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CENTRAL INTELLIGENCE AGENCY      50X1-HUM

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COUNTRY	Poland	REPORT	[REDACTED]	50X1-HUM
SUBJECT	Research Concerned with Disease of Barley	DATE DISTR.	9 Apr. 63	
		NO. PAGES	1	
		REFERENCES		
DATE OF INFO.	[REDACTED]			50X1-HUM
PLACE & DATE ACQ.	[REDACTED]			

THIS IS UNEVALUATED INFORMATION

[REDACTED] an annual report of a Polish research project entitled "Sources of Resistance to Loose Smut in Barley and Identifying Genes for Resistance." The project is being conducted at the Cereals Department, Plant Breeding and Acclimatization Institute located in Cracow and is under the direction of Dr Tadeusz Reubenbauer.

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1. Title page.

1. Name and address of reporting institution: Plant Breeding and Acclimatization Institute, Cereals Department, Cracow, Wróblewskiego 5.
2. Name of principal investigator: Professor Dr. Tadeusz Ruebenbauer.
3. Project title: Finding sources of resistance to loose smut in barley and identifying genes for resistance.
4. Project number: E-21-CR-18.
5. Grant number: FG-PG-129-61.
6. Dates of research period covered by report: From 1.I to 31.XII. 1962.

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**CONFIDENTIAL****II. Summary.**

The aim of this work is to find, in various varieties of spring barley, genes causing the resistance to 2 groups of physiologic races of loose smut in barley occurring in Poland.

52 various cross combinations were made in order to find linkages between morphological characters of plants and their resistance to loose smut. Among these combinations the most part was new, but some of them were the replications of these crosses of 1961, which yielded too little hybrid grain.

The plants of the  $F_1$  generation were not infected to investigate exactly the inheritance of morphological characters of these barley varieties, which were used for crosses.

For this purpose a thoroughly description of hybrid material was carried out and therefore the occurrence of some characters, not following strictly the laws of heredity, was observed.

This hybrid material will be then investigated.

Collaterally to the above mentioned work, the detailed description of the barley varieties, obtained from the USA, was carried out. to examine accurately the material, which will be used for crossing, in order to determine the VI and VII linkage groups.

Since the obtained samples were very small, this material was only increased in 1962.

During the flowering time of barley the infection of these varieties was carried out, which resistance to both groups of races of loose smut occurring in Poland, is hitherto unknown.

At the same time we are trying the simultaneous crossing and infecting the plants. If the results of this procedure are positive, we shall be able to test the resistance of loose smut as early as in the  $F_1$  generation.

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III. Detailed report.**CONFIDENTIAL**1. Introduction.

Many scientists were trying to solve the problem of inheritance of resistance to loose smut in barley. This resistance, according to variety, may be conditioned by one or two pairs of independent genetic factors dominant or recessive.

Zeiner /17/ stated that resistance of varieties Blaue Neckte and Walpersii /except one cross/ depends on single gene, which was impossible to determine whether it was dominant or recessive.

In the highly susceptible cross: Walpersii x Heils Franken the resistance to loose smut was conditioned by two factors.

The resistance of variety Valentine to race marked by Vr was conditioned by single dominant gene marked by Un<sub>1</sub> /1,2/. This variety was susceptible to race Vs. Dominant genes Un<sub>2</sub> in Trebi variety and Un<sub>3</sub> in Jet variety caused the highest resistance /5,6,12,14/. Dominant homozygous genes Un<sub>4</sub> in Dorsett variety and Un<sub>5</sub> in line X-173-10-5-6-1. conditions the resistance within the limits of 13-43 per cent, the same heterozygous genes cause the greater resistance within the limits of 55-65 per cent.

There are the possibility of linkage between genes Un<sub>3</sub> and Un<sub>4</sub>, which occurred in varieties Jet and Dorsett /4, 12/. The gene Un<sub>4</sub> belongs to the VI linkage group /7/.

The resistance of Jet variety to race Tr was conditioned by single dominant factor Un<sub>6</sub> /5,14/, or by two factors /8/.

The resistance of Anoldium variety to race Tr is caused by recessive gene un<sub>7</sub>, and to race Vc by dominant gene, probably Un<sub>7</sub> /1,2, 16/. Moreover other dominant genes for resistance to loose smut are known, but have not yet been determined e.g. in Ogaliteu variety - 1 dominant gene /16/, in Abyssinian variety - 2 dominant genes, in Valki variety - 1 dominant gene /5/.

The morphological characters are inherited independently from the susceptibility to loose smut /10, 12/.

Nevertheless, according to Shends /12/ there is a connection between resistance to loose smut and resistance to rust in selected barley H-47-26 and according to Vavilov the resistance to Helminthosporium gramineum.

2. Experimental procedures.

The crossing procedure was as follows: the lemma was incised along central veins with a scalpel. Through this fissure the anthers were removed /castration/ or slipped in /pollination/. In many-rowed barley the side spikelets were removed. The awns were not removed neither in 2-rowed nor in many-rowed barleys in order not to disturb the biologic balance of crossed plants. The crossed

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spikes were isolated with ~~CONFIDENTIAL~~ <sup>CONFIDENTIAL</sup> The plants were infected through similar lemma fissure as made for crossing, where the smut spores were put on the stigmas with thin brush.

15 spikes of each variety were infected to obtain the highest possible number of infected grains, which made possible the exact estimation of investigated varieties.

The above mentioned method of infection is primitive and very laborious indeed, but very reliable. The percentage of smutted plants, caused by this method of infection in our previous work on identification of the races of loose smut, reached even 99.2.

The threshing of investigated material was carried out in December 1962, because it is known from literature data as well as from own practice that the earlier threshed seeds are characterized by lower germination power.

The description of morphological characters during the vegetative season as well as in laboratory was carried out as follows:

- a. the values of following characters: rachis internode length, plant height, number of normal developed stems are given as an average of 5 measurements.
- b. the infection with Powdery Mildew was determined by 4- degree scale: 0 - no infection, 1 - weak, 2 - moderate, 3 - strong infection.
- c. the infection of rust occurred sporadically, therefore its intensity was not given.

The investigated material was strictly selected before the description of morphological characters began, in order to remove the plant derived from selfing.

Immediately after threshing the not infected grain was sown in the glasshouse in order to examine whether and when the heading should occur. The aim of investigating this problem is to grow two generations within a year, and by this means to accelerate the research course.

3. Results. The obtained results are showed in tables I, II and III. Morphological description of the varieties obtained from the USA in 1962 is not enclosed, since this material is well known there. The results concerning the possibility of simultaneous crossing and infecting the barley plants as well as the data concerning the susceptibility of these parental varieties to loose smut, which resistance to this pathogen is unknown, will have been given next year on account of biennial life cycle of the fungus.

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#### 4. Discussion.

The number of obtained grain from the 52 cross combinations carried out in 1962 is given in table I. The cross combinations, which yielded too little grain i.e. 3, 5, 9, 20, 32, 44, 52 and 56 will be replicated next year.

The unsatisfactory seed setting was caused, in some instances, through late flowering of the pollen parents e.g. Zeocrithon - at 28.VI, Hordeum hexastichon album monstrosum - at 1.VII, Werribee 6-rowed at 27.VI, in comparison with the seed parents, which were ready for emasculation as early as 20.VI.

This inconvenience will be improved in current year by duly adjusted sowing terms.

The description of morphological characters of the F<sub>1</sub> generation of the crosses carried out in 1961 is given in table II.

In order to examine accurately the morphological characters of the parental varieties, this hybrid material could not be infected / as a result of infection with loose smut the spikes of barley are heavy damaged, therefore the determination of their characters is impossible/.

This assumption seems to be right, since in some cross combinations certain characters occurred/marked in table II by x/, which do not follow accurately the laws of heredity.

In order to explain this problem these characters will be investigated again. To provide the better illustration of inheritance of studied characters, the morphological description of parental varieties is given in table III.

5. Conclusions. On the base of the exact analysis of the I-st hybrid generation it was stated that some characters were irregularly inherited. This phenomenon occurred most often in these cross combinations, where the variety OAC 21 was used as seed parent, and in two instances, where other two many-rowed varieties/ Walperail and Atlas/ were used for this purpose. It is difficult to decide what genetic factor conditions such a phenomenon, until it is exactly investigated.

#### 6. Plan for future work.

- a. Replication of these cross combinations, which yielded too little grain in 1962.
- b. Replication of these cross combinations, where in the F<sub>1</sub> generation the irregularly inherited characters occurred.
- c. Making new crosses with the american varieties in order to determine the VI and VII linkage groups.

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- d. Replicating to test the susceptibility to loose smut of parental varieties, in which this character is hitherto unknown. Replicating the trial on possibility of simultaneous crossing and infecting the barley plants. These replications are necessary with respect to the influence of climatic conditions on the infection results in particular years, what was observed in our work on identification of groups of physiologic races of loose smut
- e. Investigating the susceptibility to loose smut of the varieties obtained from the USA.
- f. Infecting with loose smut the plants of the F<sub>1</sub> generation of crosses carried out in 1962.

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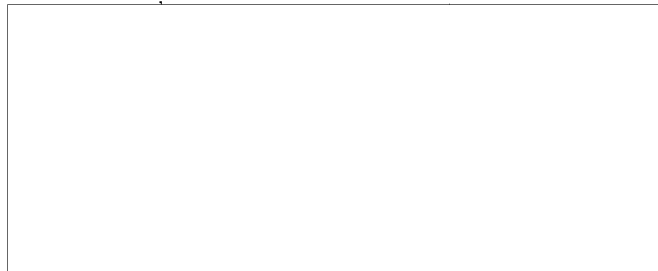
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enclosures: tables I, II, III.



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Morphological description of the F<sub>2</sub> generation of the crosses carried out in 1961

Number of cross	Parental varieties	Resistances		Cover-colour		Type of rachis		Number of spikelets	Spike type	Spike colour	Rachis brittle or stout
		to R II	to R IV	ed or naked	of lemma	la	B				
1	2	3	4	5	6	7	8	9	10	11	12
1.	OAC 21 x Karlsberg II	149.3	189.3	cover. white	a	rough	4.0	2-row /x side spike- lets well developed	mutans	white	v. brittle /x
2.	OAC 21 x Boryna	149.3	189.3	fair	a	"	3.4	2-row	"	fair	stout
3.	OAC 21 x R 612	149.3	189.3	white	a	"	4.0	2-row as Rr 1/x	"	white	brittle /x
4.	OAC 21 x Rajski	142.6	185.2	yellow	a	"	4.3	2-row as Rr 1/x	"	yellow	brittle /x
5.	OAC 21 x Gladys	172.9	198.4	white	a	"	3.9	2-row as Rr 1/x	"	fair	v. brittle /x
6.	OAC 21 x Atlas	138.0	162.2	yellow	c	"	4.0	4-row rectan- gular	"	yellow	stout
7.	OAC 21 x Nigrum 10345 from Manchuria	149.3	189.3	black	a	very rough	4.3	4-row	"	black	"
8.	OAC 21 x H.nativ. macrolepis nigrum	149.3	189.3	"	c	rough	3.7	2-row	mutans	black	brittle /x
9.	OAC 21 x H.nativ. furcatus distichum nigrum	149.3	189.3	ashy	c	"	4.1	"	loose	ashy	" /x
10.	Walpersii x Karlsberg II	149.3	189.3	white	a	smooth	3.9	"	mutans	white	stout
12.	Walpersii x R 612	149.3	189.3	"	a	rough	4.1	"	"	fair	brittle /x
19a	Karlsberg II x Violaceum barley from Persival	149.3	189.3	black violaceous	a	"	3.9	"	"	black	stout
19b	Karlsberg II x Black barley from Persival	149.3	189.3	black	a	"	4.0	"	"	black	"
20a	Karlsberg II x H.nativ. macro- lepis nigrum	149.3	189.3	"	a	"	4.1	"	"	"	"
20b	Karlsberg II x H.distichum, cro- lepis nigrum	149.3	189.3	"	a	"	4.0	"	"	"	"
21.	Karlsberg II x H.nativ. furcatus distichum nigrum	149.3	189.3	ashy	a	smooth	4.7	"	loose	ashy	stout
22.	Boryna x H.nativ. macro- lepis nigrum	149.3	189.3	black	a	rough	3.7	"	mutans	black	"
23.	Boryna x H.nativ. furcatus distichum nigrum	149.3	189.3	ashy	a	smooth	3.1	"	loose	ashy	"
24a	R 612 x H.nativ. macro- lepis nigrum	149.3	189.3	black	a	rough	3.9	"	mutans	black	"
24b	R 612 x H.dist. macro- lepis nigrum	149.3	189.3	"	a	"	3.6	"	"	black	"
25.	R 612 x H.nativ. furc. dist. nigrum	149.3	189.3	ashy	c	smooth	4.1	"	loose	ashy	"
26.	Rajski x H.nativ. macro- lepis nigrum	142.6	185.2	black	a	rough	3.9	"	mutans	black	"
28a	Gladys x H.nativ. macro- lepis nigrum	172.9	198.4	black	a	"	4.1	"	"	"	"
28b	Gladys x H.distichum, macro- lepis nigrum	172.9	198.4	"	a	"	4.4	"	"	"	"
31.	Gramus x H.nativ. furc. dist. nigrum	149.3	189.3	ashy	c	"	4.1	"	loose	ashy	"
32a	Atlas x OAC 21	138.0	162.2	white	c	"	4.5	4-row rectan- gular	"	white	" /x
33.	Atlas x H.nativ. furc. dist. nigrum	138.0	162.2	ashy	c	"	4.1	2-row	loose	ashy	brittle
35a	Nigrum 10345 from Manchuria x H.nativ. furcatus, distich. nigrum	149.3	189.3	"	a	"	3.6	"	"	"	brittle
35b	Black barley from Persival x H.nativ. furcatus dist. nigrum	149.3	189.3	black	c	"	3.9	"	"	black	stout

- Remarks:
- The characters: rachis internode length, height of plant, number of normal developed stems are given as an average of 5 measurements.
  - The characters marked by /x. occurred unexpectedly and are not connected with the habitus of parents.
  - The infection with Powdery Mildew is determined by 4-degree scale: 0 - no infection, 1 - weak, 2 - moderate, 3 - strong infection.
  - The infection with rust occurred sporadically, therefore its intensity is not given.
  - The right side of this table ought to be put together with the left one.

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**T A B L E I**

Project number E-21-CR-18

**Threshing results of the crosses carried out in 1962.**

number of cross	number of	Seed parent	number of	Pollen parent	number of grain obtained	number of cross	number of	Seed parent	number of	Pollen parent	number of grain obtained
1	2	3	4	5	6	7	8	9	10	11	12
1.		OAC 21	3	H. sat. fureatum dist. nigrum	263	444	41	Browarny / K	11	H. nigrum 10345 from Manchuria	27
2.		"	8	Ineras	36	46.		"	40	Gladyss	66
3.	21	"	16	Zecorithon	21	48.		Gladyss	4	H. trifurcatum nigrescens	173
4.		"	69	Hajski	52	49.		"	9	Silasia 6-row	88
5.		"	40	Gladyss	12	50.		"	7	American 6-row No 166	94
6.		"	99	Atlas	248	51.		"	11	H. nigrum 10345 from Manchuria	60
7.		Walpersii	3	H. sat. fureatum dist. nigrum	64	52.	40	"	16	Zecorithon	6
8.		"	8	Ineras	73	53.		"	71	Mlochowski	278
9.	25	"	16	Zecorithon	13	54.		"	99	Atlas	66
10.		"	40	Gladyss	74	55.		Rajski	4	H. trifurcatum nigrescens	242
11.		Abed Maja	7	American 6-row No 166	103	56.		"	10	Waribos 6-row	21
12.		"	12	Black barley from Persival	79	57.		"	8	H. hexastichon album monstr.	58
13.		"	16	Zecorithon	43	58.	69	"	11	H. nigrum 10345 from Manchuria	78
14.		"	71	Mlochowski	89	59.		"	16	Zecorithon	54
15.	35	"	40	Gladyss	63.	60.		"	40	Gladyss	109
16.		"	99	Atlas	88	61.		"	99	Atlas	133
17.		Borzyna	6	H. hexastichon album monstr.	27	62.	41	Browarny / K	71	Mlochowski	58
18.		"	16	Zecorithon	7	63.	21	OAC-21	78	Ebro	42
19.	77	"	71	Mlochowski	170	64.		"	36	Karlsberg II	181
20.		Browarny 246 Pulawski	7	American 6-row No 166	123	65		Abed Maja	78	Ebro	145
21.		"	11	H. nigrum 10345 from Manchuria	48	66.	39	"	36	Karlsberg II	68
22.	67	"	40	Gladyss	243	69.		Pul. Browarny 246	78	Ebro	122
23.		Browarny 246 Pulawski	99	Atlas	141	70.	57	"	36	Karlsberg II	123
24.		"	16	Zecorithon							
25.		"	7	American 6-row No 166							
26.	36	"	12	Black barley from Persival							
27.		"	16	Zecorithon							
28.		"	40	Gladyss							
29.		"	99	Atlas							
30.					35						
31.					74						
32.					63						
33.					57						
34.					159						
35.					30						

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TABLE III.

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Morphological description of the parental varieties

No.	Variety	cover-	colour	type	veines	number	spike	rachis	type	awn	cover-	Powdery	Lodging	Rust	type	Remarks
		naked or grain	of lemma	of rachis back lat of grain	of of row	of of colour	of of colour	or stout	or of colour	or of smooth	ring	Mildew		of leaf		
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1.	OAC 21	cover	yellow	e	rough	polistich.	yellow	stout	yellow	rough	strong	3	none	0	normal	
2.	Walpersii	naked	white	a	-	"	white	"	"	"	moderate	1	"	0	"	
3.	Karlsberg II	cover	yellow	a	smooth	distich.	yellow	"	yellow	"	none	0	"	0	"	
4.	Borzyna	cover	yellow	a	smooth	"	yellow	"	yellow	"	strong	0	"	0	"	
5.	R-612	cover	yellow	a	smooth	"	yellow	"	yellow	"	"	0	"	0	"	
6.	Rajaki	naked	yellow	a	rough	"	yellow	"	yellow	"	"	2	"	0	"	
7.	Gladys	cover	yellow	a	smooth	"	yellow	"	yellow	smooth	moderate	1	"	0	"	
8.	Atlas	cover	yellow	e	rough	polistich.	yellow	"	yellow	rough	very strong	1	"	0	"	
9.	Gramm	cover	yellow	e	rough	"	yellow	"	yellow	rough	strong	1	"	0	"	
10.	H. sativum macrolepis nigrum	cover	black	e	"	distich.	black	-	ashy	"	strong	0	"	0	"	
11.	H. sativum fuscum distichon nigrum.	cover	ashy	e	smooth	"	ashy	brittle	hoods	-	strong	3	"	0	"	
12.	H. distichon macrolepis nigrum	cover	black	e	rough	"	black	?	ashy	rough	none	3	"	0	"	
13.	Nigrum 10345 from Manchuria	cover	black	a	rough	polistich	black	?	clinging white open	"	moderate	2	"	0	"	
14.	Black barley from Persival	cover	black	e	"	"	black	?	ashy open	"	"	1	"	0	"	

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Morphological description of the F<sub>2</sub> generation of the crosses carried out in 1961

Spikes		Plant								Characters determined during the vegetative period				
Type and colour of awn	awn height	awn colour	awn number	awn length	awn colour	nodes	straw	nodes	straw	covering	Powdery mildew	Lodging	Rust	type of leaf
smooth	cm.	in	of	mm.	fragile	or stout	or pithy	or stout	or hollow					
14	15	16	17	18	19	20	21	22	23	24	25			
white open	rough	119	7	fair yellow	stout	hollow	none	1	none	0	normal			
white clinging	"	108	6	yellow with	"	"	"	2	"	0	"			
white open	"	119	7	orange shade	/x	"	"	1	"	0	"			
yellow open	"	111	10	yellow	stout	"	"	1	"	0	"			
white clinging	"	116	7	yellow with	/x	orange shade	"	1	"	0	"			
dark yellow open	"	89	8	yellow	"	"	strong	0	"	0	"			
white open	"	99	4	yellow	"	"	none	0	"	0	"			
ashy open	"	113	8	yellow	"	"	imoderate	0	"	0	broad			
ashy hoods	"	110	12	ashy	"	"	none	1	"	0	normal			
white clinging	"	114	5	yellow	"	"	"	1	"	scattered	"			
yellow fragile	"	108	15	fair yellow	"	F	moderate	2	"	0	"			
yellow clinging	"	90	10	yellow	"	"	"	3	"	0	"			
ashy open	"	95	5	"	"	"	"	0	"	0	"			
ashy open	"	89	9	fair yellow	"	"	"	2	"	0	"			
ashy clinging	"	97	6	yellow	"	"	"	2	"	0	"			
long, single ashy hoods	-	95	21	yellow with orange shade	"	"	"	2	"	0	"			
ashy open	rough	93	12	yellow	"	"	strong	2	"	0	"			
white hoods	-	107	8	yellow	"	"	"	3	"	0	"			
ashy open	rough	94	11	dark yellow	"	"	"	0	"	0	"			
ashy clinging	"	96	11	yellow	"	"	"	0	"	0	"			
long ashy hoods	"	47	10	yellow	"	"	"	1	"	0	"			
ashy open	rough	106	6	dark yellow	"	"	"	0	"	0	"			
black open	"	90	8	yellow	"	"	"	0	"	0	"			
fair ashy clinging	"	92	4	yellow	"	"	none	0	"	scattered	"			
ashy hoods	-	96	4	yellow	"	"	strong	0	"	0	"			
white clinging	rough	99	6	yellow	"	"	none	2	"	0	broad			
ashy hoods	"	79	10	yellow	fragile	/x	strong	0	"	0	normal			
fair ashy single hoods	-	99	9	yellow	stout	"	imoderate	2	"	0	"			
black hoods	-	100	8	dark yellow	"	"	strong	2	"	0	"			

The left side of this table ought to be put together with the right one.

50X1-HUM



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