J. Petr and I. Capouchová

Causes of the occurrence of malting barley kernel discoloration

The blackened tips of barley grains disclose a certain flaw and they can bring a risk of a negative effect on the quality of malt and beer. The decisive effect on the occurrence of blackened tips of malting barley had rainy weather at the time of caryopsis formation and maturation, i.e. 20 days after earing till harvesting. The highest effect was found within the period of 30 – 40 days after earing of barley. One-shot, even high precipitations are not so dangerous as smaller amounts of precipitations, but frequent for a longer period of time. The factor of weather at the time period indicated to be as decisive and predominated over the effects of other ecological and growing factors. The data on precipitation course and relative humidity 15 to 40 days before harvesting could serve as a possible forecast of the occurrence of blackened tips of malting barley grains. The varietal susceptibility of malting barley varieties to the blackened tips of barley grains was found. This varietal susceptibility should be monitored during the new varieties of spring malting barley breeding and evaluation. The effect of some other factors influencing the occurrence of this kind of damage can be interpreted as reflection of plant stress. These factors can be a low pH value of soil (the effect of soil acidity), aluminium ions content and the effect of heavy soils. The similar effect had the damage of plant nutrition, e.g. a high content of nitrogen in soil or high fertilizing by nitrogen and potassium. On the other hand, the effect of phosphorus, magnesium and some microelements (Cu, Mo, Zn) was positive. The presence of pathogens, but in interaction with bad weather course at the time of caryopsis formation and maturation, is considered to be the main cause of the biological damage of barley grains. Health condition of vegetation also contributes to the damage of barley grains, when the attack of vegetation by powdery mildew (*Blumeria graminis*), net blotch (*Helmithosporium teres*) and scald (*Rhynchosporium secalis*) likely caused the enfeeblement of the plants and the percentage increase of damaged grains. For monitored vegetation pickled seeds were used and the vegetation was at least once treated against diseases, but also this procedure did not protect the vegetation from the occurrence of blackened tips. Also individual trials of treatment by means of various types of fungicides did not show demonstrably positive results. However, the blackened tips of barley grains do not have to be in all ways the carriers of fungal and bacterial pathogens causing so-called gushing – beer foaming over.

BC 11 Barley

(Descriptors: Malting barley, kernel discoloration, blackened tips, causes of the occurence.

Deskriptoren: Braugerste, Kornverfärbung, Braunspitze, Kornanomalien, Krankheitsursachen).

1 Introduction

The criteria for the evaluation of malting barley quality have constantly been tightening and the methods of evaluation improving. In the eighties, a new criterion for purchasing of malting barley was introduced, so-called "biological damage of grains". This criterion was mainly rated by the occurrence of blackened tips and subjectively determined in percentage of the occurrence of the blackened tips. The limits were up to 2% which meant exclusion of many batches of malting barley being otherwise of good quality.

Blackened tips of barley grains had always been negatively evaluated for malting purposes and showed a certain imperfection of raw material negatively influencing also the appearance of produced malt. Later, the occurrence of blackened tips was connected with possible occurrence of microorganisms negatively influencing production and quality of malt as well as beer. In the countries with this problematics being topical, the terminology for dark (brownish) grain tips has not been unified. In the USA, the term "black tip" is used for fungal diseases or "black point" for bacterial attack symptoms. In Canada, the term "kernel smudge" is used for contamination caused by fungi. In Central Europe, in German speaking countries, terms "braunspitze" or "schwarzspitzige" are used, in France "moucheté", in Italy "puntatura", in Argentina "punta nera", etc. Lately, the term "weathered" has been used for the grains colour of which is influenced by a certain course of weather.

Most works made abroad follow the occurrence partly as a consequence of microbial contamination, partly as an influence of contamination related to a certain course of weather. In the seventies, in the Czech Republic these questions had been studied in details by *Kosař* 1981 who came to a conclusion that the occurrence of blackened tips is most of all influenced by the course of weather. Similar conclusions were made by *Thorpe* 1941, *Seeley* and *Spoden* 1984 and *Etscheverse* et al. 1997. The last named author did not supply evidence, by means of correlation analysis, that the occurrence of microorganisms was the evidential cause for blackened tips. Possibly, only the occurrence of species of genus *Helminthosporium* seemed to be an accompanying factor of the occurrence of blackened tips. But a lot of other authors connect the causes of blackened tips mainly with the attack of plants by fungal and bacterial diseases, the same as well in relation to the course of weather. *Christensen* 1963, *Gorlenko* 1963, *Harranger* 1982, *Miles* et al. 1987 and other authors

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Table 1 The effect of weather and growing conditions on the formation of malting barley kernel discoloration – coefficients of correlation (years 1988 – 1990)

Monitored factors	Coefficient of correlation (r)		
	Year 1988	Year 1989	Year 1990
Temperatures in I. decade after earing (°C)	+0.08	+0.10	-0.11
Temperatures in II. decade after earing (°C)	+0.04	-0.08	+0.08
Temperatures in III. decade after earing (°C)	+0.28^{+}	-0.01	-0.06
Temperatures in IV. decade after earing (°C)	-0.42^{+}	-0.07	+0.17^{+}
Temperatures in V. decade after earing (°C)	+0.39^{+}	-0.20^{+}	-0.16
Temperatures in VI. decade after earing (°C)	+0.28^{+}	-0.04	-0.08
Precipitation amount in I. decade after earing (mm)	+0.34^{+}	+0.38^{+}	+0.42^{+}
Precipitation amount in II. decade after earing (mm)	+0.48^{+}	+0.45^{+}	+0.48^{+}
Precipitation amount in III. decade after earing (mm)	+0.54^{+}	+0.50^{+}	+0.63^{+}
Precipitation amount in IV. decade after earing (mm)	+0.58^{+}	+0.51^{+}	+0.68^{+}
Precipitation amount in V. decade after earing (mm)	+0.52^{+}	+0.48^{+}	+0.57^{+}
Precipitation amount in VI. decade after earing (mm)	+0.48^{+}	+0.38^{+}	+0.55^{+}
Atmospheric humidity in I. decade after earing (%)	+0.32^{+}	+0.34^{+}	+0.33^{+}
Atmospheric humidity in II. decade after earing (%)	+0.37^{+}	+0.48^{+}	+0.58^{+}
Atmospheric humidity in III. decade after earing (%)	+0.47^{+}	+0.43^{+}	+0.56^{+}
Atmospheric humidity in IV. decade after earing (%)	+0.50^{+}	+0.43^{+}	+0.55^{+}
Atmospheric humidity in V. decade after earing (%)	+0.46^{+}	+0.34^{+}	+0.38^{+}
Atmospheric humidity in VI. decade after earing (%)	+0.38^{+}	+0.28^{+}	+0.46^{+}
Height above see level (m above see)	-0.19^{+}	+0.14	-0.14
Average temperature of the year (°C)	+0.21^{+}	-0.08	+0.05
Average precipitation amount of the year (mm)	+0.15	+0.09	+0.10
Soil kind	+0.24^{+}	+0.18^{+}	+0.18^{+}
Soil type	-0.15	+0.07	-0.14
Forecrop	+0.30^{+}	+0.36^{+}	+0.41^{+}
Variety	+0.48^{+}	+0.46^{+}	+0.52^{+}
Sown seeds (kg.ha^{-1})	+0.15	-0.33^{+}	-0.10
pH of soil	+0.31^{+}	-0.26^{+}	-0.36^{+}
Content of N_{min} in the soil (mg.kg^{-1})	+0.33^{+}	+0.37^{+}	+0.41^{+}
Content of K in the soil (mg.kg^{-1})	+0.35^{+}	+0.29^{+}	+0.38^{+}
Content of P in the soil (mg.kg^{-1})	-0.23^{+}	-0.33^{+}	-0.36^{+}
Content of Mg in the soil (mg.kg^{-1})	-0.40^{+}	-0.39^{+}	-0.37^{+}
N – fertilizing (kg.ha^{-1})	+0.24^{+}	+0.32^{+}	+0.26^{+}
P – fertilizing (kg.ha^{-1})	-0.33^{+}	-0.09^{+}	-0.20^{+}
K – fertilizing (kg.ha^{-1})	+0.22^{+}	+0.29^{+}	+0.27^{+}
Occurence of powdery mildew (botanic grades 1-9)	-0.20^{+}	-0.30^{+}	-0.31^{+}
Occurence of net blotch (botanic grades 1-9)	-0.36^{+}	-0.32^{+}	-0.37^{+}
Occurence of scald (botanic grades 1-9)	-0.30^{+}	-0.23^{+}	-0.36^{+}
Lodging rate before harvesting (botanic grades 1-9)	-0.40^{+}	-0.37^{+}	-0.42^{+}
Yield (t.ha^{-1})	-0.09	+0.02	-0.13
HTZ of harvested grain (g)	-0.12	-0.09	-0.19^{+}
Content of N – compounds in harvested grain (%)	+0.32^{+}	+0.35^{+}	+0.25^{+}

The critical tabulated value of the coefficient of correlation r at n = 100 and significance level a = 0.05 is equal to 0.17.

indicate the presence of the above mentioned species of fungus *Helmithosporium*. In the work done by *Miles* et al. 1987, variety susceptibility to blackened tips is emphasized. Such differences in varieties were observed mainly under conditions with a higher rainfall (*Eilcoxon* et al. 1980). But, negative influence of coloration with regard to their weight and germinating capacity as well as in crop decrease were not proved.

2 Material and methods

The problematics of blackened tips of malting barley grains is wide in its polyfactorial character. From them it is necessary to observe the influence of this damage to other quality parameters of malt and beer pertinently. Farmers are very interested in possibilities of taking measures for growing that could decrease the occurrence of blackened tips as well as a possibility of forecasting blackened tips according to current weather.

We lead this research for three years from the data gleaned from the growers within the Czech Republic and we had a sample of 1 kg from each tract of land with a controlled information file about variety, previous crop, soil conditions, content of nutritive substances inclusive nitrogen content in the soil (Nmin) in spring before sowing time, growing conditions, condition of vegetation (e.g. vegetation lodging) and weather course. We checked the weather data once more from the central data of the Czech hydrometeorological institute in Komořany, from the weather station closest to the particular tract of land. We used average temperatures of the day and precipitation amount as well as average relative humidity in pertinent decades from coming to ear to maturity. In each year we analysed 100 samples for quality parametres and we determined: germinating capacity, weight of 1000 grains, volume weight, sieving factors over 2,5 mm, content of nitrogenous substances, impurities and admixtures, overgrown grains, green grains and we were concentrated on the percentual occurrence of blackened tips.

For statistical evaluation, a method of a simple regression analysis was used, in which the influence of independent variable (weather condition data, locality, vegetation course, grain quality parameters) was evaluated, on dependent variable/percentual occurrence of blackened tips in barley grain samples. Based on the number of samples evaluated from each year's crop (a), a critical tabulated value of correlation coefficient on significance level of ? = 0,05 was determined which enabled to define statistically evidential and non-evidential coefficients of correlation.

3 Results

A review of evaluated factors and coefficients of correlation to the occurrence of blackened tips is given in Table 1. It results from the table that the course of weather during forming and maturation of grains was the bottom line for the occurrence of blackened tips. Especially the precipitations of particular decades from earing to maturity had direct a biggest influence to the occurrence of blackened tips (Figs. 4,5,6). The strongest correlations were at 3rd decade of precipitation amount (30 to 40 days after earing) and at 5th decade (40 to 50 days after earing). The highest values of correlation coefficients were in 1990 (all decades). The year was characterized by significant differences in the course of weather at the time of caryopsis formation and maturation – by dry weather on the whole territory of Bohemia and ample precipitations in Moravia. The occurrence of blackened tips in Bohemia was minimal that time – around 1%. In Moravia, the average occurrence of blackened tips was 4,6% in nothern Moravia and 8,3% in southern Moravia. As it can be seen from the results, one-shot, even high precipitations are not so dangerous for the occurrence of blackened tips as lower ones with higher frequency within

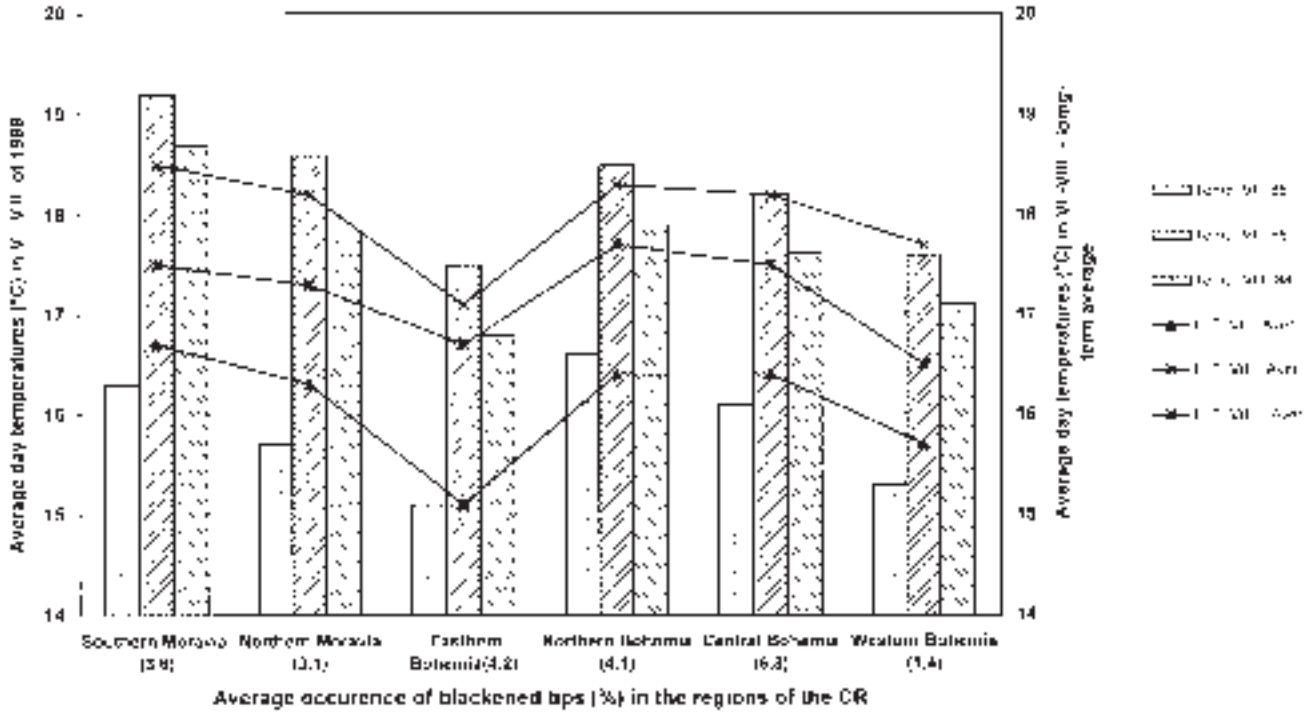

Fig. 1 The effect of average day temperatures in months VI – VIII of 1988 on the occurrence of blackened tips

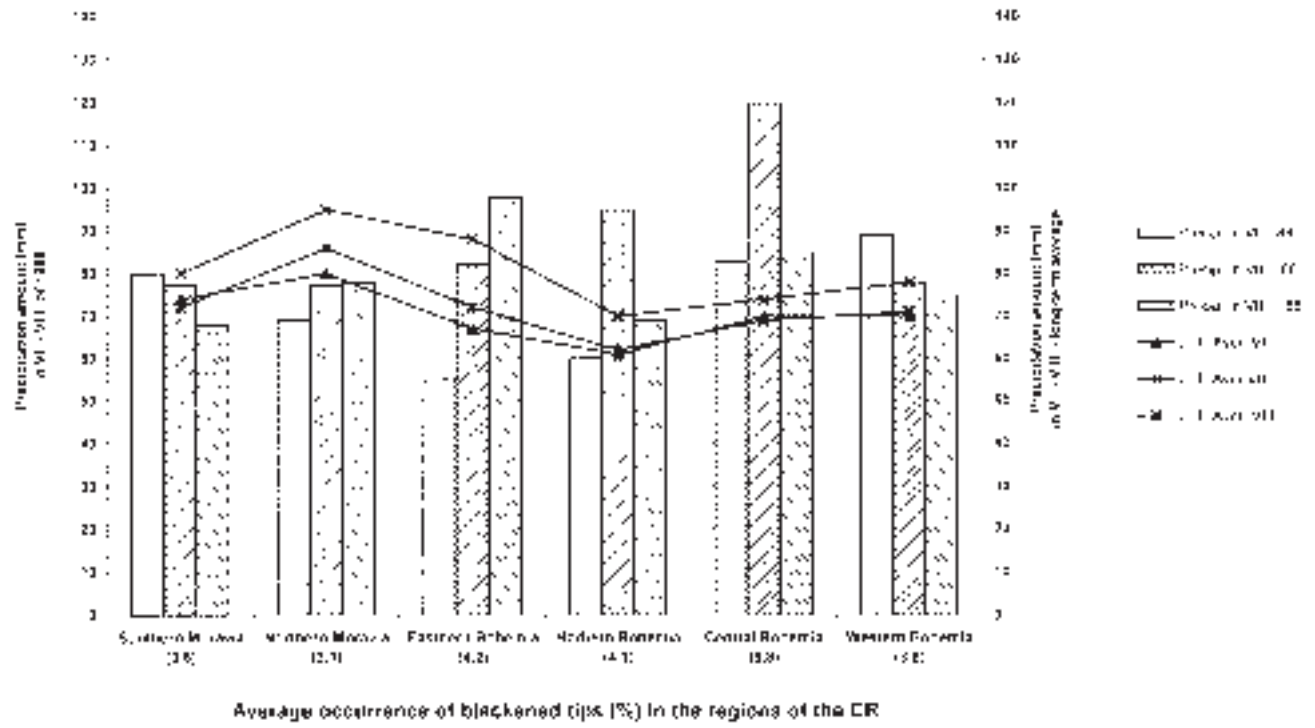

Fig. 2 The effect of precipitation amount in months VI – VIII of 1988 on the occurrence of blackened tips

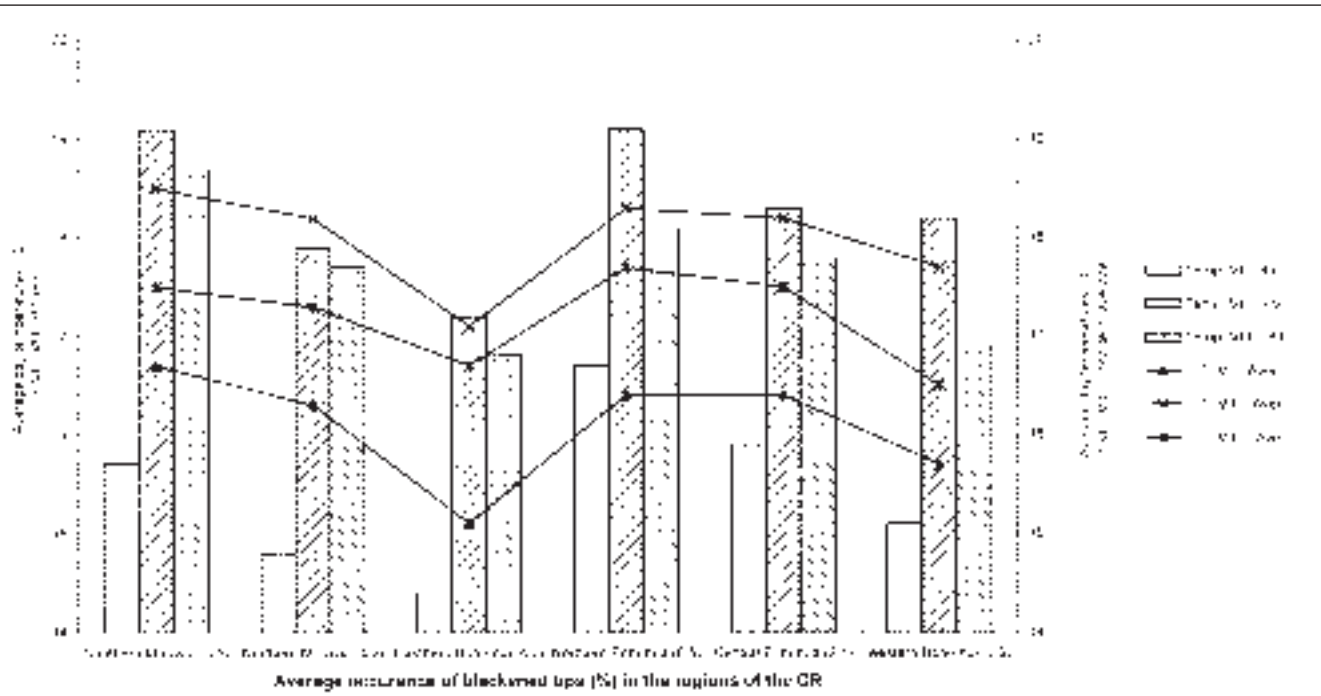

Fig. 3 The effect of average day temperatures in months VI – VIII of 1988 on the occurrence of blackened tips

longer period of time. Such moisture conditions keep humid microclimate for a longer time at ear level. This is also connected with relative humidity which has the same positive relation in all cases as precipitations and with a similar tendency in all years.

On the other hand the average day temperatures in particular time decades at the time of caryopsis formation and maturation did not have provable influence to the occurrence of blackened tips as well as annual average values of day temperatures and precipitation amount.

It is evident from the above mentioned results (Figs. 1 to 7) that the occurrence of blackened tips in various parts of the Czech Republic varied according to weather conditions, especially precipitations at the time of caryopsis formation and maturation in each year. In comparison to the above mentioned dependencis, other

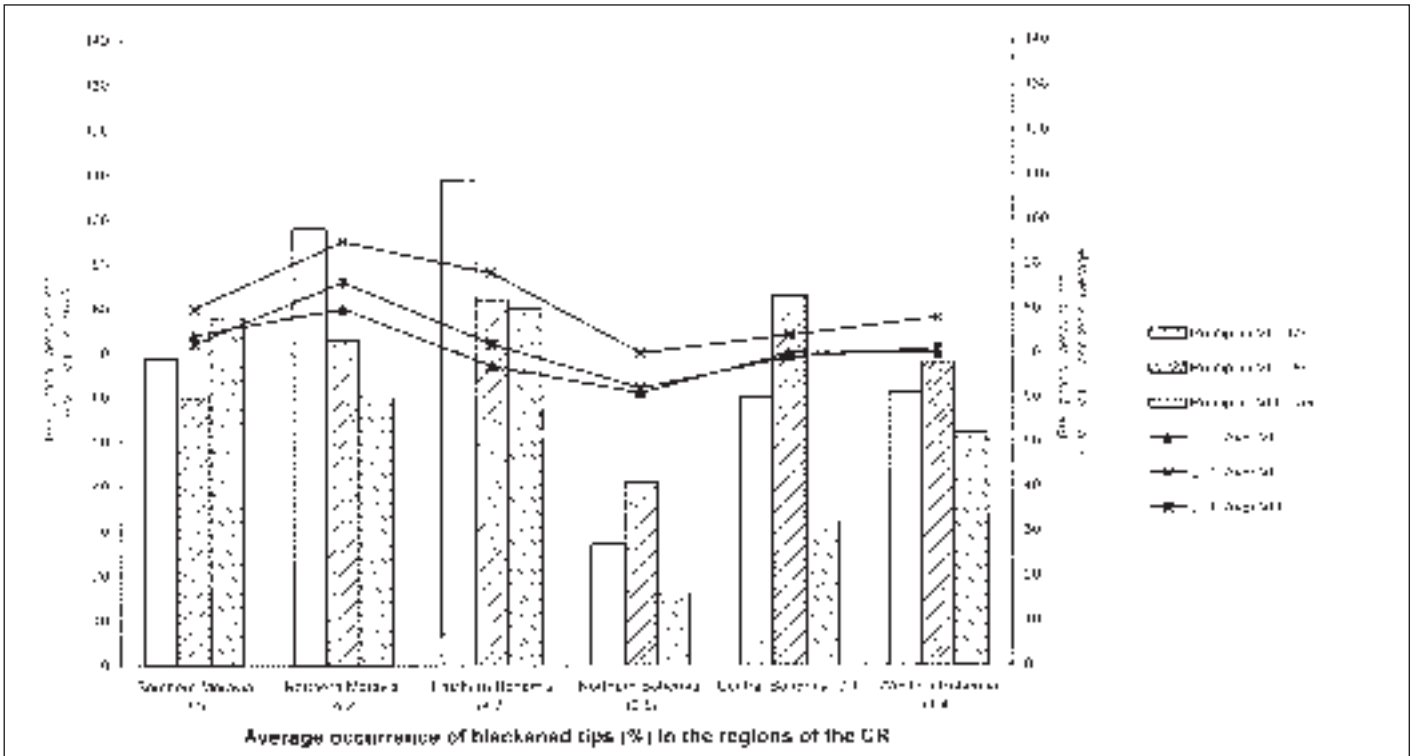

Fig. 4 The effect of precipitation amount in months VI – VIII in 1989 on the occurrence of blackened tips

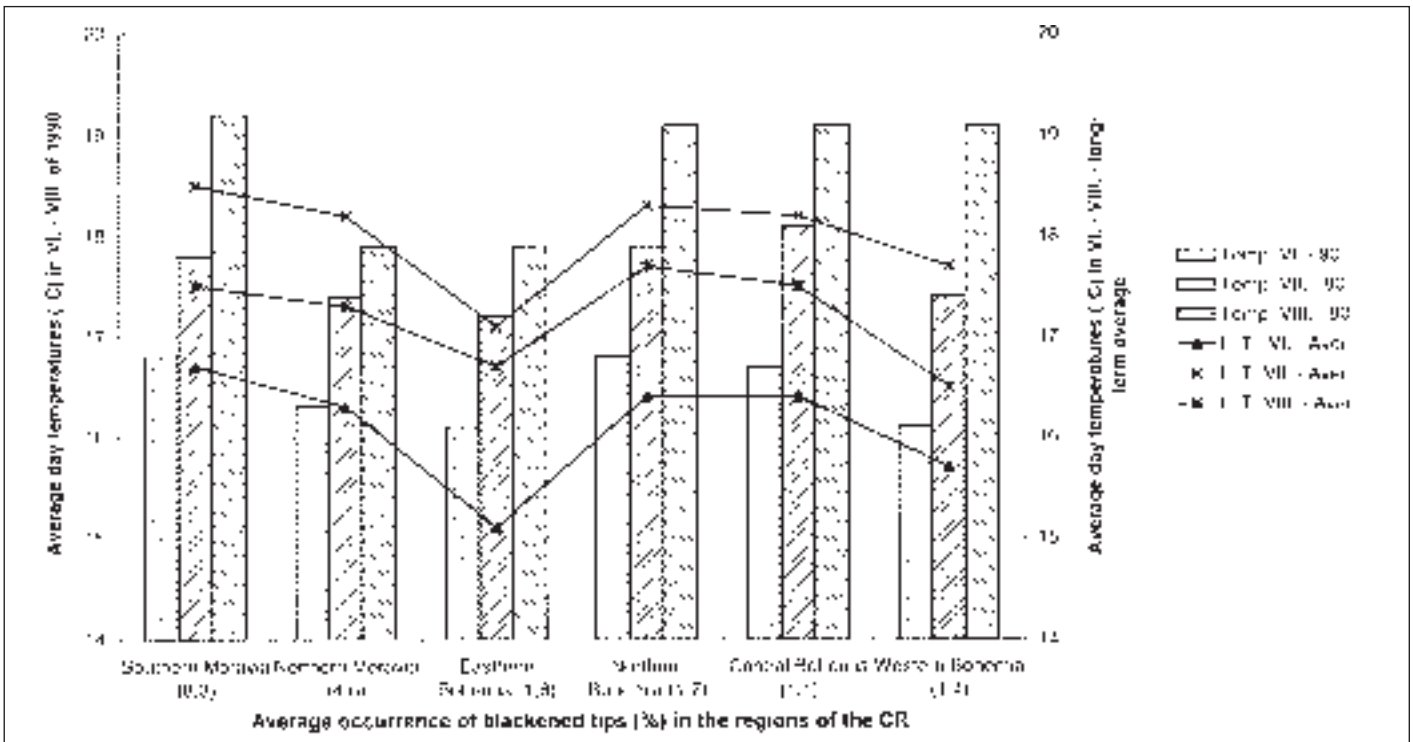

Fig. 5 The effect of average day temperatures in months VI – VIII in 1990 on the occurrence of blackened tips

factors monitored were shown as less significant, even if relations to the occurrence of blackened tips were found.

From the list of correlations the influence of sea level for growing as well as soil type and kind were not proved. The influence of pH value of the soil was evidential.The pH values were quite balanced since the tracks of land mainly from fertile areas of beet production type were included in the research, but thanks to a big collection we could monitor the dependence of the influence of acid soils on higher occurrence of blackened tips of spring barley even by concrete appraisal of registered values.

A certain influence of previous crop to the occurrence of blackened tips was found. In 1988, winter wheat comprised about one

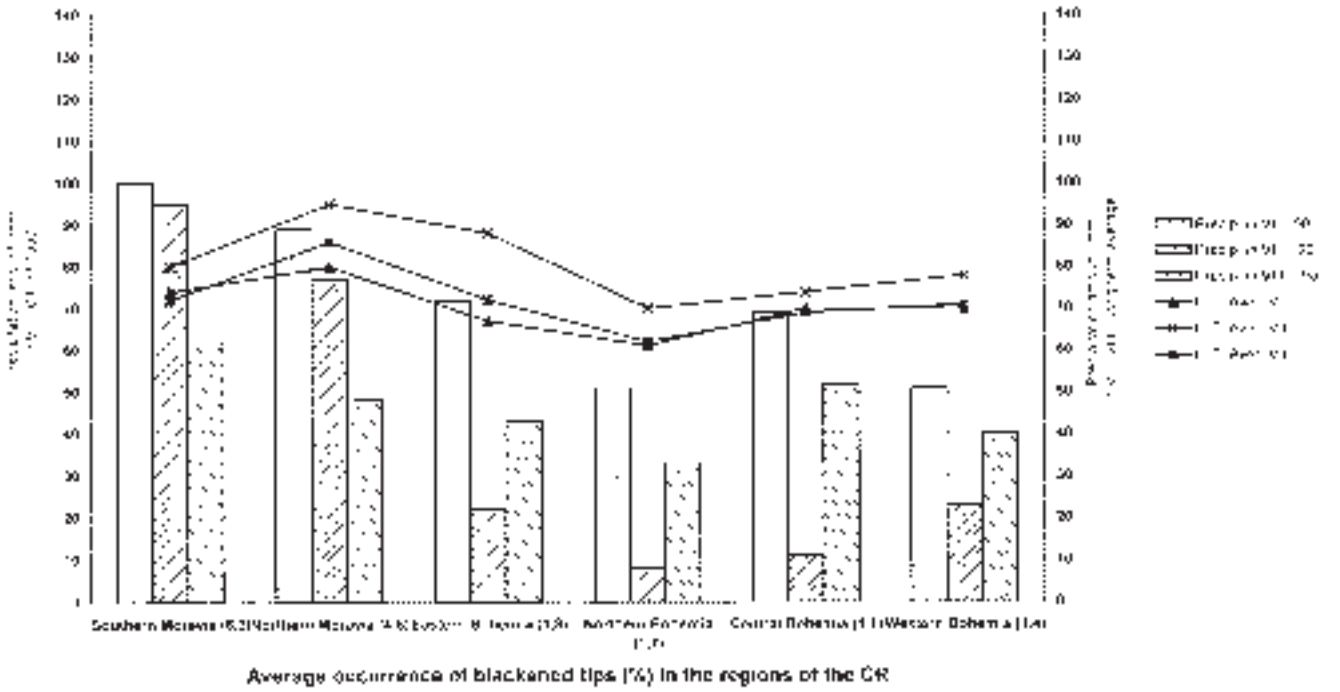

Fig. 6 The effect of precipitation amount in months VI – VIII in 1990 on the occurrence of blackened tips

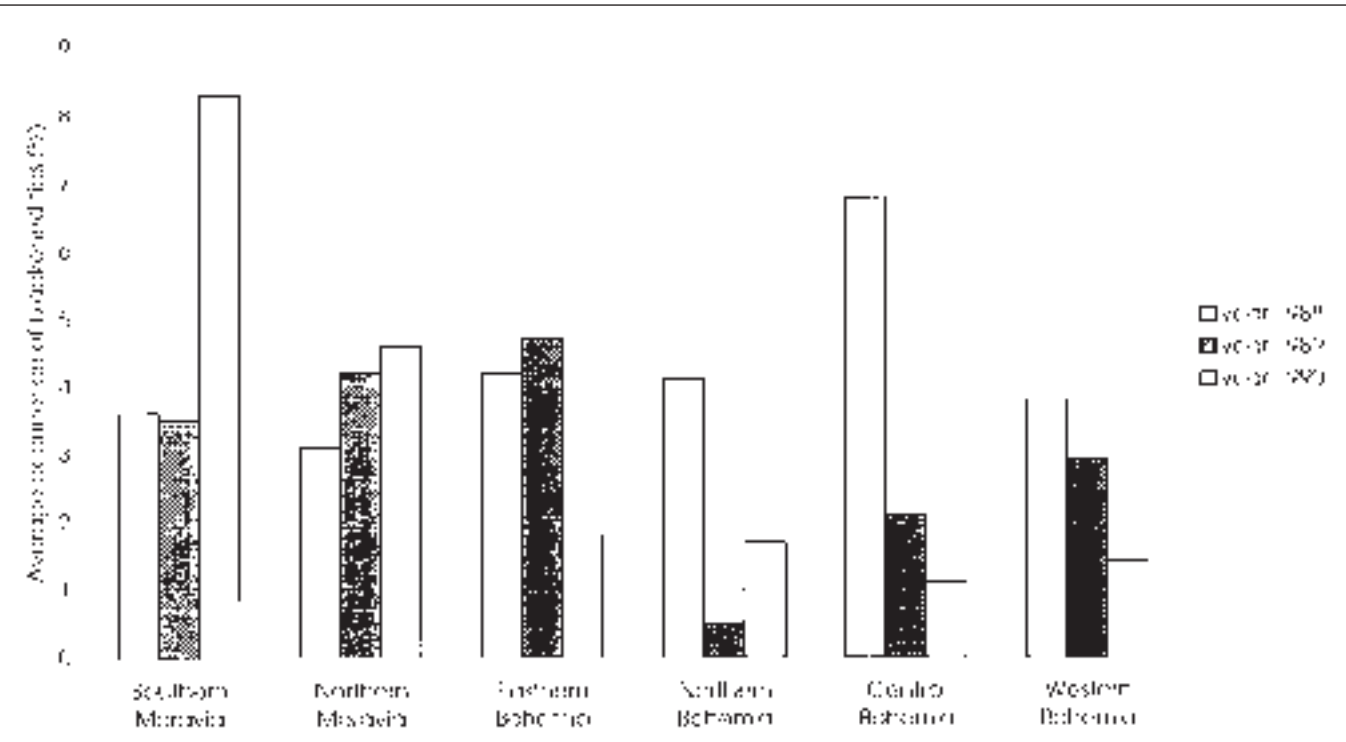

Fig. 7 Average occurrence of blackened tips (in the companies of malting barley production system in 1988 – 1990)

third of the total area of previous crops, the occurrence of blackened tips was 3,89%. When using sugar beet as previous crop which comprised 63% of the area of previous crops, the occurrence of blackened tips was 3,68%. Even in 1989, sugar beet was used as previous crop (72%) and the occurrence of blackened tips amounted to 3,53%. Winter wheat was used on 10% and the barley following it showed 4,37% of blackened tips. In 1990 and after sugar beet used as previous crop (66%) for the barley that followed, the occurrence of blackened tips amounted to 5,01%. The highest percentage of blackened tips was found in southern Moravia, where sugar beet was used as previous crop for 82% of barley area where the percentage of the occurrence of blackened

Table 2 The occurrence of blackened tips of malting barley varieties from the havest in 1988

Region	Extent	Rubín	Perun	Jaspis	Bonus	Krystal	Kredit	Korál	Orbit	Total ha monitored in the region Average occurrence of blackened tips
SM	1 ha	1373.02	526.88	825.50	670.95	183.70		5.00	6.39	3591.44
	2 % of area	37.96	14.57	22.82	18.55	5.08		0.14	0.18	
	3 % black. tips	3.19	5.09	3.02	4.11	3.05		2.07	2.21	3.56
NM	1 ha	892.46	88.52	225.88	718.13	61.00	90.00	228.47	84.56	2389.02
	2 % of area	37.46	3.71	9.47	30.10	2.56	3.77	9.58	3.54	
	3 % black. tips	2.95	4.38	2.51	3.59	2.98	2.66	2.46	2.72	3.09
EB	1 ha	240.62			161.60					402.22
	2 % of area	59.70			40.30					
	3 % black. tips	4.12			4.33					4.20
NB	1 ha	82.00			30.00					112.00
	2 % of area	73.21			26.79					
	3 % black. tips	4.16			3.94					4.10
CB	1 ha	220.00			165.00	250.00				635.00
	2 % of area	34.65			25.98	39.37				
	3 % black. tips	6.82			8.15	5,95				6.82
WB	1 ha			100.00	70.00	369.00				539.00
	2 % of area			18.55	12.98	68.47				
	3 % black. tips			3.82	4.55	3.74				3.83
MBPS	Total ha	2808.10	615.40	1151.38	1815.68	863.70	90.00	233.47	90.95	7668.68
	Variety ratio (%)	36.49	8.00	14.96	23.60	11.22	3.77	3.03	1.18	
	ø black. tips (%)	3.51	4.99	2.99	4.31	4.18	2.66	2.54	2.68	3.76

SM = Southern Moravia, NM = Northern Moravia, EB = Eastern Bohemia, NB = Northern Bohemia, CB = Central Bohemia, WB = Western Bohemia, MBPS = Malting barley production system = total for monitored agricultural farms.
1 – Variety crop area in hectars, 2 – Percentage of total area in the region, 3 – Percentage of the occurrence of blackened tips in the variety samples

tips amounted to 8,53%, while where winter wheat was used the percentage was only 3,3%. In southern Moravia, even good influence of sugar beet as previous crop was suppressed by weather conditions.

In our research different susceptibility of evaluated malting barley varieties to the occurrence of blackened tips was found (Tables 2, 3, 4). From the variety collection which was evaluated the varieties Perun as well as Bonus showed the biggest susceptibility to the occurrence of blackened tips. The variety Jaspis resulted to be resistant against it. These pieces of knowledge should be used for monitoring the susceptibility also for variety tests for the registration of new varieties.

A higher content of nitrogen in the soil (Nmin) and higher usage of nitrogenous fertilizers increased the occurrence of blackened tips. But, in the collection, an excessive usage of nitrogenous fertilizers was not applied, since two thirds of barley tracts of land followed sugar beet when no fertilizing is applied or, very small amounts of nitrogenous fertilizers are used. In spite of this, this relation was confirmed by even more blackening of the grains at an increased content of nitrogenous compounds and this is mostly conditional on higher fertilizing by nitrogen.

The discoloration was reduced by the presence of a higher content of phosphorus in the soil as well as when increased fertilizing by phosphorus was applied. Similar results were obtained when a higher content of magnesium in the soil was present. By contrast, a higher content of potassium and its application by fertilizing increased the occurrence of coloration.

In case of leaf disease widely spread, such as powdery mildew (*Blumeria graminis*), net blotch (*Pyrenophora teres*) and scald (*Rhynchosporium secalis*), a trend to greater occurrence of blackened tips was observed which can be connected with total enfeebling of the plants in consequence of high attack rate by leaf diseases and decreasing of their overall ability to face the attack of microorganisms contributing to the blackening of the tips on barley grains.

The influence of lodging on higher percentage of grain blackening had already been known in the past. However, the relation of lodging rate and lodging time was proved, when heavy and premature lodging caused a higher occurrence of blackened tips.

4 Discussion

The results quite convincingly show the influence of each year and relevant course of weather or precipitation amount and relative humidity on the occurrence of blackened tips as the case may be as a concrete criterion of biological damage. This we can support by the results from the regions of the Czech Republic when particularly in 1990, in consequence of excessive precipitation amount at the time of caryopsis formation and maturation in southern Moravia, the percentage of blackened tips was very high

Table 3 The occurrence of blackened tips of malting barley varieties from the harvest in 1989

Region	Extent	Rubín	Perun	Bonus	Orbit	Novum	Krystal	Jaspis	Profit	Malvaz	Jarek	Total ha monitored in the region Average occurrence of blackened tips
SM	1 ha	1121.57	792.29	896.11	34.45	319.78	108.00	434.05	37.46	48.69		3917.48
	2 % of area	28.63	20.22	22.87	0.88	8.16	2.76	11.08	0.96	1.24		
	3 % black. tips	3.32	4.18	3.54	3.47	3.34	4.52	2.68	3.03	2.33		3.48
NM	1 ha	742.61	648.22	320.91	207.90	105.32		140.87		25.77		2191.60
	2 % of area	33.88	29.58	14.64	9.49	4.81		6.43		1.18		
	3 % black. tips	4.38	4.93	3.84	3.26	3.31		2.98		2.99		4.20
EB	1 ha	287.91	121.32	157.00					52.96	24.00	17.00	660.17
	2 % of area	43.61	18.38	23.78					8.02	3.64	2.58	
	3 % black. tips	4.25	4.96	5.21					5.01	4.90	4.32	4.70
NB	1 ha	89.00		57.00			50.00					196.00
	2 % of area	45.41		29.08			25.51					
	3 % black. tips	0.34		0.68			0.75					0.54
CB	1 ha	305.56										305.56
	2 % of area	100.00										
	3 % black. tips	2.02										2.02
WB	1 ha		58.25	54.59	54.87	44.41	168.29	71.98				509.30
	2 % of area		11.44	10.72	10.77	8.72	33.04	14.13				
	3 % black. tips		3.45	3.51	2.43	2.88	3.06	2.51				2.97
MBPS	Total ha	2546.65	1620.08	1485.61	297.22	469.51	326.29	646.90	90.40	98.46	17.00	7780.10
	Variety ratio (%)	32.73	20.82	19.09	3.82	6.03	4.19	8.31	1.16	1.27	0.22	
	ø black. tips (%)	3.47	4.51	3.67	3.13	3.29	3.19	2.73	4.19	3.13	4.32	3.61

SM = Southern Moravia, NM = Northern Moravia, EB = Eastern Bohemia, NB = Northern Bohemia, CB = Central Bohemia, WB = Western Bohemia, MBPS = Malting barley production system = total for monitored agricultural farms.
1 – Variety crop area in hectars, 2 – Percentage of total area in the region, 3 – Percentage of the occurrence of blackened tips in the variety samples

(*Capouchová*, 1996). This problem was further studied by *Polák* and *Mokrý* (1992) who studied the occurrence of blackened tips from 20 variety stations of The Central Institute for Supervising and Testing in Agriculture (CISTA) and they confirmed the decisive influence of the course of precipitations and atmospheric humidity as well. This all in total confirms that the weather factor is decisive and more influential than the other ecological and growing factor that we evaluated. Only the variety susceptibility must be emphasized since it was proved that the susceptibility of a variety to blackened tips is kept under benign as well as bad course of weather for the appearance of this kind of damage, as it is obvious from Tables 2 – 4, especially for variety Perun in particular regions. The variety differences are also mentioned by other authors (*Miles* et al., 1987).

For updating data concerning the susceptibility of the varieties, we obtained the data from last years. For example, in 1997, totally 2787 barley samples were evaluated and an average percentage of blackend tips of 2,83% was found . Above this average, a higher percentage of blackened tips was found for varieties Amulet, 3,72%; Krona, 3,14%; Akcent, 2,92%. In case of othermalting barley varieties being purchased – Rubín, Olbram,Kompakt, Novum, Forum, Jubilant – the percentage of blackened tips was between 2,13 and 2,80%. In 1998, we examined the occurrence of blackened tips in Central Bohemia for purchased malting barley varieties. The average percentage from 250 samples was 5,66%. Above this average, a higher percentage of blackened tips was found for varieties Akcent , 7,4%; Amulet, 5,95% and Olbram, 8,2%. It is necessary to point out that in June 1998, there were 14 rainy days with a total precipitation amount of 66,8 mm and, in July there were even 20 rainy days with an abnormal total precipitation amount of 89 mm. All samples with a high percentage of blackened tips also showed high contents of nitrogenous compounds in the grains, but their germinating capacity was not influenced.

The influence of some agroecological factors on grain discoloration is interpreted by some authors as reflection of stress. This can happen in case of the influence of acid soils on the formation of blackened tips. In addition to this, aluminium ions can also play an important role. A stronger grain discoloration can be observed on heavier soils (*Votruba* et al., 1991).

The consequences of plant stress can be also seen in case of the damage of plant nutrition. We found certain negative relations of a higher content of nitrogen and potassium as well as higher doses of nitrogenous and potassic fertilizers. By interaction of both elements or under conditions of low pH value of soil yet, the negative influence was stronger. In reverse the percentage of grain discoloration was reducing at a higher content of phosphorus and magnesium or by more fertilizing with phosphatic fertilizers. This are phenomena that are known also in case of the effect on health of plants and on quality parametres of malting barley (*Bezděk*, 1992). The same author intimately studied the relation of barley

Table 4 The occurence of blackened tips of malting barley varieties from the harvest in 1990

Region	Extent	Rubín	Perun	Bonus	Orbit	Novum	Krystal	Jaspis	Malvaz	Kredit	Jarek	Total ha monitored in the region Average occurence of blackened tips
SM	1 ha	980.91	505.46	65.49		165.40		125.42	53.00			1895.68
	2 % of area	51.74	26.66	3.45		8.73		6.61	2.80			
	3 % black. tips	6.61	13.93	4.63		6.17		4.41	6.10			8.30
NM	1 ha	191.43	46.18	33.50	35.00	43.20				42.00		391.31
	2 % of area	48.92	11.80	8.56	8.94	11.04				10.73		
	3 % black. tips	4.52	3.50	6.60	3.40	3.00				7.00		4.58
EB	1 ha	337.12	63.22	71.00		81.30			158.20			710.84
	2 % of area	47.42	8.89	9.99		11.44			22.26			
	3 % black. tips	1.14	3.90	3.20		1.95		1.50				1.76
NB	1 ha	62.80		75.42				16.60				154.82
	2 % of area	40.56		48.71				10.72				
	3 % black. tips	2.22		1.43				1.00				1.70
CB	1 ha	382.40	534.40					47.10	49.18		89.30	1102.38
	2 of area	34.69	48.48					4.27	4.46		8.10	
	3 % black. tips	0.80	1.48					0.50	0.40		0.50	1.07
WB	1 ha		54.00	201.50	133.15	46.30	216.40	54.00	105.62			810.97
	2 % of area		6.66	24.85	16.42	5.71	26.68	6.66	13.02			
	3 % black. tips		0.40	0.80	1.70	2.20	1.90	1.80	0.70			1.35
MBPS	Total ha	1954.66	1203.26	446.91	168.15	336.20	216.40	243.12	366.00	42.00	89.30	5066.00
	Variety ratio (%)	38.58	23.75	8.82	3.32	6.64	4.27	4.80	7.22	0.83	1.76	
	ø black. tips (%)	4.18	6.87	2.28	2.05	4.20	1.90	2.84	1.79	7.00	0.50	4.21

SM = Southern Moravia, NM = Northern Moravia, EB = Eastern Bohemia, NB = Northern Bohemia, CB = Central Bohemia, WB = Western Bohemia, MBPS = Malting barley production system = total for monitored agricultural farms.
1 – Variety crop area in hectars, 2 – Percentage of total area in the region, 3 – Percentage of the occurrence of blackened tips in the variety samples

nutrition to the occurrence of blackened tips and confirmed the above mentioned information and he even enlarged them by the role of microelements, such as positive effects of copper, molybdenum and zinc on reducing the occurrence of studied discoloration. From his conclusions it comes out that an unbalanced availability of nutrients results in a higher intensity of barley grain discoloration.

As the main cause of so called biological damage of barley grains as well as the occurrence of blackened tips is considered the presence of pathogens in interaction with weather conditions. The presence of fungal and bacterial pathogens on the grains also causes problems during malting, it is even concluded that the presence of certain pathogens on the grains may be the case of beer foaming over – gushing (*Kosař*, 1981).

The negative influence of pathogens was proved by many authors (*Andersen* et al., 1967; *Amaha* et al., 1973; *Gorlenko*, 1963 and others). Therefore, it was possible to presuppose that a higher attack rate of growth by diseases will result in a higher percentage of blackened tips. This has been confirmed in our work.

In connexion with this, proposals to resolve the question of limitation of blackened tips also by using fungicides have been made. In monitored collections, the seed used was pickled and on the growths fungicides during growing season were also applied, for all that, the measures taken did not eliminate the occurrence of blackened tips (e.g. a high percentage of blackened tips in southern Moravia in 1990 due to weather course). At present time, new agents are available on the market and, during trials for example with a new fungicide Amistar, the percentage decrease of blackened tips was reached (*Vokřál*, 1998).

5 Zusammenfassung

Petr., J., und Capouchová, I.: Ursachen für das Auftreten von Kornverfärbungen der Braugerste — Monatsschrift für Brauwissenschaft 54. Nr. 5/6, 104 – 113, 2001

BC 11 Gerste

Die Kornverfärbung bei Braugerste zeigt einen gewissen Mangel und kann das Risiko einer negativen Auswirkung auf die Malz- und Bierqualität mit sich bringen. Der entscheidende Faktor für das Auftreten von Kornverfärbung bei Braugerste ist das Regenwetter in der Zeit der Schalfruchtbildung und Reifung, d.h. 20 Tage nach dem Ährenschieben bis zur Ernte. Die stärkste Einwirkung wurde innerhalb des Zeitraums von 30 – 40 Tagen nach dem Ährenschieben der Gerste festgestellt. Sogar hohe Ausfällungen sind nicht so gefährlich wie geringere, aber häufig über einen längeren Zeitraum auftretende Mengen von Ausfällungen. Der Wetterfaktor ist im angegebenen Zeitraum ebenso entscheidend und übersteigt die Auswirkungen anderer ökologischer und wachstumsbezogener Faktoren. Die Daten über Ausfällungsverlauf und relative Feuchtigkeit 15 bis 40 Tage vor der Ernte, könnten der möglichen Vorhersage für das Auftreten von Kornverfärbung der Braugerste dienen. Die unterschiedliche Anfälligkeit je nach Braugerstensorte für Braunspitzigkeit

wurde festgestellt. Diese sortenspezifische Anfälligkeit sollte während der Züchtung und Beurteilung neuer Sommerbraugerstensorten überwacht werden. Die Einwirkung gewisser Faktoren, welche das Auftreten dieser Art von Schaden beeinflussen, kann als Widerspiegelung der Pflanzenbelastung ausgelegt werden. Zu diesen Faktoren können ein geringer pH-Wert des Bodens zählen (die Auswirkung von saurem Boden), ein Aluminiumionengehalt und die Wirkung schwerer Böden. Einen ähnlichen Effekt hatte der Schaden aufgrund der Nahrung der Pflanzen, z.B. ein hoher Stickstoffgehalt im Boden oder starke Düngung mit Stickstoff und Kalium. Andererseits war die Wirkung von Phosphor, Magnesium und einigen Spurenelementen (Cu, Mo, Zn) positiv. Das Vorhandensein von Pathogenen, jedoch in einem Zusammenspiel mit einem schlechten Wetterverlauf in der Zeit des Ährenschiebens und der Reifung, wird als Hauptgrund für die biologische Schädigung von Gerstenkörnern erachtet. Der gesundheitliche Zustand der Pflanzen trägt ebenfalls zur Schädigung der Gerstenkörner bei, wenn der Befall der Pflanzen mit Mehltau (Blumeria graminis), Fleckenkrankheit (Helmithosporium teres) und Braunfleckigkeit (Rhynchosporium secalis) wohl eine Schwächung der Pflanzen hervorgerufen hat, und der Anteil der geschädigten Körner sich erhöht. Beim überwachten Bewuchs wurde mit Fungiziden vorbehandeltes Saatgut verwendet, und die Vegetation wurde mindestens einmal gegen Krankheiten behandelt, aber auch diese Vorgehensweise schützte den Bewuchs nicht vor dem Auftreten mehrerer Arten von Kornverfärbung. Ferner zeigten einzelne Versuche der Behandlung mit verschiedenen Arten von Fungiziden keine offensichtlich positiven Ergebnisse. Aber die schwarz verfärbten Spitzen der Gerstenkörner müssen nicht in jeder Hinsicht die Träger pilzartiger und bakterieller Pathogene sein, welche das sogenannte „gushing“ – das Überschäumen des Bieres – hervorrufen.

Petr., J., et Capouchová, I.: Causes pour l’apparition de la coloration de l’orge de brasserie — Monatsschrift für Brauwissenschaft 54. No. 5/6, 104 – 113, 2001

BC 11 Orge

La coloration noire de la pointe des orges de brasserie est due à certaines carences et peut amener le risque sur une répercussion négative sur la qualité du malt et de la bière. Le facteur déterminant de l’apparition de la coloration noire des pointes de l’orge de brasserie est le temps pluvieux pendant la durée de la formation des glumelles et pendant le mûrissement, c’est-à-dire 20 jours après l’épiage jusqu’à la récolte. La plus forte influence etait observée dans la période de 20 – 40 jours après l’épiage de l’orge. Des précipitations importantes sont moins dangereuses que de petites précipitations, mais des précipitations sur une longue période sont négatives. Le facteur temps (climat) dans la période indiquée est considéré comme décisif et prédominant sur les effets écologiques et la croissance. Les dates de précipitations et le taux d’humidité relative de 15 à 40 jours avant la récolte peut servir de prédiction sur l’apparition de coloration des grains d’orge de brasserie. L’influence variétale de l’orge de brasserie sur la coloration noire des pointes a été observée. Cette influence variétale devrait être mentionnée pendant l’élaboration et l’évaluation de nouvelles variétés d’orge. L’influence d’autres facteurs influençant l’apparition de ce type de dommages peut être interprété comme une réaction de stress de la plante. Ces facteurs peuvent être un pH bas du sol (l’effet de l’acidité du sol), teneur en ions aluminium et effet de métaux lourds. Un effet similaire du dommage était du à la nutrition de la plante, par exemple une teneur élevée en azote dans le sol ou un apport élevé en azote et en potassium. D’autre part, l’influence du phosphore, magnésium et de quelques oligo-éléments (Co, Mo, Zn) était positif. La présence de pathogènes en liaison avec le mauvais temps pendant la formation du caryopse et la maturation sont considérées comme étant la cause majeure des dommages biologiques du grain d’orge. Les conditions sanitaires de la végétation contribuent également à la détérioration des grains d’orges en particulier lorsqu’il y a un affaiblissement de la plante et une augmentation du pourcentage de grains endommagés causé par le mildiou (*Blumeria graminis*), les tâches brunes (*Helmithosporium teres*), les tâches livides (*Rhynchosporium secalis*). Pour contrôler la végétation, des semences acidifiées ont été utilisées et la végétation etait équivalente après un traitement contre les maladies. Toutefois, ce type de procédure ne protège pas la végétation contre la coloration des plantes. De Plus, un traitement individuel par le biais de différents types de fongicides ne montrait pas de résultats positifs et significatifs. Toutefois des pointes noires des grains d’orge ne doivent pas toujours être porteurs de pathogènes fongiques ou bactériens causant le gushing – le giclage de la bière.

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