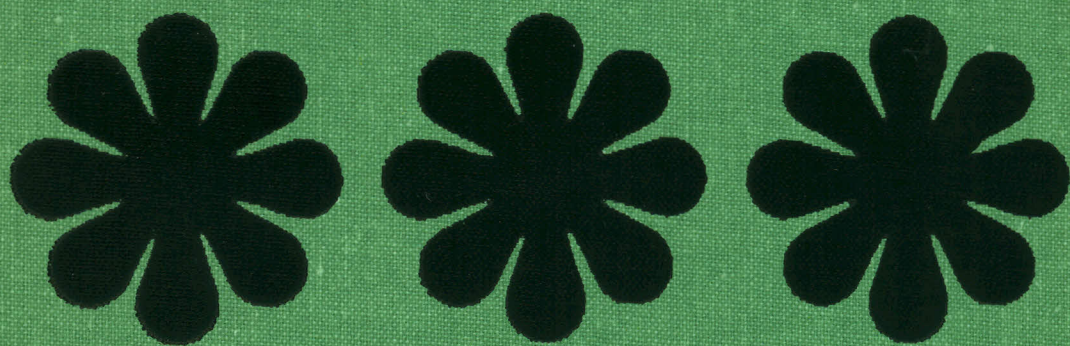


Developments in Crop Science 20



Weather and Yield

Edited by

Jiří Petr

Elsevier

Developments in Crop Science 20

Weather and Yield

Edited by

Jiří Petr

University of Agriculture, Prague (Czechoslovakia)



ELSEVIER

Amsterdam — Oxford — New York — Tokyo 1991

CONTENTS

Preface	10
1 The effect of weather on crop production	12
2 The importance of meteorological information for the management of crop production	14
3 The climate	16
3.1 The macroclimate, mesoclimate and microclimate	16
3.2 Classification of climate in Czechoslovakia	17
3.2.1 Temperatures	20
3.2.2 Rainfall	20
3.3 Agroclimatic conditions of Czechoslovakia	21
4 The atmosphere and its physical characteristics	25
4.1 Atmospheric pressure and air density	25
4.2 Air flow	25
4.3 Radiation	27
4.3.1 Basic concepts	27
4.3.2 Action of radiant energy on living organisms	29
4.3.3 Action of radiant energy on plants	30
4.4 Temperature of the soil and air	31
4.4.1 Basic concepts	31
4.4.2 Soil temperature	31
4.4.3 Air temperature	33
4.4.4 Measuring the temperature of soil and air	35
4.5 Water evaporation	36
4.6 Condensation of water vapour and its main products	38
4.7 Clouds: why they occur and how they are classified	39
4.8 Natural precipitation	42
4.9 Humidity	43
5 Meteorological services to agriculture	47
5.1 Types of meteorological services	47
5.2 Agroclimatology	48
5.3 Weather forecasts	48
6 The use of meteorological forecasts	52
6.1 Weather forecasting: history and present situation	52
6.2 General and special forecasts and their use	55
6.3 Obtaining meteorological information on the farms	58
6.4 Agrometeorological monitoring of yield formation of the main crops	62

7	The effect of weather on plant production	64
7.1	Physiological principles of production processes	64
7.2	The dependence of the main physiological processes on weather	65
7.3	The effect of temperature on the early growth of the leaf area index	69
7.3.1	Temperature sums as the measure of biological time	69
7.3.2	LAI dynamics and the yields of winter wheat	73
7.4	Weather and photosynthesis	74
7.5	Models of water balance for crop stands and for irrigation	76
7.5.1	Control of irrigation regimes using meteorological data	76
7.5.1.1	Basic data for irrigation	77
7.5.1.2	Potential moisture deficit	77
7.5.1.3	Irrigation regimes and potential moisture deficit	77
7.5.1.4	Potential evapotranspiration according to Penman	79
7.5.1.5	Modified calculation of the potential evapotranspiration	79
7.5.2	Future development of the water balance model	80
8	Influence of weather on nutrient uptake	81
8.1	Influence of weather on soil biology and nitrogen uptake	81
8.2	Nitrogen circulation in nature	81
8.3	The influence of temperature and moisture on nitrogen transformation in soil	82
8.4	Nitrogen movement in soil	83
8.5	Seasonal dynamics of nitrogen in soil	85
8.6	The influence of weather on nitrogen nutrition and fertilization of plants	86
8.7	Influence of weather on the leaching of nitrates into surface, drain and underground waters	87
8.8	The activity of soil flora and fauna in relation to weather and fertilization	89
8.9	The influence of weather on the uptake of phosphorus, potassium and microelements	89
8.9.1	Water and the uptake of nutrients	90
8.9.2	Temperature and the uptake of nutrients	93
8.9.3	Light conditions and the uptake of nitrogen	94
9	Influence of weather on the incidence of diseases and pests	95
9.1	Distribution of diseases and pests	96
9.2	Population dynamics of diseases and pests	96
9.3	The influence of environmental factors on the development of pests	98
9.4	Methods of the prognosis and early warning of harmful organisms	99
10	The influence of weather on weeds	104
10.1	The effect of weather and other factors on the occurrence of wild oat in winter and spring cereals	105
10.1.1	The relation of the sowing time of spring crops to the occurrence of wild oat	107
10.1.2	The effect of soil cultivation in spring on soil temperature and wild oat emergence	108
10.2	The effect of weather and other factors on the occurrence of silky bentgrass	109
10.2.1	1975 and 1976: two years of entirely different levels of silky bentgrass in winter cereals	109

10.2.2	The effect of weather on the occurrence of silky bentgrass in spring cereals	111
11	The effect of weather on the biological and economic yield of cereals	114
11.1	The effect of weather on the biological yield of cereals	115
11.1.1	The effect of external factors on the size of the assimilation apparatus . .	115
11.1.2	The effect of weather on the root systems of plants	118
11.1.3	The production and distribution of dry matter	118
11.2	The effect of weather on the economic yield of cereals	121
11.2.1	Dynamics of the formation of the yield components of cereals	121
11.2.2	The effect of weather on plant density	123
11.2.2.1	The effect of weather on the emergence of cereals	124
11.2.2.2	The effect of temperature on emergence	126
11.2.2.3	Effect of excess moisture and flooding on emergence and growth before winter	131
11.2.3	Developmental processes of winter cereals in relation to weather	133
11.2.4	The effect of weather on the premature development of winter crops . .	137
11.2.5	The effect of weather on the overwintering of winter crops	141
11.2.6	Agrometeorological risks to cereals in spring	152
11.2.7	The effect of weather on the survival of winter cereals in the spring . . .	152
11.2.8	The time of onset of spring growth in winter crops	153
11.2.9	The effect of weather on the tillering of cereals	157
11.2.10	Additional tillering	162
11.2.11	The effect of weather on the productivity of tillers and on the number of grains per spike	162
11.2.12	Conditions influencing the formation and weight of caryopses	169
11.2.13	The effect of weather on the lodging of cereals	174
11.3	The effect of weather on the quality of cereals	175
11.3.1	Factors influencing the quality of wheat	176
11.3.2	The effect of weather on the malting quality of barley	179
11.4	Weather and the harvest of cereals	187
11.4.1	The effect of weather during the harvest season on grain yield and quality	191
11.4.2	The effect of weather on grain sprouting	192
11.5	Agrometeorological monitoring of yield formation in cereals	193
12	The effect of weather on the biological and economic yields of legumes	198
12.1	Yield stability of legumes and the weather	198
12.2	The effect of weather on the growth and economic yield of legumes . . .	201
12.2.1	Emergence in legumes	201
12.2.2	Growth and yield formation in legumes	203
12.3	Weather and the diseases of legumes	206
12.4	Weather and the harvest of legumes	206
12.5	The effect of weather on the quality of legume seeds	206
13	The effect of weather on biological and economic yield of winter rape	208
13.1	Ecological conditions of yield formation in winter rape	208
13.2	The effect of weather on the growth and development of winter rape . .	208

13.3	The effect of weather on emergence, rooting and leaf rosette formation in winter rape	209
13.4	The effect of weather on the formation of reproductive organs	210
13.5	Weather and the wintering of winter rape	212
13.6	The effect of weather on the components of yield from the onset of spring vegetation to harvest	213
13.7	The effect of weather on the development of diseases and pests	213
13.8	The effect of weather on the quality of rapeseed	214
13.9	Weather and yield stability in winter rape	215
14	The effect of weather on the yield and quality of sugar beet	216
14.1	Agroclimatic conditions of sugar beet growing	216
14.1.1	Conditions for emergence in sugar beet	217
14.1.2	The "climate energy — sugar beet stands" system: physiological aspects .	219
14.1.3	Reaction to day length and illumination	220
14.1.4	Water demand and the effect of rainfall	220
14.1.5	Requirements for temperature	221
14.2	The thermodynamics of growth and yield formation in sugar beet	222
14.3	The effect of weather on sugar beet growth and yield and on the production of sugar	227
14.4	Agrotechnical regulation of growth rate in sugar beet until summer solstice	228
14.4.1	Irrigation of sugar beet as a stabilizing factor	228
14.4.2	Effect of weather on weed infestations of sugar beet	228
14.5	Weather and sugar beet harvesting	229
14.6	The effect of weather on the production and quality of sugar beet seed .	230
14.6.1	The effect of air temperature and rainfall on the yield and germinability of sugar beet seed	231
14.6.2	Areas of beet seed production	233
15	The effect of weather on the yield and quality of potatoes	235
15.1	Agroclimatic conditions of potato cultivation	235
15.1.1	Requirements of potatoes for environmental conditions. The potato growing regions.	235
15.1.2	The effect of precipitation and air temperatures on the growth of potatoes	237
15.1.3	The effect of day length on yield formation in potatoes	238
15.2	The effect of weather on production processes in potatoes	239
15.2.1	The effect of external conditions on the processes that take place in tubers before planting	240
15.2.2	The effect of weather on the formation of economic yield in potatoes . .	242
15.3	The effect of weather on potato quality	246
15.3.1	The effect of weather on tuber damage	246
15.4	Measures to reduce the unfavourable effect of weather on the growth of potatoes	248
16	Weather and grasslands: herbage yields and quality	250
16.1	Weather and yield variability	250
16.2	Effect of weather on the species composition of grassland	252
16.3	Effect of weather on the quality of herbage and on cultural practices . .	256
16.4	Effect of weather on forage harvesting	260

17	Mathematic models in agricultural meteorology	262
18	Remote sensing of the Earth's surface from the Space: possibilities for use in agrometeorology	268
19	References	272
	Subject Index	284