0.11 \pm 0.03	0.24 \pm 0.07	0.12 \pm 0.01	0.09 \pm 0.01



Courses of relative OBT concentrations in leaves and grains from exposure to HTO to harvest. The data represent means \pm 1SD of 7 exposures under day-time conditions and of 2 exposures under night-time conditions.



The distribution of OBT within the wheat plants exposed to atmospheric HTO during the dusk on the 20th day after anthesis (error bars represent counting error plus analytical error).

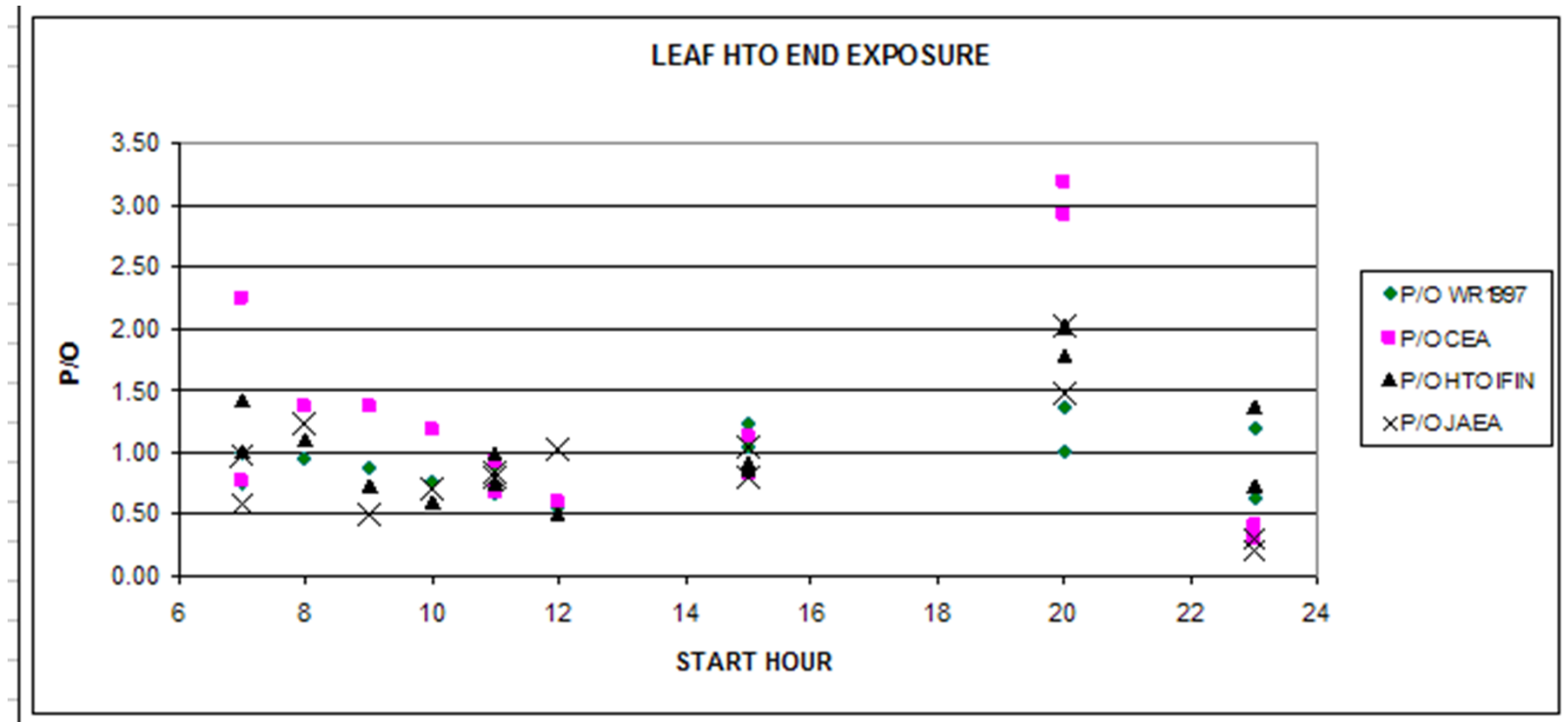
Wheat scenario

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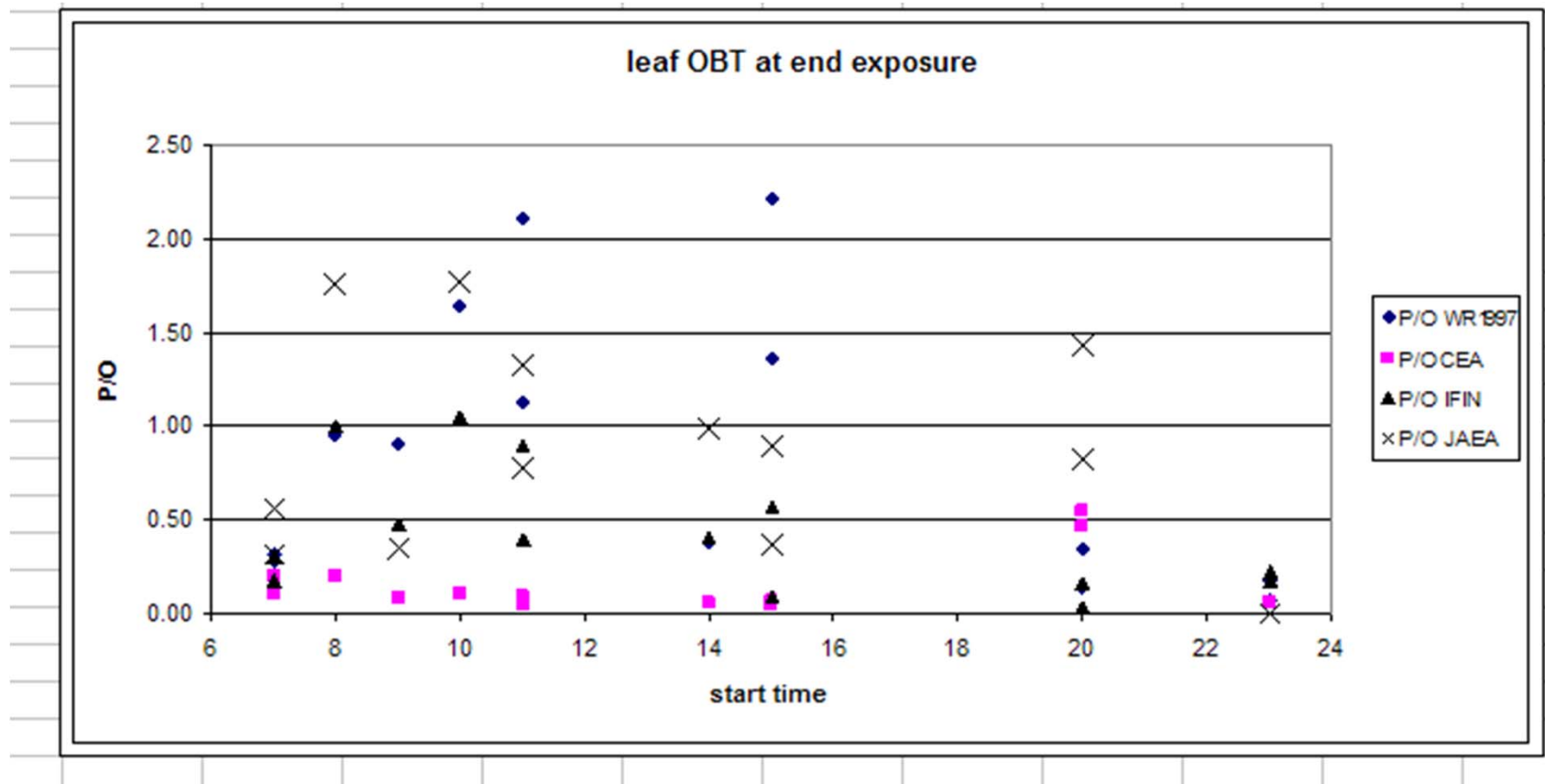
models

- Simple CEA, constant night, day exchange vel., OBT ~integrated leaf HTO/DT
- Moderate IFIN, Ronda+WOFOST, OBT in night calibrated
- Complex, JAEA Ball-Berry Farquhar, carbohydrate allocation
- AECL to come
- Plant OBT 1997 W. Raskob

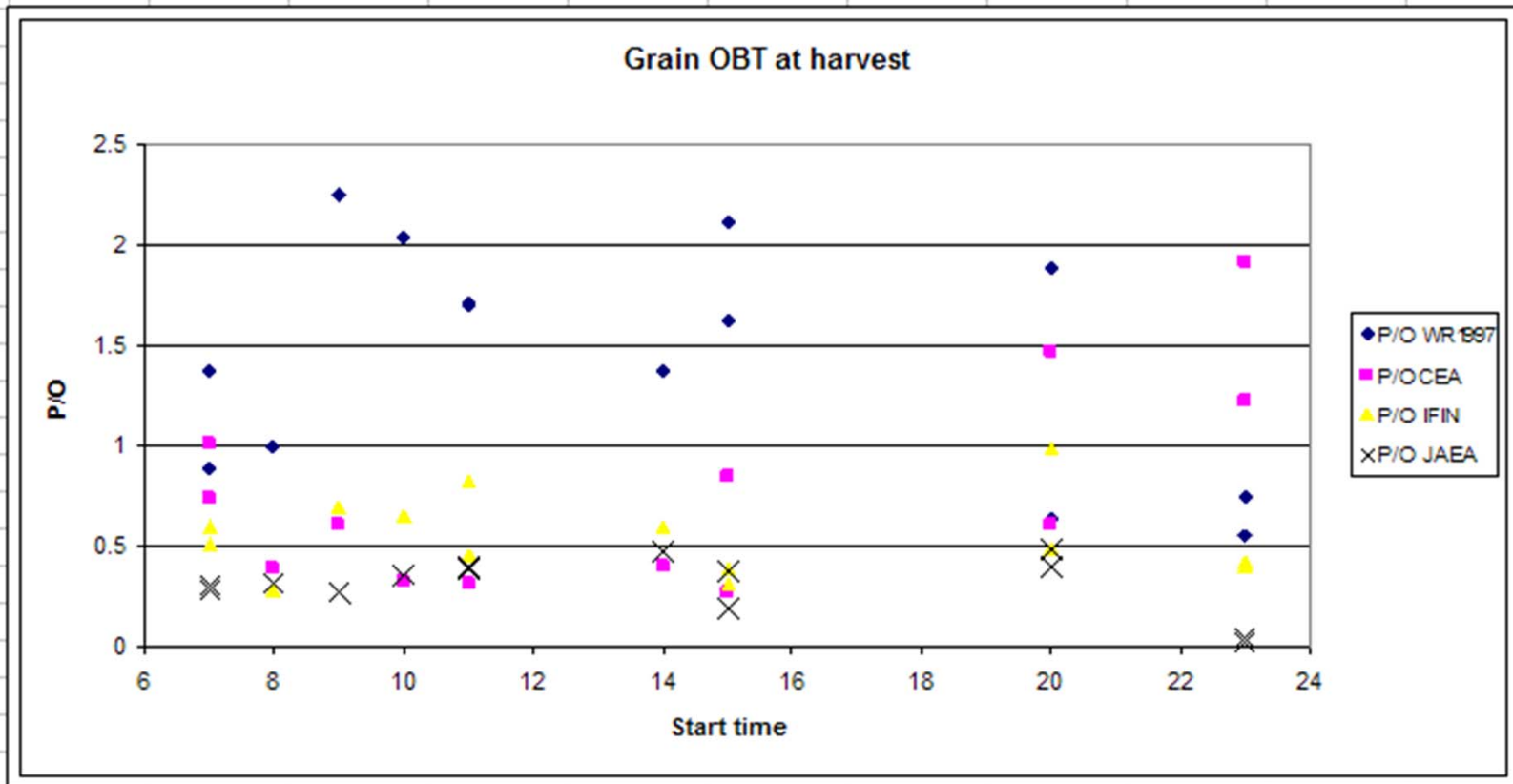
General analysis of predictions



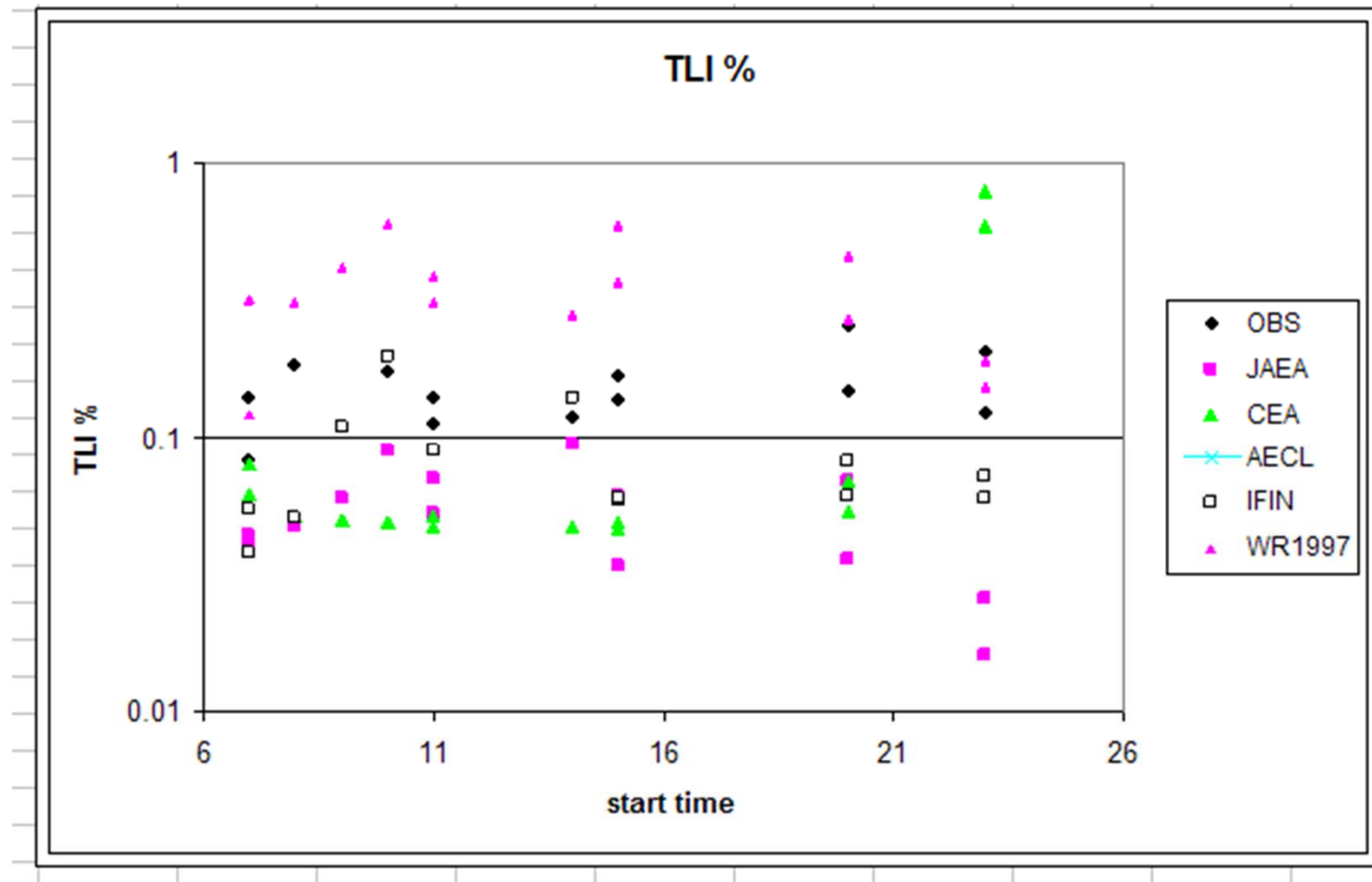
General analysis of predictions



General analysis of predictions

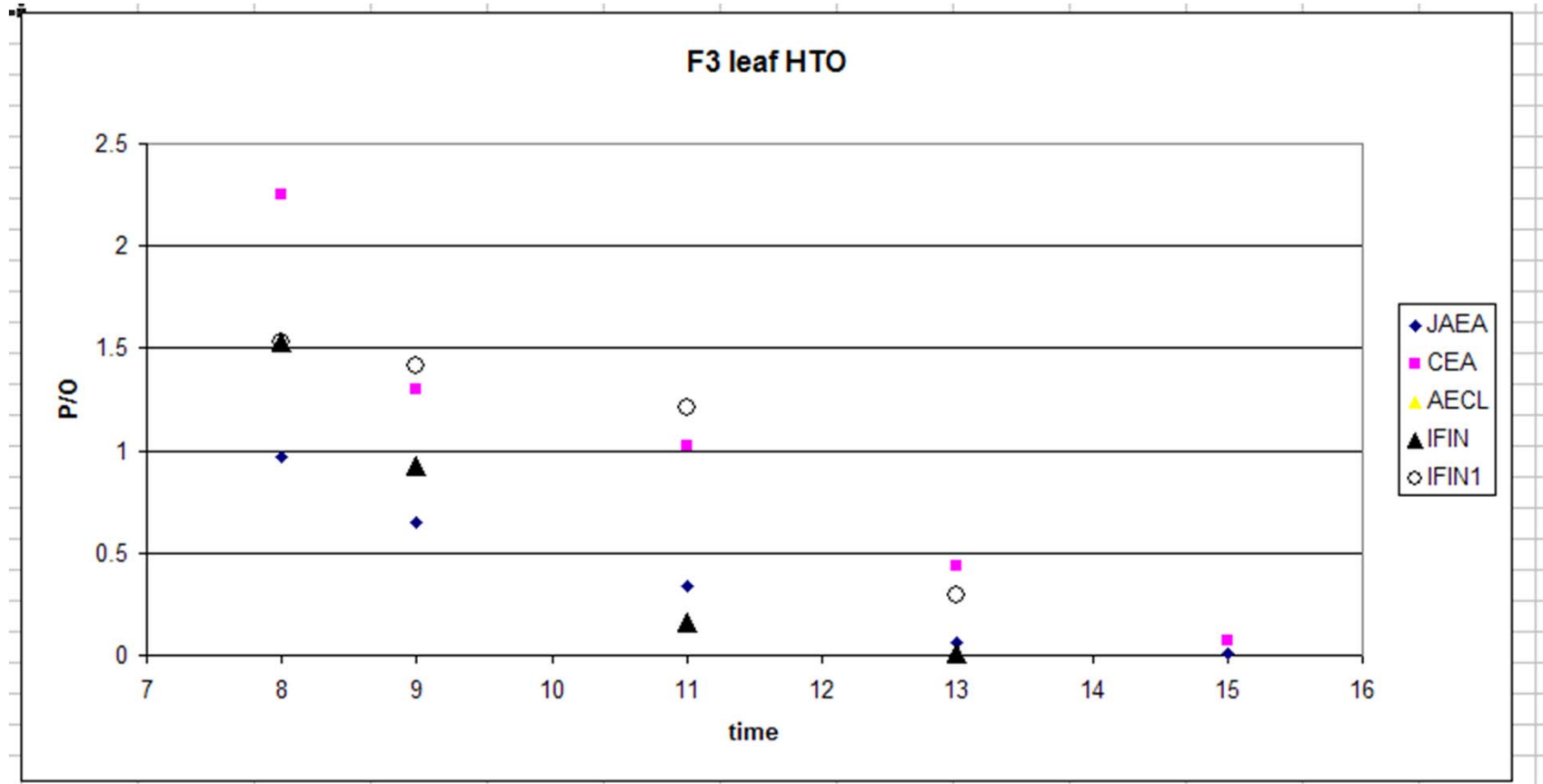


General analysis of predictions

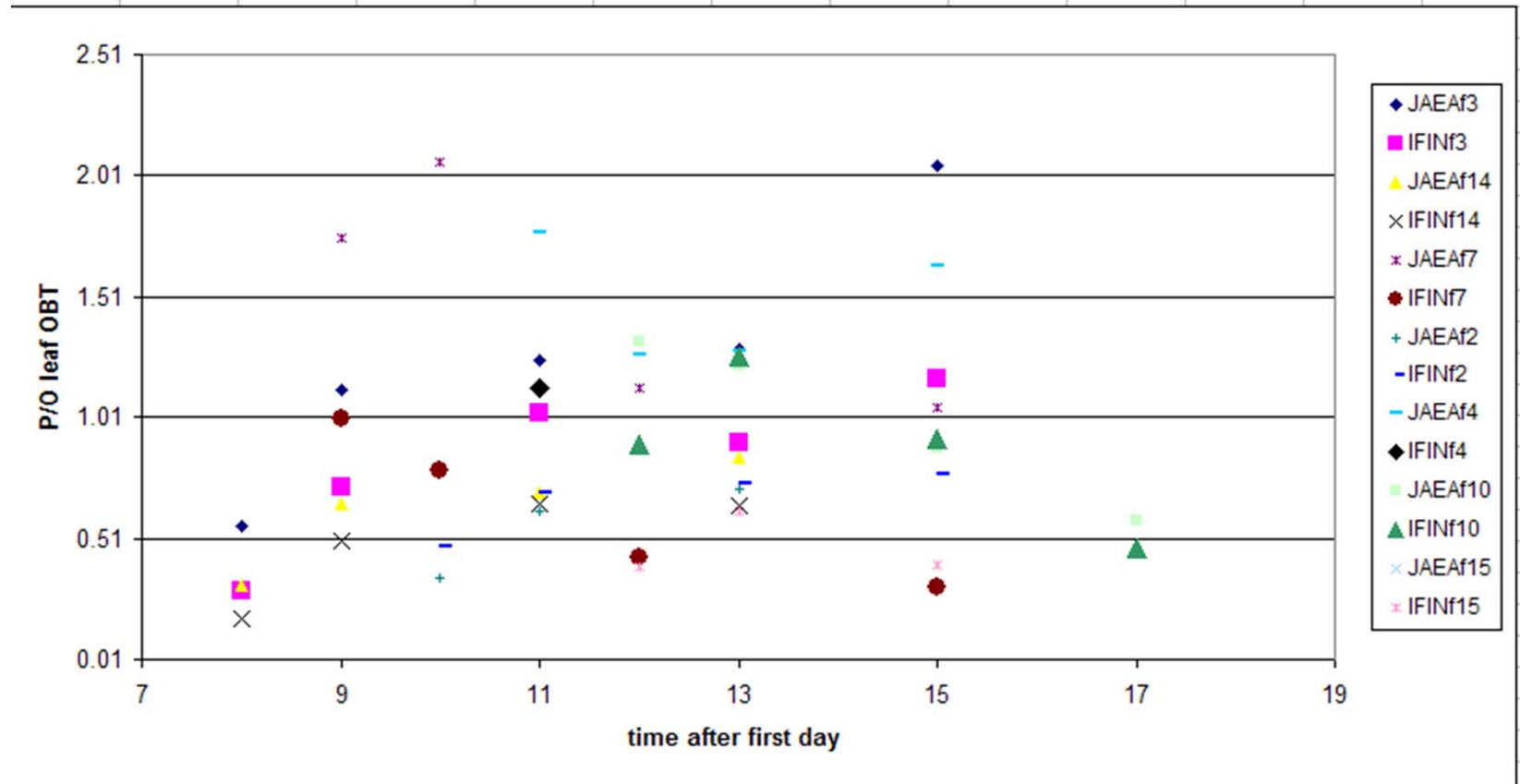


Translocation index = grain OBT (combustion water) at harvest, relative to leaf HTO at end exposure

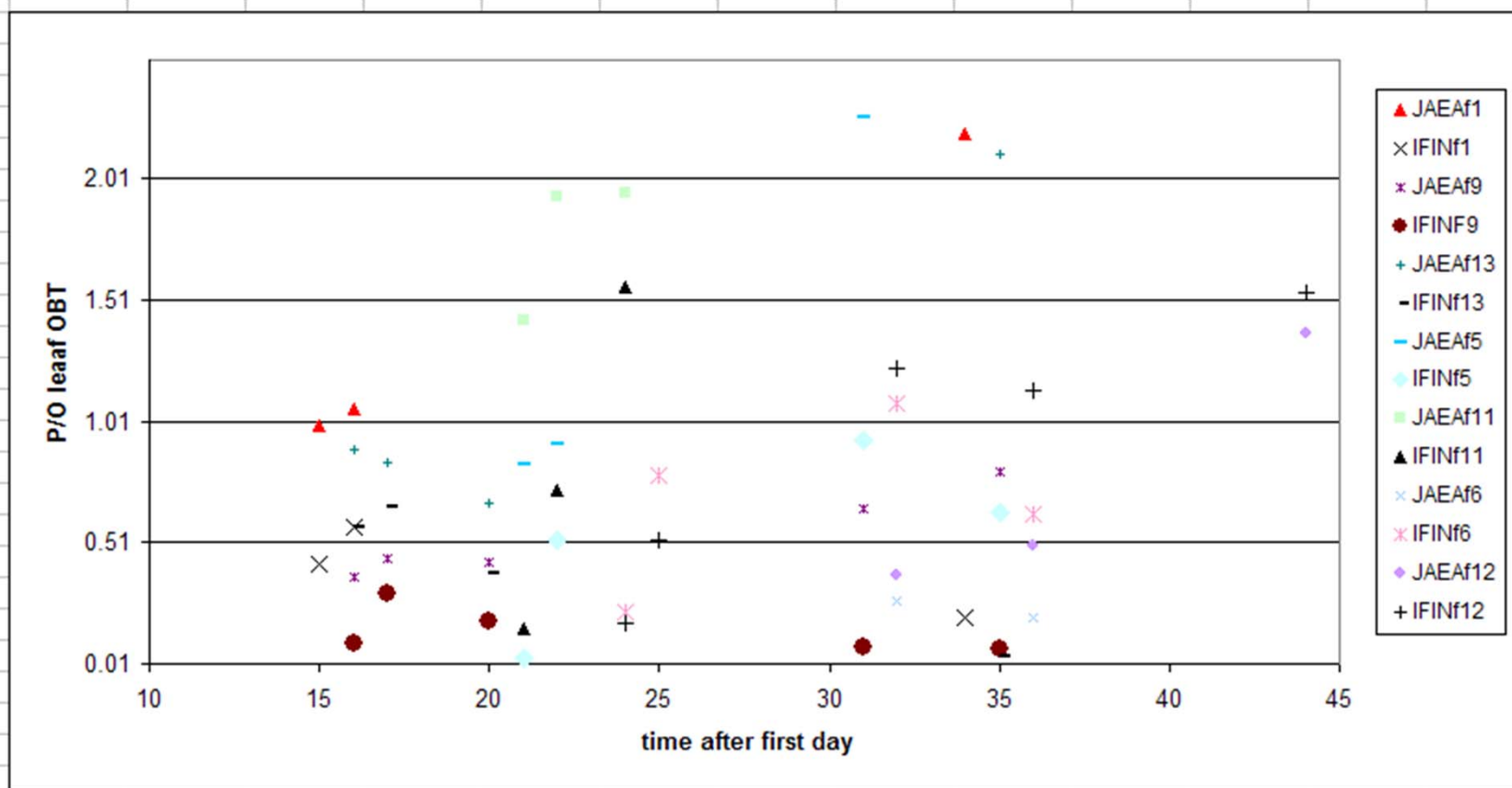
IFIN1 doubling Rab



morning



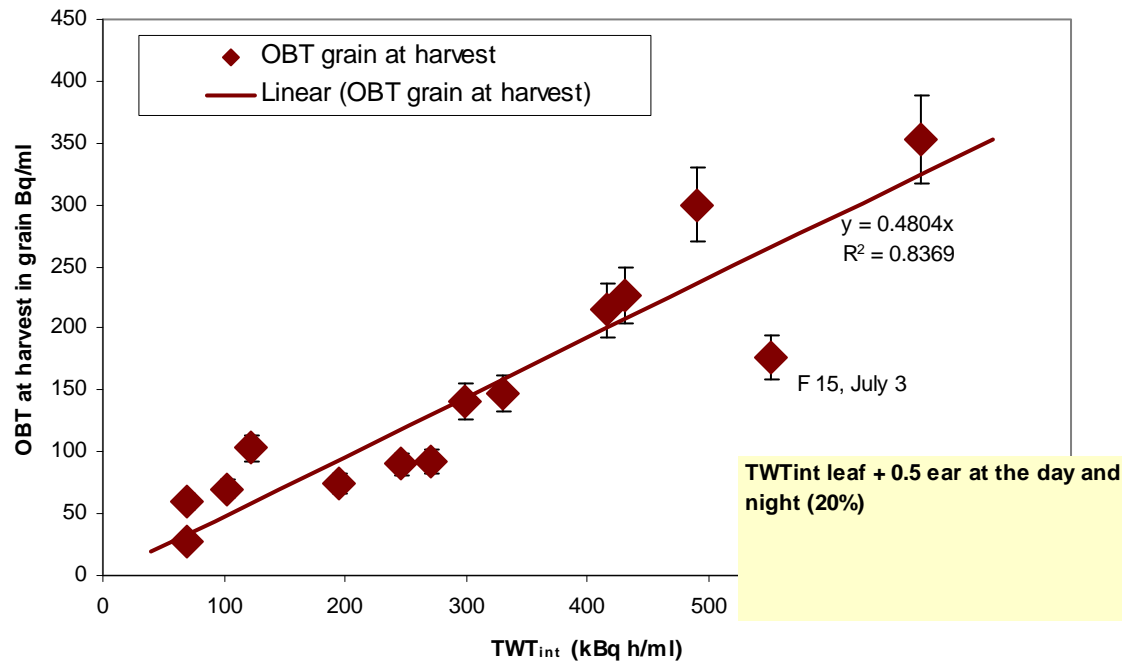
afternoon



F15

h	microE/m2s	C	%	ppm	ppm	μmol/m²s	μmol/m²s
time	PPFD	Tleaf	relh	Cs	ci	asim	conductivity
11	1710	24.4	53.2	337	281	10.171	324.4
11.0833333	1711	26.7	47.1	415	359	7.922	284.1
11.1666667	1785	29.4	40.7	385	289	11.501	216.2
11.25	1810	30.6	38.2	368	273	10.379	199.3
11.3333333	1646	31.2	36.8	352	260	10.173	204.3
11.4166667	1834	32	35.6	375	295	8.002	196.8
11.5	1859	32.7	34.1	391	305	8.002	183.9
11.5833333	1867	33.2	32.7	396	303	8.162	171.9
11.6666667	1875	33.5	31.7	366	264	9.127	169.6
11.75	1886	33.8	31	337	237	9.091	170.8
11.8333333	1893	34	30.5	357	280	6.476	171.7
11.9166667	1906	34.4	29.6	371	288	6.593	164.1
12	1909	34.7	29.1	371	285	6.674	157.8
12.0833333	1769	32	34.3	338	245	7.642	152.8
12.1666667	1947	28.6	41.3	303	204	8.927	157.1
12.25	1952	27.7	43.8	304	216	8.609	171.7
12.3333333	1966	27.6	45	305	219	9.052	183.7
12.4166667	1653	27.1	44.6	313	235	8.605	195.4
12.5	1974	28.2	43.3	309	224	8.484	177.6
12.5833333	2022	28.3	43.3	308	218	9.007	176.7
12.6666667	2015	28.2	43.4	308	220	8.846	175.5
12.75	2004	28.4	42.9	309	221	8.766	175
12.8333333	2042	28.4	42.7	308	217	8.561	166.1
12.9166667	2046	28.5	41.9	308	218	8.486	164.4
13	1968	28.6	41.3	308	217	8.195	158.7

OBT_{grain} at harvest related to TWT_{integrated} in leaves and ears



F-5 and F-15 !