

# THE AMOUNT AND DISTRIBUTION OF PRECIPITATION IN LOWER SILESIA AND WATER NEEDS OF CROPS

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## Abstract

The real precipitations in average, medium dry and dry years with precipitation demands of 15 crops in separate agrofenophases were compared on the basis of the results of extract experiments conducted at the Stations of Cultivar Valuation in Lower Silesia in Poland in the period of 1961-95. It is obvious that the water requirements of crops depends on the length of the vegetation period. Clover, lucerne, and sugar beet have the greatest demands and cereals, winter rape and yellow lupine – the lowest. Water demands of plants during the vegetation period are much different. The short vegetation plants have the greatest water demands in June and the plants of long vegetation period – in July and August.

KEY WORDS: precipitation, water needs, crops, Lower Silesia

## INTRODUCTION

From many field experiments it follows that the growth, development and yield of crops are most affected, aside of agrotechnical treatments, by the weather and course distribution of precipitation [1,2,4]. On soils of small useful retention (over 40% in Lower Silesia) and deep ground water level the main source of water for crops is precipitation. In case its quantity and distribution corresponds to plant water needs, high yields are obtained. Large yield variation over the years signifies that such cases are rare.

The aim of the work is to compare the real precipitation in mean years, medium dry and dry with precipitation demands of 15 crops in separate agrofenophases of crops on medium compact soils. The calculated deficits and excesses of precipitation allow to estimate to what degree plant water demands are met.

## METHODS AND SCOPE

Precipitation data and results of exact field experiments conducted by Stations of Cultivar Valuation over 1961-95 have been used in the present study. The amount and distribution of precipitation in Lower Silesia was elaborated using also readings from meteorological stations [3], which are named and localised in Fig. 1.

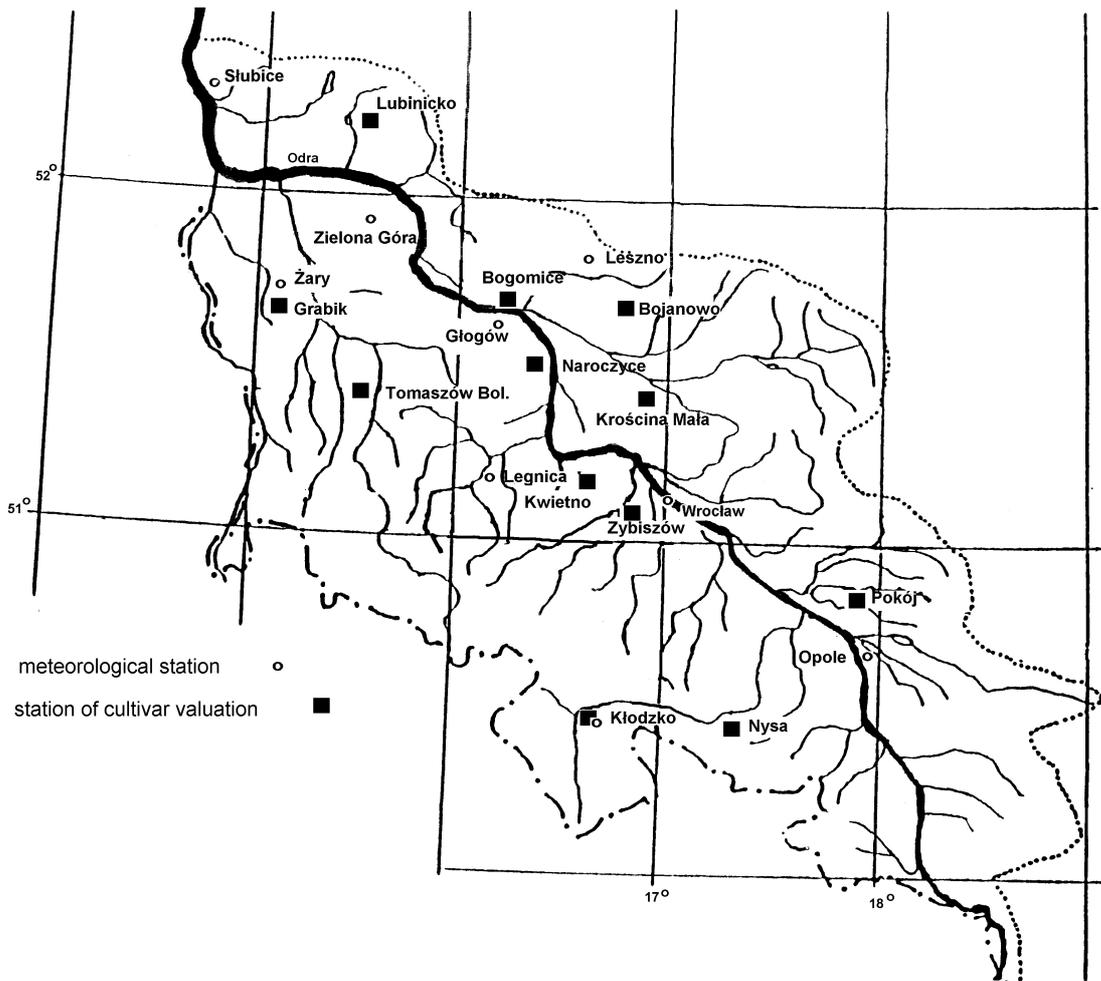


Fig.1 Stations of cultivar valuation and meteorological stations

The method for determining decade water needs of particular plants is described in J. Dzieżyc et al. [2]. Mean times of sowing (planting) and cropping, also critical terms of individual plants, were determined on the basis of multiannual exact field experiments conducted in Lower Silesia [5], and shown in Table 1. The data in Tab. 1 should be treated as approximate, since they refer to the mean weather course in Lower Silesia. The time the spring field work in agriculture begins, depending on when the snow cover melts, the ground thaws and its moisture content is adequate, is subject to considerable variations. Hence the given dates for sowing (planting) and cropping as well as the highest water needs (critical terms) of plants may shift. The mean, medium and dry years were determined on the basis of the sum of precipitation during vegetation of each plant. Hence the same year depending on the growing season of a plant may appear different year type [5]. Deficits and surpluses of precipitation were calculated as the difference between optimum and real precipitation both in the respective agrofenophases and the whole vegetation of a plant.

## RESULTS

The amount and decade distribution of precipitation optimal for 15 crops grown on medium-compact soils in Lower Silesia are given in Table 2. The precipitation needs of crops of short vegetation, expressed as optimum decade precipitation, increase with plant development and reach a maximum (25-30 mm per decade) in the critical period. Great water needs prevail until cropping in the case of winter rape, yellow lupine and early potatoes, or they decrease in 2 last decades in the case of cereals, peas. Whereas precipitation needs of crops of long vegetation period (late potatoes, sugar beets, clover, lucerne) increase systematically from sowing (planting) till the critical period in plant water management, when they are highest (30-35 mm per decade), and then they decrease markedly, reaching 15-18 mm per decade before cropping.

Table 1

Mean length of vegetation period and critical period of plant water management

Plant	Vegetation period	Critical period
Winter rape	1 d. IV-1 d.VII	2 d. V-2.d. VI
Spring barley	1 d. IV-2 d.VII	2 d. V-1 d. VII
Oats	1 d. IV-2 d.VII	2 d. V-1 d. VII
Spring wheat	1 d. IV-2 d.VII	2 d. V-1 d. VII
Winter wheat	1 d. IV-2 d.VII	2 d. V-1 d. VII
Rye	1 d. IV-2 d.VII	2 d. V-1 d. VII
Pea	1 d. IV-2 d.VII	2 d. V-3 d. VI
Broad bean	1 d. IV-2 d.VIII	3 d. V-2 d. VII
Yellow lupine	1 d. IV-1 d.VII	2 d. V- to harvest
Red clover	1 d. IV-1 d.IX	2 d. V-to harvest
Lucerne	1 d. IV-1 d.IX	2 d. V-to harvest
Early potato	2 d. IV-1 d.VII	1 d. VI-to harvest
Medium early potato	3 d. IV-1 d.VIII	3 d. VI-3 d. VII
Late potato	3 d. IV-2 d.IX	3 d. VI-3 d. VIII
Sugar beet	3 d. IV-1 d.X	3 d. VI-1 d. IX

The overall water needs of crops depend on the length of vegetation period. The longer the period, the greater the total water requirements. The crops of largest water needs (400 mm on average) are sugar beets, clover and lucerne. Less water (340-375 mm) requires late potato, and pea and broad bean 270-300 mm. For cereals, winter rape and yellow lupine the precipitation total is within the range 210-250 mm. The decade water needs given in Table 2 refer to plants grown on medium compact soils. For plants grown on light soils the optimum

precipitation is about 15-20% higher, and on heavy soils by ca. 15-20% lower than those in Table 2.

Indices of deficit or surplus of precipitation for the crops studied grown on light soils in mean years, medium dry and dry years for three developmental periods and for the whole vegetation period are given in Tab. 3.

In mean years the greatest deficit in precipitation (66-81 mm) was found for lucerne, clover and sugar beet; lower (30-43 mm) for late potato, pea, yellow lupine, broad bean and medium early potato, while the deficits for the remaining crops studied did not exceed 20 mm.

In medium dry years precipitation deficits are considerably greater than in medium years, and vary from 39 to 114 mm depending on plant. The greatest deficits, over 100 mm, were found for lucerne, clover, sugar beet and late potato; smaller (58-75 mm) for early and medium potato, pea, broad bean and yellow lupine. The precipitation deficits in the vegetation period of the other plants do not exceed 56 mm.

In dry years, depending on plant, precipitation deficits varied from 70 to 174 mm. The lowest deficits (70-80 mm) were found for cereals, the greatest (174 mm) for sugar beet.

The presented indices of precipitation deficit refer to the whole vegetation period of the plants studied. From the investigations [3] conducted so far it follows that plant's reaction to precipitation deficit is different in the respective developmental phases, but they are most sensitive during the period of critical water management. The percent distribution of precipitation deficit in the developmental period compared of the plants is the following: On average for three types of years of precipitation deficits from sowing (planting) or vegetation start in the spring till the beginning of the critical period is 18%, in critical period 75% and after critical period 7% of the total deficit. With increase dryness of the years the percent precipitation deficit in critical period decreases. In mean years it constitutes 89% and in dry years 61%. In the other two periods a reversed tendency was found.

Table 2

Decade precipitation needs of crops (in mm) on medium soil in the south-western macroregion.

Plant	mean yield t/ha	IV			V			VI			VII			VIII			IX			X			Sum
		1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
Winter rape	3,2	9	15	17	19	24	27	28	26	23	23												211
Spring barley	4,6	14	16	17	21	26	30	29	25	23	20	18											249
Oats	4,5	13	13	16	19	23	28	31	27	25	22	19											236
Spring wheat	4,7	14	17	18	22	24	27	30	26	25	23	20											246
Winter wheat	5,0	13	16	19	23	26	29	31	29	25	20	17											248
Rye	4,5	11	13	18	22	24	28	28	27	24	23	21											239
Pea	3,0	16	17	19	23	26	29	31	30	28	25	24											268
Bead bean	3,3	15	18	20	23	26	28	30	31	31	28	26	25	22	17								340
Yellow lupine	48,0	12	15	17	22	27	29	31	30	27	26												236
Red clover	64,0	15	18	21	26	29	30	32	33	31	30	28	26	25	24	23	17						408
Lucerne	62,0	16	18	18	23	27	29	30	32	32	34	32	30	29	27	24	16						417
Early potato	32,0		13	18	20	23	26	28	30	32	31												221
Medium early potato	40,0			19	21	25	28	30	32	32	30	28	27	25									297
Late potato	42,0			18	20	24	25	26	28	30	32	30	30	28	23	23	20	18					375
Sugar beet	51,0			17	21	22	24	25	27	30	31	34	35	35	29	26	23	19	16	15			429

Table 3

Deficits and surpluses of precipitation in mean, medium and dry years (in mm)

Plant	Mean years				Mean dry years				Dry years			
	1*	2*	3*	4*	1	2	3	4	1	2	3	4
Winter rape	+3	-5	-7	-9	-3	-31	-5	-39	-33	-26	-27	-86
Spring barley	-8	-31	+18	-21	-2	-50	-4	-56	-21	-50	-9	-80
Oats	-1	-24	+17	-8	+5	-43	-5	-43	-14	-43	-10	-67
Spring wheat	-11	-23	+16	-18	-5	-42	-6	-53	-24	-42	-11	-77
Winter wheat	-11	-28	+19	-20	-5	-47	-3	-55	-24	-47	-8	-79
Rye	-4	-22	+15	-11	+2	-41	-7	-46	-17	-41	-12	-70
Pea	-15	-12	-13	-40	-9	-31	-35	-75	-28	-31	-40	-99
Broad bean	-26	-15	+10	-31	-7	-58	-3	-68	-50	-56	-11	-117
Yellow lupine	-3	-31		-34	-9	-55		-64	-39	-72		-111
Red clover	-24	-48		-72	-20	-85		-105	-30	-128		-158
Lucerne	-19	-62		-81	-15	-99		-114	-25	-142		-167
Early potato	+6	-24		-18	-22	-36		-58	-32	-25		-84
Mean early potato	-9	-19	-2	-30	-34	-39	+5	-68	-47	-56	-16	-119
Late potato	-7	-37	+1	-43	-31	-52	-20	-103	-36	-81	-30	-147
Sugar beet	+9	-61	-14	-66	-21	-91	+1	-111	-21	-126	-27	-174

1 – since sowing (planting) till start of critical period

2 – in critical period

3 – since end of critical period till cropping

4 – for whole vegetation period

Table 4

Frequency of mean, medium dry and dry years during vegetation of crops studied (% of years)

Plant	Year		
	mean	medium dry	dry
Winter rape	32	32	8
Cereal	36	16	16
Pea	36	16	16
Broad bean	28	20	16
Yellow lupine	32	32	8
Red clover, lucerne	28	12	16
Early potato	28	28	16
Mean early potato	32	24	12
Late potato	40	12	12
Sugar beet	28	20	12

The frequency of mean, medium dry and dry years during vegetation of all the plants studied is shown in Tab. 4. In the 35-year period studied mean years constituted 32%, medium dry 23% and dry 13% on average. Whereas in cultivation of the respective crops the participation of mean, medium and dry years was as follows: mean years occur most often (36% of years) during vegetation of cereals and pea, and least frequent (28% of years) during vegetation of broad beans, early potatoes and sugar beets. Medium dry years occurred every 8 years for red clover and lucerne, every 5 years for cereals and pea, every 5 years for broad beans and late potatoes and every 3 years for winter rape and yellow lupine. Whereas dry years every 12 years for winter rape and yellow lupine, every 8 years for medium early and late potatoes, sugar beets and every 6 years for the other plants studied.

## CONCLUSIONS

1. The amount of water needs of crops depends on the length of vegetation period. The greatest demands (over 400 mm) have plants of long vegetation period, such as clover, lucerne and sugar beet; whereas the lowest - cereals, winter rape and yellow lupine.
2. Water demands of plants during vegetation period are much different. The greatest water demands have plants during intensive vegetation (critical period), which is June for species of short vegetation, and July and August for plants of long vegetation
3. The mean precipitation in Lower Silesia does not meet the demands for water of crops. The deficit is 8 to 72 mm depending on species. In dry year the deficit is much higher and varies within the range 67-174 mm depending on species.

4. In Lower Silesia for a ten-year period there are 6 to 7 years with precipitation short of the water demands of crops.

## SUMMARY

In the present work are used precipitation data and results of exact field experiments conducted by Stations of Cultivar Valuation over 1961-95 in Lower Silesia.

From the investigations it follows that water requirements of crops depends on the length of vegetation period. The greatest demands (over 400 mm) have plants of long vegetation period, such as red clover, lucerne and sugar beet; whereas the lowest (below 250 mm) - cereals, winter rape and yellow lupine.

The greatest water demands have plants during intensive vegetation (critical period), which is June for species of short vegetation period, and July and August for plants of long vegetation. The mean precipitation in Lower Silesia do not cover the water demands of crops, the deficit being 8 to 72 mm depending on species. In dry years the deficit is much higher and vary in the range 67-174 mm depending on plant. In Lower Silesia on average for a 10-year period in 6 to 7 years precipitation falls short of the crops water demands.

## LITERATURE

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