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NDP-073

A Database of Herbaceous Vegetation Responses to Elevated Atmospheric CO2

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CDIAC

OHIO STATE

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A DATABASE OF HERBACEOUS VEGETATION RESPONSES TO ELEVATED ATMOSPHERIC CO_2

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CONTENTS

ABSTRACT

Jones, M. H., P. S. Curtis, R. M. Cushman, and A. L. Brenkert. 1999. *A Database of Herbaceous Vegetation Responses to Elevated Atmospheric CO_2*. ORNL/CDIAC-124, NDP-073. Carbon Dioxide Information Analysis Center, U.S. Department of Energy, Oak Ridge National Laboratory, Oak Ridge, Tennessee, U.S.A.

To perform a statistically rigorous meta-analysis of research results on the response by herbaceous vegetation to increased atmospheric CO_2 levels, a multiparameter database of responses was compiled from the published literature. Seventy-eight independent CO_2-enrichment studies, covering 53 species and 26 response parameters, reported mean response, sample size, and variance of the response (either as standard deviation or standard error). An additional 43 studies, covering 25 species and 6 response parameters, did not report variances. This numeric data package accompanies the Carbon Dioxide Information Analysis Center's (CDIAC's) NDP-072, which provides similar information for woody vegetation.

This numeric data package contains a 30-field data set of CO_2-exposure experiment responses by herbaceous plants (as both a flat ASCII file and a spreadsheet file), files listing the references to the CO_2-exposure experiments and specific comments relevant to the data in the data sets, and this documentation file (which includes SAS®[1] and Fortran codes to read the ASCII data file).

The data files and this documentation are available without charge on a variety of media and via the Internet from CDIAC.

Keywords: carbon dioxide, meta-analysis, vegetation

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[1]SAS® is a registered trademark of the SAS Institute, Inc., Cary, North Carolina 27511.

1. BACKGROUND INFORMATION

To perform a statistically rigorous synthesis of research results on the response by vegetation to increased atmospheric CO_2 levels, a multiparameter database of herbaceous-plant responses was compiled from the published literature (Wand et al. 1999; Jones et al. submitted). Seventy-eight independent CO_2-enrichment studies, covering 53 species 1and 26 response parameters, reported mean response, sample size, and variance of the response. An additional 43 studies, covering 25 species and six response parameters, did not report variances. The plant species included in the database are listed in Appendix A. Meta-analytical methods (Cooper and Hedges 1994; Gurevitch and Hedges 1993; Gurevitch et al. 1992) have been applied to part of this database (Wand et al. 1999). This numeric data package accompanies the Carbon Dioxide Information Analysis Center's (CDIAC's) NDP-072 (Curtis et al. 1999), which provides similar information for woody vegetation.

Physiological "acclimation" or "downward regulation" of photosynthetic rates, stomatal conductance, dark respiration, and water-use efficiency of plants exposed to elevated CO_2 levels can be analyzed according to the following definitions. "Acclimation" is in general defined as "diminishing enhancement of photosynthesis by elevated CO_2 with time" (Mousseau and Saugier 1992). "Downward regulation" can be defined as "the initial stimulation of enhanced photosynthesis and growth by atmospheric enrichment eroding with time" (Idso and Kimball 1992). The phenomenon is also called "downward acclimation": "following prolonged exposure to high CO_2, photosynthetic capacity measured at either elevated or ambient CO_2 partial pressure falls to below that of plants exposed only to ambient CO_2" (Curtis and Teeri 1992).

Data were compiled for the database according to the following guidelines. The durations of experimental exposures are always reported. When more than one elevated-CO_2 treatment level is reported, only the level that is approximately twice the ambient level is included. For photosynthetic rates, stomatal conductance, dark respiration, and water use efficiency, only final-exposure experiment results are included; multiple measurements over time for the same plant are not. For acclimatory responses, only data for (1) plants grown at ambient CO_2 levels and measured at elevated CO_2 levels and (2) plants grown at elevated CO_2 levels and measured at elevated CO_2 levels are included.

2. APPLICATIONS OF THE DATA

This database was produced to support a meta-analysis of the effects of elevated CO_2 on herbaceous vegetation (Wand et al. 1999), and it was formatted accordingly. For other applications, the user should be aware that the data may be reported in more than one unit for a given variable (e.g., aboveground weight is reported in units of grams, grams per square meter, grams per plant, grams per pot, kilograms per hectare, kilograms per square meter, milligrams, milligrams per plant, and tons per hectare); this is not a problem for meta-analysis, but for other applications the user may need to convert the data to consistent units.

The effects of environmental factors (e.g., nutrient levels, light intensity, temperature), stress treatments (e.g., drought, heat, ozone), and the effects of experimental conditions (e.g., duration of CO_2 exposure, pot size, type of CO_2 exposure facility) on plant responses to elevated CO_2 levels can be explored with this database.

3. DATA LIMITATIONS AND RESTRICTIONS

In many papers, the data were reported graphically rather than numerically. In such cases, values reported in the database were digitized from the printed figures and may therefore be less accurate.

Some of the standard deviations (and derived standard errors and coefficients of variation) in this database may be incorrect. When a "standard deviation" was reported in a published paper, it was not generally possible to verify whether this value was a *sample* standard deviation or the standard deviation *of the mean*, which is sometimes used synonymously with standard error (i.e., standard error of the mean). Unfortunately, it was not possible to settle this issue definitively without personally contacting the authors of the published papers. In all cases, where not specified or known to be otherwise, a reported standard deviation was taken to be the sample standard deviation. If this assumption was in error, then the standard deviation, standard error, and coefficient of variation reported in this database would be incorrect.

In some cases an error bar in a figure or confidence interval in a table was not specified as standard deviation or standard error. If it was not possible to determine whether the reported variability was standard deviation or standard error, a missing-value indicator (-9.99) is entered under standard deviation and standard error for that observation.

In some cases (e.g., in long-term exposures), the duration of CO_2 exposure was approximated.

As noted in Sect. 2, various units may be used for the same parameter, so the user should apply caution in integrating observations from more than one paper. Units are reported in the database.

4. DATA CHECKS AND PROCESSING PERFORMED BY CDIAC

An important part of the data-packaging process at CDIAC involves the quality assurance (QA) of data before distribution. To guarantee data of the highest possible quality, CDIAC performs extensive QA checks, examining the data for completeness, reasonableness, and accuracy, through close cooperation with the data contributor.

All entries in the data file were visually inspected for reasonableness, and selected entries were spot-checked against the original publications.

The following paragraphs describe the additional data checks that were performed in the preparation of this numeric data package and the resulting revisions to the database.

Excel®[2] was used to convert the spreadsheets provided by the principal investigators to Lotus 1-2-3®[3] format. Two separate databases, one including observations for which standard deviation or standard error was reported ("weighted") and the other consisting of observations without reported standard deviation or standard error ("unweighted"), were merged into one.

Lists of entries for each field were generated to identify possible spelling variants, typographical errors, or order-of-magnitude errors in the original literature or in the compilation and data entry of the database.

Where a cited paper reported standard error, standard deviation was calculated and tabulated (such occurrences are indicated in the database with a **SDC** flag-code).

The ratio of elevated/ambient for X, SE, SD, and N was calculated for all parameters and all observations; then all observations were ranked on the basis of each ratio, whenever possible (all these variables were not present for all observations), to identify suspect values (defined as jumps of greater than twofold between adjacent observations). The ranked ratios of **X_ELEV/X_AMB** ranged without abrupt jumps from 0.19 to 3.5, except for the ratio for variable AGWT reported from **PAP_NO** 2440 (**X_ELEV/X_AMB** = 9.2); the individual values for **X_ELEV** and **X_AMB** were verified in that publication (they were digitized from Fig. 5). The ranked ratios of **SE_ELEV/SE_AMB** and **SD_ELEV/SD_AMB** ranged without abrupt jumps from 0.05 to 18, except for the ratios of 0 for variables TOTWT, RGR, PN, and GS reported from **PAP_NO** 2363; the individual values for which standard error was reported as 0 were verified in that publication. The ranked ratios of **CV*_ELEV/CV*_AMB** ranged without abrupt jumps from 0.07 to 29.25, except for the same observations for **PAP_NO** 2363, for which the reported standard error of 0 was verified. The ranked ratios of **N_ELEV/N_AMB** ranged without abrupt jumps from 0.4 to 1.43. Thus, this analysis did not reveal any aberrant and unverifiable observations in the databases.

To search for possible confusion between standard error and standard deviation (see Sect. 3), coefficients of variation **CV*** (after Sokal & Rohlf 1981) were calculated, whenever possible, for each **PARAM** from each mean, standard deviation, and sample size. It was expected that, for any **PARAM**, an anomalously low coefficient of variation for a given observation might signal that a standard error was mis-labeled as a standard deviation. The database was sorted by **PARAM**, then by **CV*_AMB** and **CV*_ELEV**, and was inspected for jumps of greater than

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[2]Excel® is a registered trademark of the Microsoft Corporation, Redmond, Washington 98052.

[3]Lotus 1-2-3® is a registered trademark of the Lotus Development Corporation, Cambridge, Massachusetts 02142.

fourfold between adjacent observations. Where the standard error, rather than standard deviation, was reported in the cited publication, no mislabeling should have been possible. This analysis identified two pairs of adjacent observations that warranted further scrutiny. The following list contains those pairs of adjacent observations, along with the results of the checks.

PAP_NO = 3034
PARAM = PN
SPECIES = *Echinochloa crusgalli*
SOURCE = F1
X_ELEV = 44.400
SE_ELEV = 0.100
CV*_ELEV = 0.694

and

PAP_NO = 2723
PARAM = PN
SPECIES = *Poa alpina*
SOURCE = F4
X_ELEV = 40.120
SE_ELEV = 0.505
CV*_ELEV = 2.955

Data for both of the above observations were verified in the original publications.

PAP_NO = 2184
PARAM = TILLERS
SPECIES = *Phleum pratense*
SOURCE = T2
X_ELEV = 726.000
SE_ELEV = 52.000
CV*_ELEV = 28.203

and

PAP_NO = 2717
PARAM = TILLERS
SPECIES = *Bromus erectus*
SOURCE = F1
X_ELEV = 4.590
SE_ELEV = 0.400
CV*_ELEV = 129.991

Data for both of the above observations were verified in the original publications. However, the error bars in Fig. 1 of **PAP_NO** 2717 were not labeled as to their meaning; they were assumed to represent standard error (see Sect. 3).

5. INSTRUCTIONS FOR OBTAINING THE DATA AND DOCUMENTATION

This database (NDP-073) is available free of charge from CDIAC. The files are available via the Internet, from CDIAC's World-Wide-Web site (**http://cdiac.esd.ornl.gov**), or from CDIAC's anonymous file transfer protocol (FTP) area (**cdiac.esd.ornl.gov**) as follows:

1. FTP to cdiac.esd.ornl.gov (128.219.24.36).
2. Enter "ftp" as the user id.
3. Enter your electronic mail address as the password (e.g., fred@zulu.org).
4. Change to the directory "pub/ndp073" (i.e., use the command "cd pub/ndp073").
5. Set ftp to get ASCII files by using the ftp "ascii" command.
6. Retrieve the ASCII database documentation file by using the ftp "get ndp073.txt" command.
7. Retrieve the ASCII data files by using the ftp "mget *.dat" command.
8. Set ftp to get binary files by using the ftp "binary" command.
9. Retrieve the binary spreadsheet files by using the ftp "mget *.wk1" command.
10. Exit the system by using the ftp "quit" command.
11. Uncompress the files on your computer if they are obtained in compressed format.

For non-Internet data acquisitions (e.g., diskette or 8-mm tape) or for additional information, contact:

User Services
Carbon Dioxide Information Analysis Center
Oak Ridge National Laboratory
P.O. Box 2008
Oak Ridge, Tennessee 37831-6335, U.S.A.

Telephone: 1-865-574-3645
Telefax: 1-865-574-2232
Email: cdiac@ornl.gov

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Wand, S. J. E., G. F. Midgley, M. H. Jones, and P. S. Curtis. 1999. Responses of wild C4 and C3 grass (Poaceae) species to elevated atmospheric CO_2 concentration: a test of current theories and perceptions. *Global Change Biology* 5:723-741 (available online via Blackwell Science Ltd.'s *Synergy* subscription service; see http://www.blackwell-science.com/online/).

7. LISTING OF FILES PROVIDED

The database consists of seven files (see Table 1), including this documentation file. The data files (**ndp073.dat** and **ndp073.wk1**), reference files (**refs.dat** and **refs.wk1**), and comment files (**comments.dat** and **comments.wk1**) are available in two formats: as flat ASCII files and as binary spreadsheet files (in Lotus 1-2-3® format, but readable by other spreadsheet programs).

The 30-field **ndp073.dat** and **ndp073.wk1** files contain data (954 observations in all) relevant for CO_2-exposure meta-analysis for herbaceous plants. The **ndp073.dat** file can be read into SAS® or Fortran programs, using the access codes provided in Sect. 11 of this numeric data package. The **ndp073.dat** file can also be converted into a spreadsheet file for processing, although it is simpler to use the corresponding **ndp073.wk1** spreadsheet file provided.

The **refs.dat** file (included in this report as Appendix B) and **refs.wk1** file list the selected literature represented in the data file (119 references), and the **comments.dat** file (included in this report as Appendix C) and **comments.wk1** file provide additional information about the studies, beyond what appears in the **ndp073.dat** and **ndp073.wk1** data files. The reference numbers in the **refs.dat**, **refs.wk1**, **comments.dat**, and **comments.wk1** files correspond to the paper numbers in the **ndp073.dat** and **ndp073.wk1** data files.

Table 1. Data files in the database

File number	File name	File size (kB)	File type	File description
1	**ndp073.txt**	85	ASCII text	Documentation file
2	**ndp073.dat**	223	ASCII text	Data file
3	**ndp073.wk1**	507	Binary spreadsheet	Data file
4	**refs.dat**	24	ASCII text	Reference file
5	**refs.wk1**	30	Binary spreadsheet	Reference file
6	**comments.dat**	21	ASCII text	Comment file
7	**comments.wk1**	29	Binary spreadsheet	Comment file

8. DESCRIPTION OF THE DOCUMENTATION FILE

The **ndp073.txt (File 1)** file is an ASCII text equivalent of this document.

9. DESCRIPTION, FORMAT, AND PARTIAL LISTINGS OF THE ASCII DATA FILES

Table 2 describes the format and contents of the ASCII data file **ndp073.dat (File 2)** distributed with this numeric data package. Table 2 also indicates the column in the corresponding spreadsheet file **ndp073.wk1** in which each variable is found. The missing-value indicator in this database is the period (.), except for the real numeric fields **SE_AMB**, **SD_AMB**, **CV*_AMB**, **SE_ELEV**, **SD_ELEV**, and **CV*_ELEV**, in which the missing-value indicator is -9.99, and the integer numeric fields **N_AMB** and **N_ELEV**, in which the missing-value indicator is -9.

Table 2 (continued)

Table 2. Contents and format of ndp073.dat (File 2)

Variable	Variable type	Variable width	Starting column	Ending column	Units	Spreadsheet column	Definition and comments
PAP_NO	Numeric	6	1	6		A	Cited paper number
PARAM	Character	7	7	13		B	Measured parameter
P_UNIT	Character	14	14	27		C	Unit for PARAM
GENUS	Character	13	28	40		D	Plant genus name
SPECIES	Character	13	41	53		E	Plant species name
DIV1	Character	6	54	59		F	Functional division #1
DIV2	Character	7	60	66		G	Functional division #2
DIV3	Character	5	67	71		H	Functional division #3
DIV4	Character	6	72	77		I	Functional division #4
AMB	Character	3	78	80	See CO2_UNIT	J	Ambient CO_2 treatment level
ELEV	Character	4	81	84	See CO2_UNIT	K	Elevated CO_2 treatment level
CO2_UNIT	Character	10	85	94	See text following table	L	Units for CO_2 exposure concentration
TIME	Character	5	95	99	Days	M	Maximum duration of CO_2 exposure
POT	Character	13	100	112		N	Growing method
MTHD	Character	4	113	116		O	CO_2-exposure facility
STOCK	Character	9	117	125		P	Planting stock
XTRT	Character	6	126	131		Q	Interacting treatment

Table 2 (continued)

Variable	Variable type	Variable width	Starting column	Ending column	Units	Spreadsheet column	Definition and comments
LEVEL	Character	7	132	138		R	Interacting treatment level
QUANT	Character	17	139	155		S	Quantity and unit associated with LEVEL
SOURCE	Character	6	156	161		T	Figure, table, or page from which data taken
X_AMB	Numeric	8	162	169	See P_UNIT	U	Mean response of plants grown in ambient CO_2
SE_AMB	Numeric	8	170	177	See P_UNIT	V	Standard error of X_AMB
SD_AMB	Numeric	8	178	185	See P_UNIT	W	Standard deviation of responses of plants grown in ambient CO_2
CV*_AMB	Numeric	7	186	192	%	X	Coefficient of variation of responses of plants grown in ambient CO_2
N_AMB	Numeric	5	193	197		Y	Sample size of responses of plants grown in ambient CO_2
X_ELEV	Numeric	9	198	206	See P_UNIT	Z	Mean response of plants grown in elevated CO_2
SE_ELEV	Numeric	7	207	213	See P_UNIT	AA	Standard error of X_ELEV
SD_ELEV	Numeric	8	214	221	See P_UNIT	AB	Standard deviation of responses of plants grown in elevated CO_2

Variable	Variable type	Variable width	Starting column	Ending column	Units	Spreadsheet column	Definition and comments
CV*_ELEV	Numeric	8	222	229	%	AC	Coefficient of variation of responses of plants grown in elevated CO_2
N_ELEV	Numeric	6	230	235		AD	Sample size of responses of plants grown in elevated CO_2
SDC	Character	3	236	238		AE	Calculated versus reported standard deviation

Where:

For **PARAM**, the following list defines the possible measured parameters:

plant parts

AGPROD: aboveground productivity (= AGWT + clippings)
AGWT: total aboveground weight
BGWT: total belowground weight
LFWT: total leaf weight
RGR: relative growth rate
ROOTWT: root weight
SHTWT: shoot weight
STWT: stem weight
TILLERS: number of tillers
TOTWT: whole plant weight

leaf area components

INDLA: maximum individual leaf area
MAXLA: maximum canopy leaf area
SLA: specific leaf area (leaf area/unit mass of leaf)
SLW: specific leaf weight (leaf mass/unit area of leaf)

gas-exchange parameters

GR: stomatal resistance of ambient-grown plants measured at ambient CO_2 levels (**X_AMB**) and of elevated-grown plants measured at elevated CO_2 levels (**X_ELEV**)

GR_AC: stomatal resistance of ambient-grown plants measured at elevated CO_2 levels (**X_AMB**) and of elevated-grown plants measured at elevated CO_2 levels (**X_ELEV**)
GS: stomatal conductance of ambient-grown plants measured under ambient CO_2 (**X_AMB**) and elevated-grown plants measured under elevated CO_2 levels (**X_ELEV**)
PN: net CO_2 assimilation of ambient-grown plants measured under ambient CO_2 (**X_AMB**) and elevated-grown plants measured under elevated CO_2 levels (**X_ELEV**)
PN_AC: net CO_2 assimilation of ambient-grown plants measured at elevated CO_2 (**X_AMB**) and elevated-grown plants measured at elevated CO_2 levels (**X_ELEV**)
RD: dark respiration of ambient-grown plants measured under ambient CO_2 (**X_AMB**) and elevated-grown plants measured under elevated CO_2 levels (**X_ELEV**)
WUE: water use efficiency of ambient-grown plants measured under ambient CO_2 (**X_AMB**) and elevated-grown plants measured under elevated CO_2 levels (**X_ELEV**)
WUE_AC: water use efficiency of ambient-grown plants measured at elevated CO_2 (**X_AMB**) and elevated-grown plants measured at elevated CO_2 levels (**X_ELEV**)

biochemical constituents

AGN: aboveground N
BGN: belowground N
LFN: leaf N
STEMN: stem total N
TOTN: total N

The value of **PARAM** is linked to that shown for **P_UNIT** (parameter units), **X_AMB** (parameter value for plants grown under ambient CO_2 exposure conditions), and **X_ELEV** (parameter value for plants grown under elevated CO_2 exposure conditions).

The only entry for **DIV1** (functional division #1) is ANGIO (angiosperms)

Entries for **DIV2** (functional division #2) are

GRASS
GRASS_C: typically monotypic crop; generally does not include pasture species
SEDGE

Entries for **DIV3** (functional division #3), if known, are

C3
C4
C3/C4: C3/C4 intermediate, as reported by the authors of the cited paper

Entries for **DIV4** (functional division #4) are general habitat or location:

ALPINE
BOREAL
GRASS (grassland)
MEAD (meadow)
WETL (wetland)

The values of **AMB** and **ELEV** are linked to those shown for **CO2_UNIT**.

Entries for **CO2_UNIT** are

- Pa (Pascals)
- μbar (1 μbar = 0.1 Pa)
- ppm
- μl/l
- cm^3/m^3
- μmol/mol
- μmol/l
- ml/l

TIME represents the maximum duration (days) of the CO_2 exposure.

For **POT** (growing method), a numeric entry signifies pot size (in liters) used during the major part of the experiment; the other entries are

- GRND: plants rooted in the ground
- HYDRO: solution or aeroponic culture

Entries for **MTHD** (CO_2-exposure facility) are

- FACE: Free-Air CO_2 Enrichment
- GC: indoor, controlled environment: growth chambers
- GH: sunlit greenhouses and chambers within greenhouses; also includes closed-top chambers in the field, covering ecosystems
- OTC: field-based open-top chambers
- SACC: screen-aided CO_2 control

Entries for **STOCK** (planting stock codes) are

- CLONE: experimental plants started from cuttings (graminoids); published paper refers to specific genotype
- ECOSYS: entire ecosystem exposed
- MATURE: mature plants exposed
- MIXED: typically ecosystems where species are propagated from multiple sources
- RAMETS: small plants (with 2 to 3 tillers) propagated from cuttings, rather than grown from seed
- SEED: plants started from seeds
- SEEDLINGS: young plants grown from seed

TILLERS: equivalent to rhizomes or stolons, depending upon species; that is, more-or-less horizontal stems or culms

Entries for **XTRT** (codes for interacting treatment, used together with CO_2) are

COMP: plant competition
DEFOL: defoliation (clipping by any means)
FERT: soil fertility
FLD: flooding treatment
F+O3: fertility plus ozone
H2O: well-watered versus drought
LIGHT: light treatment
NONE: no additional treatment beyond CO_2 enrichment; usually optimal growth conditions
O3: ozone exposure
SALT:
TEMP: temperature treatment

The entries for **LEVEL** (which qualitatively describes the treatment level) are treatment-dependent; this field is linked with **XTRT** (which characterizes the treatment type) and **QUANT** (which quantifies the treatment level).

For **XTRT** = COMP, FERT+L, NATIVE, NONE, or SALT, **LEVEL** = . (missing value) (see entry for corresponding paper in **comments.dat** and **comments.wk1** files)

For soil fertility treatment:

CONTROL
HI
LOW
MED
TRT-1
TRT-2
TRT-3
missing (.) when treatment cannot be clearly described (see entry for corresponding paper in **comments.dat** and **comments.wk1** files).

For H2O treatment:

DRT: drought
FLD: flooding
PRECIP: natural levels of precipitation
WW: well-watered

For LIGHT, TEMP, OZONE, and UVB treatments:

CONTROL

HI
LOW

Entries for **QUANT**, which quantify the interacting treatment level, are treatment-dependent. The combination of quantity and unit is reported in this one field (see also the corresponding entry in **comments.dat** and **comments.wk1** file). If **QUANT** data are not available or inappropriate, a missing value (.) is present.

Possible entry formats for **SOURCE** (figure, table, or page from which data were extracted) are:
F1a (Fig. 1a)
T1 (Table 1)

Entries for **X_AMB**, **SE_AMB**, **SD_AMB**, **X_ELEV**, **SE_ELEV**, and **SD_ELEV** are linked to the units given for **P_UNIT**. The suffix "**AMB**" refers to measurements of plants grown under ambient CO_2 exposure conditions, and the suffix "**ELEV**" refers to measurements of plants grown under elevated CO_2 exposure conditions.

For **CV*_AMB** and **CV*_ELEV**, corrected (for small sample size) coefficient of variation was calculated according to Sokal and Rohlf (1981) as follows:

$$CV^* = (1 + 1/4N)(SD \times 100)/X$$

where SD = standard deviation, X = mean, and N = sample size.

SDC indicates whether the tabulated values for standard deviation (used to calculate coefficient of variation) were extracted directly from the cited publications or calculated from reported values for standard error. The tabulated values of **SDC** are either Y (yes) or N (no).

First two data records:

```
    38AGWT   G PLANT-1     TRITICUM     AESTIVUM     ANGIO GRASS_CC3   GRASS 330 660UL
L-1       461.45         GC  SEED     H2O   LO     10 ML PL-1 D-1   F4        3.61
-9.99   -9.99  -9.99   10     5.13  -9.99   -9.99   -9.99    10  .
    38AGWT   G PLANT-1     TRITICUM     AESTIVUM     ANGIO GRASS_CC3   GRASS 330 660UL
L-1       371.45         GC  SEED     H2O   CTL    40 ML PL-1 D-1   F4        2.98
-9.99   -9.99  -9.99   10     3.97  -9.99   -9.99   -9.99    10  .
```

Last two data records:

```
  3042PN     UMOL M-2 S-1  ZEA          MAYS         ANGIO GRASS_CC4   GRASS 330
640UBAR        305            GH  SEED     FERT  HI     .                  F2
64.80    2.10    5.94   9.45    8    52.40   0.90    2.55    5.01     8  Y
  3042PN     UMOL M-2 S-1  ZEA          MAYS         ANGIO GRASS_CC4   GRASS 330
640UBAR        305            GH  SEED     FERT  LO     .                  F2
27.90    1.84    5.20  19.24    8    21.90   2.10    5.94   27.97     8  Y
```

The **refs.dat (File 4)** ASCII file provides citations of papers included in the database. A full listing of the file is included as Appendix B.

The **comments.dat (File 6)** ASCII file provides experimental details from papers included in the database. A full listing of the file is included as Appendix C.

10. DESCRIPTION AND FORMAT OF THE LOTUS 1-2-3® BINARY SPREADSHEET FILES

Three Lotus 1-2-3® binary spreadsheet files (files 3, 5, and 7) contain the same information as the corresponding ASCII files (files 2, 4, and 6).

File **ndp073.wk1 (File 3)** corresponds to ASCII file **ndp073.dat (File 2)**.

Table 2, which describes the contents and format of **ndp073.dat**, also indicates the column of **ndp073.wk1** in which each variable is found.

File **refs.wk1 (File 5)** corresponds to ASCII file **refs.dat (File 4)**.

File **comments.wk1 (File 7)** corresponds to ASCII file **comments.dat (File 6)**.

11. SAS® AND FORTRAN CODES TO ACCESS THE DATA

The following is SAS® code to read file **ndp073.dat**.

```
*SAS data retrieval routine to read ndp073.dat;

data ndp073;
infile 'ndp073.dat';
input PAP_NO 6. @7 PARAM $char7. P_UNIT $ 14-27 GENUS $ 28-40
      SPECIES $ 41-53 DIV1 $ 54-59 DIV2 $ 60-66 DIV3 $ 67-71
      DIV4 $ 72-77 AMB $ 78-80 ELEV $ 81-84
      CO2_UNIT $ 85-94 TIME $ 95-99 POT $ 100-112 MTHD $ 113-116
      STOCK $ 117-125 XTRT $ 126-131 LEVEL $ 132-138 QUANT $ 139-155
      SOURCE $ 156-161 X_AMB 162-169 SE_AMB 170-177 SD_AMB 178-185
      CV_AMB 186-192 N_AMB 193-197 X_ELEV 198-206 SE_ELEV 207-213
      SD_ELEV 214-221 CV_ELEV 222-229 N_ELEV 230-235 SDC $ 236-238 ;

* In the above INPUT statement, the variables CV*_AMB and CV*_ELEV have
  been renamed CV_AMB and CV_ELEV, respectively.;

proc print;
run;
```

The following is Fortran code to read file **ndp073.dat**.

```
C *** Fortran program to read the file "ndp073.dat"
C
      INTEGER PAP_NO, N_AMB, N_ELEV
C
      REAL X_AMB, SE_AMB, SD_AMB, CV_AMB, X_ELEV, SE_ELEV,
     +     SD_ELEV, CV_ELEV
C
      CHARACTER PARAM*7, P_UNIT*14, GENUS*13, SPECIES*13, DIV1*6,
     + DIV2*7, DIV3*5, DIV4*6, AMB*3, ELEV*4, CO2_UNIT*10,
     + TIME*5,  POT*13, MTHD*4, STOCK*9, XTRT*6, LEVEL*7,
     + QUANT*17, SOURCE*6, SDC*3
C
      OPEN (UNIT=1, FILE='ndp073.dat')
C
C     Note that the variables CV*_AMB and CV*_ELEV have
C     been renamed CV_AMB and CV_ELEV, respectively
C
   10 READ (1,100,END=99) PAP_NO, PARAM, P_UNIT, GENUS, SPECIES,
     + DIV1, DIV2, DIV3, DIV4, AMB, ELEV, CO2_UNIT, TIME, POT,
     + MTHD, STOCK, XTRT, LEVEL, QUANT, SOURCE, X_AMB, SE_AMB,
     + SD_AMB, CV_AMB, N_AMB, X_ELEV, SE_ELEV, SD_ELEV, CV_ELEV,
     + N_ELEV, SDC
C
  100 FORMAT (I6,A7,A14,2A13,A6,A7,A5,A6,A3,A4,A10,A5,A13,A4,A9,
     + A6,A7,A17,A6,3F8.2,F7.2,I5,F9.2,F7.2,2F8.2,I6,A3)
C
      GO TO 10
   99 CLOSE (UNIT=1)
      STOP
      END
```

APPENDIX A. SPECIES INCLUDED IN THE DATABASE

Agropyron caninum
Agropyron smithii
Agrostis capillaris
Andropogon gerardii
Avena barbata
Avena fatua
Avena sativa
Bouteloua curtipendula
Bouteloua eriopoda
Bouteloua gracilis
Briza subaristata
Bromus erectus
Bromus hordaeceus
Bromus willdenowii
Calamagrostis epigejos
Carex curvula
Dactylis glomerata
Digitaria macroblephara
Digitaria sanguinalis
Echinochloa crusgalli
Eleusine indica
Eriophorum vaginatum
Festuca arundinacea
Festuca durviscula
Festuca elatior
Festuca idahoensis
Festuca ovina
Festuca pratense
Festuca rupicola
Festuca vivipara
Hordeum vulgare
Lolium boucheanum
Lolium multiflorum
Lolium perenne
Nardus stricta
Oryza sativa
Panicum antidotale
Panicum laxum
Panicum millioides
Pascopyrum smithii
Paspalum dilatatum
Pennisetum clandestinum
Phalaris aquatica
Phleum pratense
Poa alpina
Poa annua
Poa pratensis
Puccinellia maritima
Rottboellia exaltata
Schizachyrium scoparium
Scirpus olneyi
Setaria faberi
Sorghum bicolor
Sorghum helpense
Spartina patens
Sporobolus kentrophyllus
Stipa occidentalis
Themeda triandra
Triticum aestivum
Vulpia microstachys
Zea mays

APPENDIX B. FULL LISTING OF REFS.DAT (FILE 4)

The number at the beginning of each entry corresponds to **PAP_NO**, the cited paper number, as defined in Sect. 9.

38. Andre, M., and H. Du Cloux. 1993. Interaction of CO2 Enrichment and Water Limitations on Photosynthesis and Water-Use Efficiency in Wheat. Plant Physiology and Biochemistry 31:103-112.

186. Drake, B. G. 1992. A Field Study of the Effects of Elevated CO2 on Ecosystem Processes in a Chesapeake Bay Wetland. Australian Journal of Botany 40:579-595.

488. Nie, D., H. He, M. B. Kirkham, and E. T. Kanemasu. 1992. Photosynthesis of a C3 Grass and a C4 Grass under Elevated CO2. Photosynthetica 26:189-198.

618. Ryle, G. J. A., C. E. Powell, and V. Tewson. 1992. Effect of elevated co2 on photosynthesis, respiration and growth of perennial ryegrass. Journal of Experimental Botany 43:811-818.

754. Ziska, L. H., and J. A. Bunce. 1993. Inhibition of Whole Plant Respiration by Elevated CO2 as Modified by Growth Temperature. Physiologia Plantarum 87:459-466.

765. Baker, J. T., L. H. Allen Jr., and K. J. Boote. 1992. Response of Rice to Carbon Dioxide and Temperature. Agricultural and Forest Meteorology 60:153-166.

2066. Samarakoon, A. B., W. J. Muller, and R. M. Gifford. 1995. Transpiration and leaf area under elevated CO2: Effects of soil water status and genotype in wheat. Australian Journal of Plant Physiology 22:33-44.

2119. Greer, D. H., W. A. Laing, and B. D. Campbell. 1995. Photosynthetic responses of thirteen pasture species to elevated CO2 and temperature. Australian Journal of Plant Physiology 22:713-722.

2125. Baxter, R., M. Gantley, T. W. Ashenden, and J. F. Farrar. 1994. Effects of elevated carbon dioxide on three grass species from montane pasture. Journal of Experimental Botany 45:1267-1287.

2132. Rao, M. V., B. A. Hale, and D. P. Ormrod. 1995. Amelioration of ozone-induced oxidative damage in wheat plants grown under high carbon dioxide. Plant Physiology 109:421-432.

2133. Tuba, Z., K. Szente, and J. Koch. 1994. Response of photosynthesis, stomatal conductance, water use efficiency and production to long-term elevated CO2 in winter wheat. Journal of Plant Physiology 144:661-668.

2158. Gloser, J., and M. Bartak. 1994. Net photosynthesis, growth rate and biomass allocation in a rhizomatous grass Icalamagrostis epigejos grown at elevated CO2 concentration. Photosynthetica 30(1):143-150.

2159. Ziska, L. H., and J. A. Bunce. 1994. Increasing growth temperature reduces the stimulatory effect of elevated CO2 on photosynthesis or biomass in two perennial species. Physiologia Plantarum 91:183-190.

2168. Knapp, A. K., E. P. Hamerlynck, and C. E. Owensby. 1993. Photosynthetic and water relations responses to elevated CO_2 in the C4 grass Andropogon geradii. International Journal of Plant Science 154(4):459-466.

2184. Saebo, A., and L. M. Mortensen. 1995. Growth and regrowth of Phleum pratense, Lolium perenne, Trifolium repens and Trifolium pratense at normal and elevated O_2 concentration. Agriculture, Ecosystems and Environment 55:29-35.

2192. Knapp, A. K., J. T. Fahnestock, and C. E. Owensby. 1994. Elevated atmospheric O_2 alters stomatal responses to variable sunlight in a C4 grass. Plant, Cell and Environment 17:189-195.

2202. Wilsey, B. J., S. J. McNaughton, and J. S. Coleman. 1994. Will increases in atmospheric O_2 affect regrowth following grazing in C4 grasses from tropical grasslands? Oecologia 99:141-144.

2208. Crush, J. R. 1994. Elevated atmospheric O_2 concentration and rhizosphere nitrogen fixation in four forage plants. New Zealand Journal of Agricultural Research 37:455-463.

2211. Morgan, J. A., W. G. Knight, L. M. Dudley, and H. W. Hunt. 1994. Enhanced root system C-sink activity, water relations and aspects fo nutrient acquisistion in mycotrophic Bouteloua gracilis subjected to CO_2 enrichment. Plant and Soil 165:139-146.

2227. Bowler, J. M., and M. C. Press. 1993. Growth responses of two contrasting upland grass species to elevated CO_2 and nitrogen concentration. New Phytologist 124:515-522.

2229. Mitchell, R. A. C., V. J. Mitchell, S. P. Driscoll, J. Franklin, and D. W. Lawlor. 1993. Effects of increased CO_2 concentration and temperature on growth and yield of winter wheat at two levels of nitrogen application. Plant, Cell and Environment 16:521-529.

2246. Baxter, R., T. W. Ashenden, T. H. Sparks, and J. F. Farrar. 1994. Effects of elevated carbon dioxide on three montane grass species. Journal of Experimental Botany 45 (272):305-315.

2300. Bassirirad, H., D. T. Tissue, J. F. Reynolds, and F. S. Chapin. 1996. Response of Eriophorum vaginatum to CO_2 enrichment at different soil temperature: effects on growth, root respiration and PO-4 uptake kinetics. New Phytologist 133:423-430.

2312. Wilsey, B. J. 1996. Urea additions and defoliation affect plant responses to elevated CO_2 in a C3 grassland from Yellowstone National Park. Oecologia 108:321-327.

2315. Casella, E., J. F. Soussana, and P. Loiseau. 1996. Long-term effects of CO_2 enrichment and temperature increase on a temperate grass sward. 1. Productivity and water use. Plant and Soil 182:83-99.

2316. Soussana, J. F., E. Casella, and P. Loiseau. 1996. Long-term effects of CO_2 enrichment and temperature increase on a temperate grass sward. 2. Plant nitrogen budgets and root fraction. Plant and Soil 182:101-114.

2329. Jones, M. B., M. Jongen, and T. Doyle. 1996. Effects of elevated carbon dioxide concentrations on agricultural grassland production. Agricultural and Forest Meteorology 79:243-252.

2330. Stewart, J., and C. Potvin. 1996. Effects of elevated CO2 on an artificial grassland community: competition, invasion and neighbourhood area. Functional Ecology 10:157-166.

2337. Saebo, A., and L. M. Mortensen. 1996. The influence of elevated CO2 concentration on growth of seven grasses and one clover species in a cool maritime climate. Acta Agriculturae Scandinavia Section B-Sorland Plant Science 46:49-54.

2341. Schappi, B., and C. Korner. 1996. Growth responses of an alpine grassland to elevated CO2. Oecologia 105:43-52.

2342. Jackson, R. B., and H. L. Reynolds. 1996. Nitrate and ammonium uptake for single and mixed species communities grown at elevated CO2. Oecologia 105:74-80.

2345. Hakala, K., and T. Mela. 1996. The effects of prolonged exposure to elevated temperatures and elevated CO2 leveles on the growth, yield and dry matter partitioning of filed-sown meadow fescue. Agricultural and Food Science in Finland 5(3):285-298.

2347. Jackson, R. B., Y. Luo, Z. G. Cardon, O. E. Sala, C. B. Field, and H. A. Mooney. 1995. Photosynthesis, growth and density for the dominant species in a CO2 enriched grassland. Journal of Biogeography 22:221-225.

2350. Teughels, H., I. Nijs, P. Van Hecke, and I. Impens. 1995. Competition in a global change environment: The importance of different plant traits for competitive success. Journal of Biogeography 22:297-305.

2351. Campbell, B. D., W. A. Laing, D. H. Gree, J. R. Crush, H. Clark, D. Y. WIlliamson, and M. D. J. Given. 1995. Variation in grassland populations and species and the implications for community responses to elevated CO2. Journal of Biogeography 22:315-322.

2357. Chu, C. C., C. B. Field, and H. A. Mooney. 1996. Effects of CO2 and nutrient enrichment on tissue quality of two California annuals. Oecologia 107:433-440.

2358. Ferris, R., I. Niy, T. Bejaeghe, and I. Impens. 1996. Contrasting CO2 and temperature effects on leaf growth of perennial rye grass in spring and summer. Journal of Experimental Botany 47:1033-1043.

2362. Wheeler, T. R., G. R. Batts, R. H. Ellis, P. Hadley, and J. J. L. Morison. 1996. Growth and yield of winter wheat (Triticum aestium) crops in response to CO2 and temperature. Journal of Agricultural Science 127:37-48.

2363. Volin, J. C., and P. B. Reich. 1996. Interaction of elevated CO2 and O3 on growth, photosynthesis and respiration of three perennial species grown in low and high nitrogen. Physiologia Plantarum 97:674-684.

2364. Miglietta, F., A. Giuntoli, and M. Bindi. 1996. The effect of free air carbon dioxide enrichment (FACE) and soil nitrogen availability on the photosynthetic capacity of wheat. Photosynthesis Research 47:281-290.

2366. Ziska, L. H., W. Weerakoon, O. S. Namuco, and R. Pamplona. 1996. Influence of nitrogen on the elevated CO2 response in field-grown rice. Australian Journal of Plant Physiology 23:45-52.

2367. Saebo, A., and L. M. Mortensen. 1996. Growth, morphology and yield of wheat, barley and oats grown at elevated atmospheric CO2 concentration in a cool maritime climate. Agriculture, Ecosystems and Environment 57:9-15.

2369. Ziska, L. H., P. A. Manalo, and R. A. Ordonez. 1996. Intraspecific variaiton in the response of rice (Oryza sativa L) to increased CO2 and temepratrure: growth and yield response of seventeen cultivars. Journal of Experimental Botany 47:1353-1359.

2372. Nijs, I., H. Teughels, H. Blum, G. Hendrey, and I. Impens. 1996. Simulation of climate change with infrared heaters reduces the productivity of Lolium perenne L in summer. Environmental and Experimental Botany 36:271-280.

2379. Veisz, O., N. Harnos, L. Szunies, and T. Tischner. 1996. Overwintering of winter cereals in Hungary in the case of global warming. Euphytica 92:249-253.

2383. Nijs, I., and I. Impens. 1996. Effects of elevated CO2 concentration and climate-warming on photosynthesis during winter in Lolium perenne. Journal of Experimental Botany 47:915-924.

2387. Leadley, P. W., and J. Stocklin. 1996. Effects of elevated CO2 on model calcareous grasslands: Community, species, and genotype responses. Global Change Biology 2:389-397.

2395. Tuba, Z., K. Szente, Z. Nagy, Z. Csintalan, and J. Koch. 1996. Responses of CO2 assimilation, transpiration and water use efficiency to long-term elevated CO2 in perennial C3 xeric loess steppe species. Journal of Plant Physiology 148:356-361.

2398. Mortensen, L. M., and A. Saebo. 1996. The effects of elevated CO2 concentration on growth of Phleum pratense L. in different parts of the growth season. Acta Agriculturaie Scandinavia Section B-Soil and Plant Science 46:128-134.

2401. Jackson, R. B., and A. L. Reynolds. 1996. Nitrate and annomium uptake for single- and mixed species communities grown at elevated CO2. Oecologia 105:74-80.

2403. Fanymeier, A., U. Geuters, U. Hesstein, H. Sandhagel, A. Hoffmann, B. Vermebren, and A. J. Jager. 1996. Effects of elevated CO2, nitrogen supply and tropospheric ozone on spring wheat. 1. Growth and Yields. Environmental Pollution 91:381-390.

2407. Kinball, B. A., P. J. Pinter, R. L. Garcia, R. L. La Mort, G. W. Wall, D. J. Hunsaker, G. WEchsung, F. Wechsung, and T. Kartschall. 1995. Productivity and water use of wheat under free-air CO2 enrichment. Global Change Biology 1:429-442.

2420. Hunt, H. W., E. T. Elliot, J. K. Detling, J. A. Morgan, and D. X. Chen. 1996. Responses of a C3 and a C4 perennial grass to elevated CO2 and temperature under different water regimes. Global Change Biology 2:35-47.

2427. Samarakoon, A. B., and R. M. Gifford. 1996. Elevated CO2 effects on water use and growth of maize in wet and drying soils. Australian Journal of Plant Physiology 23:53-62.

2430. Ruget, F., O. Bethenod, and L. Combe. 1996. Repercussions of increased atmospheric CO2 on maize morphogenesis and growth for various temperature and radiation levels. Maydica 41:181-191.

2440. Frank, A. B., and A. Bauer. 1996. Temperature, nitrogen and carbon dioxide effects on spring wheat development and spikelet numbers. Crop Science 36:659-665.

2441. Read, J. J., and J. A. Morgan. 1996. Growth and partitioning in Pascopyrum smithii (C3) and Bouteloua graciles (C4) as influenced by carbon dioxide and temperature. Annals of Botany 77:487-496.

2443. Polley, H. W., H. B. Johnson, H. S. Mayeux, D. A. Brown, and J. W. C. White. 1996. Leaf and plant water use efficiency of C4 species grown at glacial to elevated CO2 concentrations. International Journal of Plant Sciences 157:164-170.

2444. Bowler, J. M., and M. C. Press. 1996. Effects of elevated CO2 nitrogen form and concentration on growth and photosynthesis of a fast- adn slow-growing grass. New Phytologist 132:391-401.

2448. RowlandBamford, A. J., J. T. Baker, H. L. Allen, and G. Bowes. 1996. Interactions of CO2 enrichment and temperature on carbohydrate accumulation and partitioning in rice. Environmental and Experimental Botany 36:111-124.

2454. Bagash, D. Z., M. J. Paul, M. A. J. Parry, A. J. Keys, and D. W. Lawlor. 1995. Increased capacity for photosynthesis in wheat grown at elevated CO2. The relationship between electron-transport and carbon metabolism. Planta 197:482-489.

2468. Rao, M. V., and L. J. Dekok. 1994. Interactive effects of high CO2 and SO2 on growth and antioxidant levels in wheat. Phyton-Annales Rei Botanicae 34:279-290.

2474. Newbery, R. M., J. Wolfenden, T. A. Mansfield, and A. F. Harrison. 1995. Nitrogen, phosphorus and potassium uptake and demand Agrostis capillaria. The influence of elevated CO2 and nutrient supply. New Phytologist 130:565-574.

2480. Lenssen, G. M., W. E. Vandium, P. Jak, and J. Roxema. 1995. The response of Aster tripolium and Puccinellia maritima to atmospheric carbon dioxide enrichment and their interaction with flooding and salinity. Aquatic Botany 50:181-192.

2492. Schenk, U., R. Maderscheid, J. Hugen, and H. J. Weigel. 1995. Effects of CO2 enrichment and intraspecific competition on biomass partitioning, nitrogen content, and microbial biomass carbon in soil of perennial rye grass and white clover. Journal of Experimental Botany 46:987-993.

2502. Jacob, J., C. Greitner, and B. G. Drake. 1995. Acclimation of photosynthesis in relation to Rubisco and non-structural carbohydrate contents and in-situ carboxylase activity in Scirpus olnei grown at elevated CO2 in the field. Plant, Cell and Environment 18:875-884.

2503. Jongen, M., M. B. Jones, T. Hebeisen, H. Blum, and G. Hendrey. 1995. The effects of elevated CO2 concentrations on the root growth of Lolium perenne and Trifolium repens grown in a FACE system. Global Change Biology 1:361-371.

2504. Kleemola, J., J. Peltonen, and P. Peltonen-Sainio. 1994. Apical development and growth of Barley under different CO2 and nitrogen regimes. Journal of Agronomy and Crop Science 173:79-92.

2510. Demothes, M. A. G., and D. Knoppik. 1994. Effects of long term enhanced CO2 partial pressure on gas exchange parameters and saccharide pools of wheat leaves. Photosynthetica 30:435-445.

2521. Balaguer, L., J. D. Barnes, A. Panicucci, and A. M. Borland. 1995. Production and utilization of assimilates in wheat leaves exposed to elevated O3 and/or CO2. New Phytologist 129:557-568.

2522. Barnes, J. D., J. H. Ollerenshaw, and C. P. Whitfield. 1995. Effects of elevated CO2 and/or O3 on growth, development and physiology of wheat. Global Change Biology 1:129-142.

2525. Hattenschwiler, S., and C. Korner. 1996. System-level adjustments to elevated CO2 in model spruce ecosystems. Global Change Biology 2:377-387.

2531. Owensby, C. E., P. I. Coyne, J. M. Ham, L. M. Avea, and A. K. Knapp. 1993. Biomass production in a tallgrass prairie ecosystem exposed to ambient and elevated CO2. Ecological Applications 3:644-653.

2541. Jackson, R. B., O. E. Sala, C. B. Field, and H. A. Mooney. 1994. CO2 alters water use, carbon gain, and yield for the dominant species in a natural grassland. Oecologia 98:257-262.

2547. Baker, J. T., L. H. Allen, and K. J. Boote 1992. Temperature effects on rice at elevated CO2 concentration. Journal of Experimental Botany 43:959-964.

2579. Billes, G., H. Rouhier, and P. Bottner. 1993. Modifications of the carbon and nitrogen allocations in the plant Triticum aestivum L. soil system in response to increased atmospheric CO2 concentration. Plant and Soil 157:215-225.

2580. Baker, J. T., S. L. Albrecht, D. Pan, L. H. Allen, N. B. Pickering, and K. J. Boote. 1994. Carbon dioxide and temperature effects on rice (Oryza sativa L., CV 1R-72). Soil and Crop Science Society of Florida, Proceedings 53:90-97.

2595. Santruce, J., H. Santurckova, J. Kueton, M. Simkoua, and K. Rohacek. 1994. The effect of elevated CO2 concentration on photosynthetic CO2 fixation, respiration and carbon economy of wheat plants. Rostlinna Vyroba 40:689-696.

2597. Ingaurdsen, C., and B. Veierskov. 1994. Response of young barley plants to CO2 enrichment. Journal of Experimental Botany 45:1373-1378.

2644. Reeves, D. W., H. H. Royers, S. A. Prior, C. W. Wood, and G. B. Runion. 1994. Elevated atmospheric carbon dioxide effects on sorghum and soybean nutrient status. Journal of Plant Nutrition 17:1939-1954.

2654. Jackson, R. B., Y. Lou, Z. G. Cardon, O. E. Sala, C. B. Field, and H. A. Mooney. 1995. Photosynthesis, growth and density for the dominant species in a CO2 enriched grassland. Journal of Biogeography 22:221-225.

2666. Samarakoon, A. B., and R. M. Gifford. 1995. Soil water content under plants at high CO2 concentrations and interaction with the direct CO2 effects: A species comparison. Journal of Biogeography 22:193-202.

2669. Schenk, U., A. J. Jager, and H. J. Weigel. 1996. Nitrogen supply determine responses of yeild and biomass partitioning of perennial rye grass to elevated atmospheric carbon dioxide concentrations. Journal of Plant Nurtition 19:1423-1440.

2692. Kimball, B. A., P. J. P. Pinter, R. L. Garcia, R. L. LaMorte, G. W. Wall, D. J. Hunsaker, G. Wechsung, F. Wechsong, and T. Kartschall. 1995. Productivity and water use of wheat under free-air CO2. Global Change Biology 1:429-442.

2698. Potvin, C., and L. Vasseur. 1997. Long-term CO2 enrichment of a pasture community: species richness, dominance, and succession. Ecology 78:666-677.

2709. Hebeisen, T., A. Luscher, and J. Nosberger. 1997. Effects of elevated atmospheric CO2 and nitrogen fertilisation on yield of Trifolium repens and Lolium perenne. Acta Oecologica/Oecologia Plantarum 18:277-284.

2710. Hebeisen, T., A. Luscher, S. Zanetti, B. U. Fischer, U. A. Hartwig, M. Frehner, G. R. Hendrey, H. Blum, and J. Nosberger. 1997. Growth response of Trifolium repens L and Lolium perenne L as monocultures and bi-species mixture to free air CO2 enrichment and management. Global Change Biology 3:149-160.

2711. Ghannoum, O., S. vonCaemmerer, E. W. R. Barlow, and J. P. Conroy. 1997. The effect of CO2 enrichment and irradiance on the growth, morphology and gas exchange of a C3 (Panicum laxum) and a C4 (Panicum antidotale) grass. Australian Journal of Plant Physiology 24:227-237.

2715. Cotrufo, M. F., and A. Gorissen. 1997. Elevated CO2 enhances below-ground C allocation in three perennial grass species at different levels of N availibility. New Phytologist 137:421-431.

2718. Wilsey, B. J., J. S. Coleman, and S. J. McNaughton. 1997. Effects of elevated CO2 and defoliation of grasses: A comparative ecosystem approach. Ecological Applications 7:844-853.

2723. Stirling, C. M., P. A. Davey, T. G. Williams, and S. P. Long. 1997. Acclimation of photosynthesis to elevated CO2 and temperature in five British native species of contrasting functional type. Global Change Biology 3:237-246.

2735. Nijs, I., and I. Impens. 1997. An analysis of the balance between root and shoot activity in Lolium perenne cv Melvina. Effects of CO2 concentration and air temperature. New Phytologist 135:81-91.

2737. Mortensen, L. M. 1997. Effects of carbon dioxide concentrations on three grass species grown in mixture in two soil types at different ozone concentrations or temperatures. Acta Agriculturae Scandinavica, Section B, Soil and Plant Sciences 47:14-19.

2756. Hamerlynck, E. P., C. A. McAllister, A. K. Knapp, J. M. Ham, and C. E. Owensby. 1997. Photosynthetic gas exchange and water relation responses of three tallgrass prairie species to elevated carbon dioxide and moderate drought. International Journal of Plant Sciences 158:608-616.

2758. Stocker, R., P. W. Leadley, and C. Korner. 1997. Carbon and water fluxes in a calcareous grassland under elevated CO2. Functional Ecology 11:222-230.

2785. Hungate, B. A., J. Canadell, and F. S. Chapin. 1996. Plant species mediate changes in soil microbial N in response to elevated CO2. Ecology 77:2505-2515.

2793. Fitter, A. H., G. K. Self, J. Wolfenden, M. M. I. vanVuuren, T. K. Brown, L. Williamson, J. D. Graves, and D. Robinson. 1996. Root production and mortality under elevated atmospheric carbon dioxide. Plant and Soil 187:299-306.

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APPENDIX C. FULL LISTING OF COMMENTS.DAT (FILE 6)

Listed are

paper number (**PAP_NO**, as defined in Sect. 9.)
- CO_2 exposure facility
- light
- temperature
- watering
- humidity
- nutrient
- interacting treatment
- biome
- location, and
- comments.

Abbreviations are as described in the body of this report for data files **ndp073.dat** and **ndp073.wk1**.

```
38
     GC
     600+/-90 UE M-2 S-1
     14/10
     24/18
     40 OR 10 ML PL-1 D-1
     0.588235294
     HOAGLAND'S
     H2O
     GRASS
     EU

186

     OTC
     AMB
     AMB
     AMB
     AMB
     AMB
     NONE
     CO2 ONLY
     WETL
     NA

488
     GH
     AMBIENT
     AMBIENT

     FIELD CAPACITY OR NONE
```

NONE
CO2 AND WATER
GRASS
NA
2ND YEAR; NO TEMP DATA; FIELD PLANTS.

618
GC
AMB
12H
20/15 C (DAY/NIGHT)
WW
AMB
NITRATE' SOLUTION
NONE
GRASS
EU
.

754
GC
0.6 MMOL M-2 S-1
14 H
"15, 20, 25, 30 DEG C CONSTANT DAY/NIGHT"
WW
>50 %
COMPLETE NUTRIENT SOLUTION ADDED DAILY
TEMP
MEAD
NA
MAINTENANCE RESPIRATION RECORDED HERE. GROWTH RESPIRATION
ALSO REPORTED ONE GC PER CO2 TREATMENT

765
GC
AMB
AMB
.
WW
.
.
TEMP
GRASS_C
NA
CONTROL: 28/21/25 C; HI: 40/33/37 C

2066
GH
24.8 MOL M-2 D-1
16 H
20/14
.
.
COMPLETE FERTILIZER ADDED
H2O
GRASS_C
AU

TWO VARIETIES USED

2119
GC
700 UMOL M-2 S-1
1/12/00
12/7; 18/13; 28/23
WW
0.4/0.3 +- 0.05 KPA VPD
HALF-STRENGTH HOAGLAND'S
TEMP
GRASS
AU
"USABLE DATA ON 4 SPP ONLY, FOR PN"

2125
OTC
AMB
AMB
AMB
WW DAILY FC
AMB
0.2 MOL M-3 N AND 0.05 MOL M-3 P
CO2 ONLY
GRASS
EU
"OTHER NUTRIENT DATA, EFFICIENCIES -   P,"

2132
GC
500 UMOL M-2 S-1
14/10
25/18
WW
50-70
HOAGLAND'S ALTERNATE DAYS
O3
GRASS
NA

2133
OTC
AMB
AMB
AMB
.
.
NPK APPLIED
.
GRASS_C
EU

2158
GC
200 UMOL M-2 S-1
16 H
220
WW

0.8
SURPLUS NUTRIENTS
NONE
BOREAL
EU
"1 GC AT EACH CO2 LEVEL. QY, RHZWT, LWR, LAR"

2159
GC
.6 MMOL M-25-1
14H
"15,20,25,30"
WW
>50%
"""COMPLETE"" IN DAILY WATER"
TEMP
GRASS
NA

2168
OTC
AMBIENT
AMBIENT
AMBIENT
AMBIENT
AMBIENT
AMBIENT
NONE
GRASS
NA
1991 PRECIPITATION: 17.1 CM; 1992 PRECIPITATION: 26.8 CM; SAMPLE SIZE INFERRED FROM DESIGN. LFY.MD

2184
OTC
AMBIENT
15-18
12-Nov
AMB AND DRIP
.
ADDED WITH DRIP WATER; AMT NOT STATED
HARVEST
GRASS
EU
CLIPPED TO 5CM AT EACH HARVEST

2192
OTC
AMB
AMB
AMB
AMB
AMB
.
CO2
GRASS
NA
"DATA USED FROM LAST MEASUREMENT PRIOR TO SHADING, F2."

2202
GC
725-890 UE
.
.
WW
.
HOAGLAND'S; 2 G/M2 N WEEKLY
CLIPPING TO 5 CM
GRASS
AF
C4; SPOROBOLUS KENTROPHYLLUS; ADDT'L LF NUTRIENTS AVAILABLE IN T1

2208
GC
700 UMOL M-2
12 H
.
WW
AMB
FERT
TEMP
GRASS_C
NA
THERE ARE TWO LOLIUM HYBRIDS (2N AND 4N). EACH ONE WAS TREATED AS A SPECIES.

2211
GH
~900 UMOL M-2 S-1
14/10
25/16
WW
35/90
NONE
NONE
GRASS
NA

2227
GC
600 UMOL M-2 S-1 AT SEEDLING HT
15/9
20/15
WW
65/70
0.8 NM NH4NO3 + 50% LONG ASHTON SOLUTION
"HI N, LOW N"
GRASS
EU

2229
GC
AMB
.
+4C
.
.

HI/LOW
TEMP/FERT
GRASS_C
EU

2246
OTC
AMBIENT
AMBIENT
AMBIENT
WW
AMBIENT
"WEEKLY 1/5 MODIFIED LONG ASHTON- 0.2 MOL M-3 N, 0.05 MOL M-3 P"
NONE
GRASS
EU
"NAR, LAR, LWR"

2300
GC
800 UMOL/M2S ACTIVE RADIATION
18 H
15 C
WATERED DAILY TO SATURATION
.
HALF-STRENGTH MODIFIED HOAGLAND SOLUTION WITH AMMONIUM NITRATE AND P CONCENTRATION OF 32 PPM
"SOIL TEMPERATURE (5,15, AND 25 C)"
TUNDRA
NA
THIS STUDY FOCUSES ON THE EFFECTS OF SOIL TEMPERATURE. RATE OF PO4 ABSORPTION WAS LEFT OUT.

2312
GC
615 UE (603-621)

23/11
100 ML EACH 3 D
NOT CONTROLLED
C= HOAGLAND'S T=HOAGLAND'S + UREA (40 G/M2)
"UREA, CLIPPING"
GRASS
NA
RINSED SAND; CONTROLS HAD HOAGLAND'S

2315
GH
AMB/SEASONAL
AMB/SEASONAL
AMB/SEASONAL
SEASONAL; SUMMER WW/DEFICIT
.
N-= 160 KG/HA YR; N+=530 KG/HA YR
"N HI, LO"
GRASS
EU

2 YR STUDY; MICROCLIMATE DETAILS AVAIL. PKS ALSO APPLIED. DATA USED FROM SUMMER DROUGHT ONLY.

2316
GH
AMB
AMB
AMB
IRRIGATION AT AMB LEVELS
AMB
160 OR 530 KG N HA-1 YR-1
FERT
GRASS
EU
"PLASTIC TUNNELS. SWARDS, SOWN. PERIODIC CLIPPING OF ALL PLOTS."

2329
OTC
REDUCED ~20%
AMB
"AMB + 1-2 DAY, 0-1 NIGHT"
WW
.
NPK; 600 KG N/HA FOR SEASON
CLIPPING
GRASS
EU
SOWN IN GROUND. DATA FROM 2 GROWING SEASONS. CO2 TMNT YR-ROUND

2330
OTC and GC
"OTC= AMBIENT, GC NOT AVAILABLE"
"OTC=AMBIENT, GC=NOT AVAILABLE"
"OTC= AMBIENT, GC= FOLLOWED AMBIENT"
"OTC= AMBIENT, GC= EVERY 1-3 DAYS"
"OTC= AMBIENT, GC= NOT AVAILABLE"
GROWTH CHAMBERS; 5-10-15 NPK PLUS MICRONUTRIENTS. 2 ML/H EVERY TWO WEEKS
COMPETITION AND METHOD (OTC AND GC)
GRASS
NA
"GC (PH = 6.5) PHOTOPERIOD, LIGHT AND HUMIDITY ARE REPORTED IN WANT, LECHOWICZ AND POTWIN (1994). COMPETING SPECIES (TRIFOLIUM REPENS, POA PRATENSIS, PHLEUM PRATENSE, AGROSTIS STOLONIFERA) NO INDIVIDUAL POTS."

2337
OTC
AMB
AMB
AMB; X=11.3
DRIP
AMB
"YES, UNKNOWN"
NONE
MEAD
EU
COMMON SPP + CULTIVARS; NORWAY; MARITIME

2341

OTC
AMB
AMB
AMB
AMB/WW
AMB
NPK 1.5:1:1.5; =40 KG N HA-1 Y-1
"CO2, NUTRIENTS"

EU
3 YR EXP. OTCS UP 98-108 D Y-1. SOME DATA ALSO FROM YEARS 1 & 2

2342
OTC
AMBIENT
AMBIENT
AMBIENT
AMBIENT
AMBIENT
"N, P, K 20 G M-2, 120 DAY TIME-RELEASE OSMOCOTE"
"ADDITIONAL NUTRIENTS N, P, K"
GRASS
NA
MONOCULTURES OF SIX SPECIES AND ONE MIXED COMMUNITY. SERPENTIME SOIL

2345
otc
amb
AMR
AMB; AMB +3
WW
.
NPK + NUTRIENTS
TEMP
GRASS
EU
OTCS PLACED IN GH FOR WARMING

2347
OTC
AMB
AMB
AMB
AMB
AMB
NONE
CO2 ONLY
GRASS
NA
JASPER RIDGE

2350
GH
AMB
AMB
17
WW
.

7 G M-2 N; 5 G M-2 P; 7 G M-2 K
CLIPPING EVERY 4 WK
GRASS
EU
"ALSO INCLUDED TEMP, CO2 X TEMP, MIXTURES OF SPP"

2351
GC
700 UMOL M-2 S-1
12
12/7; 18/13; 28/23
WW
.
HALF-STRENGTH HOAGLAND'S GX D-1
TEMP
GRASS
AU
GROWN IN STERILE SAND

2357
OTC
AMB
AMB
AMB
AMB
AMB
OSMOCOTE: 20 G M
NUTRIENTS
GRASS
NA
JASPER RIDGE

2358
GH
AMB; 640 UMOL M-2 S-1
AMB; 640 UMOL M-2 S-1
13-26
WW
0.08
13 G N M-2; 3.18 G P M-2; 10.61 G K M-2
TEMP (+4)
GRASS
EU
GERMINATION IN POTS IN FIELD; CO2 BEGAN AFTER ~6.5 MONTHS

2362
GH
AMB
AMB
13;10
WW
.
NOT LIMITING
NONE
GRASS
EU
TUNNELS = GH

2363
GC
552 UMOL M-2 S-1
14 H
26/21
WW
60-70%
HALF STRENGTH HOAGLAND'S; N=6 OR .5 mM
O3 + FERT
GRASS
NA
"OZONE = 3 +/- .3, 92 +/- .4 nMOL MOL-1; FERT = 6 OR .5 nM N.
MACRONUTRIENTS SAME FOR HI/LO FERT TMNT."

2364
FACE
AMB
.
.
.
.
.
.
GRASS_C
EU
MINIFACE

2366
OTC
89% OF AMB
AMB
32 / 24.9
WW
.
.
FERT
GRASS_C
AS
NO SUPPLEMENTAL N

2367
OTC
AMB
AMB
AMB
WW
.
IRRIGATED WITH NUTRIENT ENRICHED WATER
NONE
GRASS_C
EU
.

2369
GH
AMB
AMB
29/21 OR 37/29

WW
70 +/- 5
PROVIDED
WETL
WETL
AS
29/21= CTL; 37/29 = HI TEMP (PC.1354). 17 CULTIVARS TREATED AS REPS

2372
FACE
AMB
AMB
"AMB/AMB+2.5, 18-30"
WW
AMB
7 G N M-2
TEMP
GRASS
EU
"TEMP INCREASE USING INFRA-RED LAMPS ALL MATERIAL CLIPPED PRIOR
TO START OF TEMP TMT. EFFECTIVE CO2 DURATION USED. 12- AGWT, LFN, PN"

2379
GC
AMB
AMB
AMB
.
.
.
NONE
GRASS_C
EU
10 CULTIVARS TREATED AS REPS.

2383
GH
.
AMB
AMB AND AMB+4
WW
.
FERTILIZED
TEMP
GRASS_C
EU

2387
GH
AMB- ~MAX=800 UMOL M-2 S-1
"16, W LIGHTS"
18/10-24/18
WW 1X WK-1
.
NO ADDITIONAL
"330, 500, 660 UL L-1 CO2"
GRASS
EU

"CALCEROUS GRASSLAND. SPP AND ECOSYS 76 PLANTS/ CONTAINER
REPRESENTING FIELD %, PESTICIDES USED."

2395
OTC
AMB
AMB
AMB
WATERED OCCASIONALLY
AMB
.
.
GRASS
EU
THE SPECIES GROW IN A XERIC TEMPERATE LOESS STEPPE.

2398
OTC
AMB
AMB
AMB (~11)
WW
..
"ADDED, BUT NOT SPECIFIC; SEE TEXT."
SEASONALITY
GRASS
EU
USING GRAND MEANS AND SE ONLY; NOT USING SEASONAL DATA.

2401
OTC
AMB
AMB
AMB
WW
AMB
LOW/HI NPK
FERT
GRASS
NA

2403
OTC
AMB
AMB
AMB
WW
.
150 KG N HA-1 AND 270 KG N HA-1
FERT/OZONE
GRASS_C
EU

2407
FACE
AMB
AMB
3 C LESS THAN AMB

WW + DROUGHT
.
.
H2O
GRASS_C
NA
.

2420
GC
550 UMOL M-2 S-1
SEASONAL
SEASONAL
WW
.
NONE
TEMP
GRASS
NA
"WATER TMT ALSO, BUT NOT USED IN DATASET. ""WINTER"" TEMP = 3"

2427
GH
AMB + SUPPL (28.4 MOL M-2 S-1)
16
28/22
WW/DRY
.
5KG M-3 15:10:10:2 NPK MG 3 MO RELEASE
H2O
GRASS
AU

2430
GH
AMB 2-3.9 MJ M-2 D-1
AMB
19 - 22.5
WW
.
SUPPLEMENTED
NONE
GRASS
EU
NOT USING 1992 DATA

2440
GC
1115 UMOL M-2 S-1
16/8
25/15
WW
.
N= 0 OR 300 KG HA-1; P= 56 KG HA-1; K= 46 KG HA-1
"FERT, TEMP"
GRASS
NA

2441
GC
1000 UMOL M-2 S-1
12/12/98
"DAY 20, 35; NIGHT 15"
WW
60/~100
HALF STRENGTH HOAGLAND'S; =400 UL L-1 N
TEMP 20 = CTL
GRASS
NA

2443
GH
SEASONAL
SEASONAL
SEASONAL
WW
.
HOAGLAND'S + - N; SEE METHODS AND RESULTS
NONE. SEE RESULTS
GRASS
NA
"N HAD NO EFFECT ON PN, OR APPARENTLY ON TOTWT"

2444
GC
600 UMOL/M2S PFD
15 H
20/15 DEGREES C
WW
"65/70 % (DAY,NIGHT)"
"NITROGEN CONCENTRATIONS (.01, .1, 1.0, AND 5.0 MG N/L)"
NITROGEN CONCENTRATIONS BY N SUPPLY (AMMONIUM OR NITRATE)
GRASS
EU
SAMPLE SIZE OF GAS EXCHANGE MEASUREMENTS WAS USED FOR ALL MEASUREMENTS BECAUSE IT WAS THE ONLY ONE AVAILABLE. AGROSTIS CAPILLARIS IS A FAST GROWING GRASS. NARDUS ESTRICTA IS A SLOW GROWING GRASS.

2448
GC
AMB
AMB
AMB
WW
.
.
TEMP
GRASS_C
NA
.

2454
GC
AMB
14 HR
AMB

WW
60-70%RH
NUTRIENTS SUPPLEMENTED TWICE A WEEK
NONE
GRASS
EU
.

2468
GC
200 UMOL M-2 S-1
14H
19/15 C
.
.
.
.
GRASS_C
EU
ANOTHER SET OF DATA (CO2 * SO2) CAN BE EXTRACTED

2474
GH
AMBIENT
AMBIENT
.
WW
.
MODIFIED HOAGLANDS
"N= 5, 20, OR 50 MG L-1; P= 2, 11, OR 30 MG L-1; K=5, 20, 50 MG L-1"
GRASS
EU
"CO2= AMB, AMB+250...1:1 SAND:PEAT;   DATA TAKEN FROM P=3 + K=3 ONLY.
AGN, AGC, AGK, AGP"

2480
GH
200 UMOL M-2 S-1
14 H
25/18
"WW, FLD"
.
NATIVE SOIL
"FLD, SALT"
WETL
EU
PLANTS ROTATED BETWEEN 2 GHS

2492
GC
220-250 UMOL M-2 S-1
14/10
23.5/19
80% OF FIELD CAPACITY
30/55
"194 MG N, 13 MG P, 24 MG K, 39 MG MG POT-1"
DENSITY
GRASS

EU
"USING LOWEST AND HIGHEST DENSITIES ONLY, AS REPS"

2502
OTC
AMB
AMB
AMB
PRECIP
AMB
NONE
NONE
WETL
NA
"SAME PARAMETERS WERE MEASURED AT DIFFERENT YEARS AND/OR THE SAME YEAR, BUT DIFFERENT MONTHS. EACH MONTH AND/OR YEAR WAS CONSIDERED A SEPARATE DATA POINT BECAUSE TIME OF EXPOSITION CHANGED. THE PAPER INCLUDES DATA ON LEAF RUBISCO AND LEAF SOLUBLE PROTEIN."

2503
FACE
AMB
AMB
SEASONAL; -5-25
AMB
SEASONAL
N (100 OR 420 KG HA-1 Y-1); 120 KG HA-1 P205; 240 KG HA-1 K2O; 16 KG HA-1 MGO
FERT: 100 OR 420 KG N HA-1 Y-1
GRASS
EU
OOT IN GROWTH BAGS. ETHANOL SOLUBLE TNC USED IN DATABASE. WATER-SOLUBLE TNC ALSO AVAILABLE.

2504
GH
AMB; 180 UMOL M-2 S-1 + 100 UMOL M-2 S-1
16/8
20
WW
.
HI N=54 G M-2; LO N=9.5 G M-2; + OTHER NUTRIENTS
FERT
GRASS
EU
.

2510
GC
AMB
.
AMB
WW
AMB
FERTILIZED WEEKLY
.
.
EU

2521
GC
500 UMOL M-2 S-1
13.5 H
23/17
WW
60-70
.
OZONE
GRASS_C
EU
.

2522
GC
500 UMOL M-2 S-1
14/10
24/14
WW
65+/-5
INITIAL AND EVERY 21 DAYS
O3
GRASS
EU

2525
OTC
AMB
AMB
AMB
WW
AMB
.
.
WETL
NA
CARBON CONTENT WITH SE/SD & N; ADDT'L VAR

2531
OTC
AMB - 11%
AMB
AMB
AMB
AMB
NONE
NONE
GRASS
NA
CO2 FROM APRIL/ MAY THRU OCT EACH OF 3 YRS

2541
OTC
AMB
AMB
AMB+
AMB

AMB
NO ADDITIONAL
CO2
GRASS
NA
"JASPER RIDGE.   GS, E, LFY, PN, SEEDS, HT, AGWT, WVE, DNSITY,
 ISOTOPE, SEED WT, FRUITWT, SEED C, SEED N."

2547
GH
AMB
AMB
28/21/25(H20)
WW
.
NPK INITIAL; VARIABLE N ADDED DURING SEASON
CO2 ONLY APPROPRIATE
WETL
NA

2579
GC
1000 UMOL M-2 S-1
16/8
23/16
WW
70-80
ALL: 4.6 MG P; 5.8 MG K; N= 0 OR 32 MG POT-1
FERT
.

.

2580
GH
amb
amb
32/23; 35/26; 38/29
ww
.
"12.6, 6.3, 6.3, G N M-2 AT 7, 31 + 63 D"
NONE
WETL
NA
.

2595
GC
350 UMOL M-2 S-1
15/9
20/17
WW
.
.
.
.

.

2597
GH
AMB
AMB
AMB
WW
.
.
NONE
GRASS_C
EU
.

2644
OTC
AMB
AMB
AMB
WW
.
101 KG N HA-1; SEE ALSO T1
NONE
GRASS
NA

2654
OTC
AMB
AMB
AMB
AMB
AMB
AMB
NONE
GRASS
NA
JASPER RIDGE

2666
GH
AMB 25-29 MOL M-2 D-1
16 H
20/14
WW / DRY
.
SOLUBLE OR SLOW RELEASE ADDED
H2O
GRASS_C
AU

2669
GC
220-250 UMOL M-2 S-1
14/10
17-Dec
WW
0.571428571

N: 0 OR 765 MG POT-1; 114 MG P; 193 MG K; 26 MG MG
FERT
GRASS
EU
USING ONLY CTL; HIGHEST FERT LEVELS

2692
FACE
AMB
AMB
32/23; 35/26; 38/29
WET/DRY
AMB
NON-LIMITING; REPEATED APPLICATIONS
H2O
GRASS
NA
DRY = HALF OF WET (WW). USE WET AS CTL

2698
OTC
AMB
AMB
AMB
AMB
AMB
NONE
NONE
GRASS
NA
"SUM Y EXPERIMENT. 2 OTC'S W/ CO2, OTC'S - CO2"

2709
FACE
AMB
AMB
AMB
.
.
.
FERT/COMP
GRASS
EU
TIME ASSUMED TO BE 730 BECAUSE AGWT WAS SUM OF TWO SEASONS

2710
FACE
AMB
AMB
AMB
AMB
AMB
LO: 10-14 G N M-2 Y-1; HI: 42-56 G N M-2 Y-1
DEFOL: 4 OR 7-8 Y-1; FERT
GRASS
EU
MET IN TABLE 1

2711
GH
9.2 + 24.9 MOL M-2 S-1
AMB
30/25
WW
>90
"30 MG N POT-1 + 60 G N POT-1, SEASONALLY"
LIGHT
GRASS
AU

2715
GC
300 UMOL M-2 S-1
16/8
18/4
WW; 14% H20
0.928571429
28 MG P + 50 MG K KG-1 + N TREATMENTS
N 8KG N HA-1 OR 278 KG N HA-1
GRASS
EU

2718
GC
794
AMB
25/13 (DAY/NIGHT)
WW
AMB
HOAGLAND'S SOLUTION EVERY 3 D
DEFOL
GRASS
NA
.

2723
GH
85-90% AMB
14-H
AMB/AMB + 3 C
WW
AMB
.
TEMP
.
EU
GS WITH NO SE/SD. Vc MAX WITH SE/SD AND N IN FIG. 4

2735
GH
AMB
AMB
"AMB, AMB+4"
WW
AMB
10 G M-2 N; 15 G M-2 P; 15 G M-2 K

TEMP
GRASS
EU
80% OF UVB

2737
GH
25 MOL M-2 DAY-1
16/8
17
WW
65
"COMPLETE, INCLUDE 188 MG L-1 N"
"O3, SOIL"
GRASS
EU
O3 NOT USED FOR PHYL DATASET

2756
OTC
AMB
AMB
AMB
AMB + DROUGHT
AMB
NONE
H2O
GRASS
NA
"UNDISTURBED TALL GRASS PRAIRIE; EARLY, MID + LATE SEASON DATA; EXP. RAN 4Y PRIOR TO THIS STUDY"

2758
OTC
AMB
AMB
AMB
.
.
.
NONE
GRASS
EU
.

2785
OTC
AMBIENT
AMBIENT
AMBIENT
AMBIENT
AMBIENT
HI FERT TRT ONLY
FERT. 20 G M-2 NPK OSMOCOTE
GRASS
NA
JASPER RIDGE. SERPENTINE SOIL

2793
OTC
AMB
AMB
AMB
AMB
AMB
.
.
GRASS
EU
MINI-RHIZOTRONE. DATA USED FROM 10 CM

2802
GH (TUNNEL)
AMB
AMB
0.3 C HIGHER DURING DAY; 0.2 C LOWER AT NIGHT
.

.
FERT
GRASS
EU
.

2821
GH
79% OF AMB
AMB
AMB
WW
.
8 G N M-2 PER 24 DAYS
CO2
GRASS
EU

2834
GC
750 UMOL M-2 S-1
16/8
16
WW
0.54 KPA
0.2 OR 2.5 MOL M-3 N; 0.04 OR 0.5 MOL M-3 P
LOW N+LOW P OR HI N + HI P
GRASS
EU
"P, OTHER MINERALS"

2835
GC
1000 UMOL M-2 S-1
16
30/20
WW
0.0025

"HOAGLAND'S, ALTERNATE WATERING"
.
GRASS
NA

2839
OTC
85% OF AMB
AMB
"25/29 (AMB, AMB+4)"
WW
.
220 KG N HA-1
TEMP
WETL
AS

2855
GH
AMB+
16/8
20/15
WW
70
NPK (HOAGLAND'S) OR 0.1 N (MODIFIED HOAGLAND'S)
FERT
GRASS
EU

2856
GH
AMB
AMB
26/16 C DAY/NIGHT
WW
.
.
FERT
GRASS_C
AS
.

2892
GC
645 UMOL M-2 S-1
16/8
24/18
WW
.
MODIFIED SHIVE'S SOLUTION
O3
GRASS
EU
TIME FOR BIOMASS ASSUMED > 42 D; SEE FIG 6

2893
OTC
AMB

AMB
19
WW
67-71%
0.4 G L-1 N; 0.3 G L-1 P205; 0.4 G L-1 K20
NONE
GRASS_C
EU
INTRODUCED IN 1890

2895
OTC
AMB
AMB
AMB
AMB
.
.
NONE
GRASS
NA

2911
OTC
AMB
AMB
AMB
AMB
AMB
AMB
O3
GRASS
EU
CTL O3 = 26-29 NMOL MOL-1; HI O3= 84 NMOL MOL-1 AVE FOR ALL DAYS

2919
GC
AMB
AMB
15 C MEAN
.
.
"150 MG N, 18.1 MG P AND 34 MG K"
H20
GRASS_C
EU

2924
GH
AMB; PN >1200 UMOL M-2 S-1
AMB
32/23; 35/26; 38/29
WW
.
"P, K= 9 G M-2; N (UREA) 12.6-6.3 G M-2 X3 DATES"
TEMP
WETL
NA

2928
OTC
85% OF AMB
AMB
X= 25; AMB+4
WW
.
N: 110 KG HA-1 WET SEASON; 220 KG HA-1 DRY
TEMP
WETL
AS
DATA ON DEVELOPMENT STAGES

2935
OTC
AMB
.
28/21 (DAY / NIGHT)
.
.
.
H2O
GRASS_C
NA
SPAR: SOIL-PLANT-ATMOSPHERE-RESEARCH CHAMBER

3034
GC
1000 UMOL M-2 S-1
14/10
28/22; 24/18; 21/25
WW
70
.
TEMP. NOTE ECOTYPES
GRASS
NA
"TEMPS: MISS: CTL=28, L0=2, . ; N.C: CTL=24, LO=21, HI=28; QUEBEC:
CTL=21, . , HI =28"

3033
GC
65 UE M-2 S-1
14/10
28/22
WW
0.7
HALF STRENGTH HOAGLANDS
NONE
MIXED
NA

3035
GC
1000 UMOL M-2 S-1
14/10
28/22; 24/18; 21/15
WW

70
.
TEMP NOTE ECOTYPES
GRASS
NA
"TEMPS: MISS: CTL=28, LO=21, . ; N.C: CTL=24, LO-21, HI=28; QUEBEC:
CTL=21, . ,   HI=28"

3036
GC
150 OR 1000 UMOL M-2 S-1
14/10
29/23
WW
70
HALF STRENGTH HOAGLANDS
LIGHT
GRASS
NA

3038
GH
AMB
AMB
34
WW
.
.
NONE
GRASS
NA
MIXED AND UNMIXED CULTURES

3042
GH
AMB; 2ME M-2 S-1
AMB
32/20
WW
50-70
"4 LEVELS OF HENITTS: 24,12, 4, OR MM NITRATE"
FERT
GRASS_C
NA
ONLY MAIZE DATA WERE TAKEN

3401
GH
AMB + LOW INTENSITY INCANDESCENT
1/16/00
28/23
"AT PLANTING ONLY, DRYING THEREAFTER"
60-70
..
H20
GRASS
AU

ASSUMING THAT TIME COURSE FOR WATER LOSS IS SIMILAR FOR ALL GRASS SPECIES (USING WHEAT (COMPANION PAPER)); WE USE TIME CLASSES FOR ANALYSES.