MODERN TECHNOLOGIES FOR STORED-GRAIN PROTECTION AGAINST INSECT-PESTS IN THE USSR

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ABSTRACT

The economic and hygienic thresholds of the insect injury have been taken as a base for the stored-grain protection against insect-pests under the USSR conditions. The modern technologies for stored-grain protection are directed to decrease grain losses from insect and pesticide pollution of grain. They include aerosol disinfestation of grain storages, insect detection in grain with special traps, an insect number prognosis, prophylactic grain treatment with insecticides, fumigation with methylbromide or phosphine and radiation disinfestation of grain. Insect control technologies using insect pheromones and juvenile hormone analogues are under developing.

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The problem of the protection of the cereals from insects is actual in the USSR.

The latest inspections in the state granaries have shown the grain damage from 26 species of insects is minimal. The 12 species were the most dangerous. They have been found in 6-45 % of grain lots. The density of the pests was often high. (Table 1).

Table 1. Store grain insects in the USSR

Insects	Number of infested grain lots, %	Average infestation density, adults/100 kg
Sitophilus oryzae	45	202
Tribolium castaneum	34	94
Psocoptera	32	-
Rhyzopertha dominica	29	161
Laemophloeus ferrugineus	23	629
Plodia interpunctella	21	-
Oryzaephilus surinamensis	20	73
Palorus subdepressus	10	24
Typhaea stercorea	8	43
Sitotroga cerealella	8	-
Ephestia sp.	8	-
Sitophilus granarius	6	27
Laemophloeus minutus	4	16
Alphitobius diaperinus	4	-
Ahasverus advena	3	12
Tribolium confusum	2	75
Cartodere filliformis	2	-
Tenebrioides mauritanicus	2	-
Blaps mortisaga	2	-
Alphitophagus bifasciatus	0,5	1
Ptinus villiger	0,2	0,2
Tribolium destructor	0,2	0,2
Ptinus sp.	0,2	0,2
Cryptophagus sp.	0,2	0,2
Dermestes lardarius	0,2	0,2
Carpophilus hemipterus	0,1	2,7

The grain weight losses increase from north (0.13 %) to south (1.75 %).

The insect infestation differences of the various grain lots and the various regions demand different approaches for the pest control organization.

As for the grain lots, the pest control is based on both the economic threshold of damage and the hygienic threshold of harmfulness of the insects.

Table 2. Pest regulation of food grain in the USSR

Pest species	Weight losses of grain, mg		Damage coef-ficient (Cd)	Economic threshold of damage, adult/kg	Hygienic threshold of harm-fulness, adult/kg	Tolerance, adult/kg multiplied by Cd (SID unit)
	Adult for day (A)	Larva for life (B)				
S. oryzae	0,38	7,6	1,0	3,0	15	15,0
Rh. dominica	0,89	7,9	1,7	1,8	5	8,5
S. granarius	0,48	13,8	1,5	2,0	5	7,5
S. cerealella	0,00	17,5	1,1	2,7	4	4,4
T. castaneum	0,16	3,6	0,4	7,5	6	2,4
O. sirunamensis	0,11	2,3	0,3	10,0	25	3,0
Acarus siro	-	-	0,05	60,0	150	3,0
Total infestation	-	-	-	-	-	**15,0**

Notes. $Cd = (Asp. : AS.o. + Bsp. : BS.o.) : 2$

Summary infestation density (SID) = Σ ($Dsp. \times Cd$).

The investigations of the dependance of the cost of the grain losses from the infestation density with S. oryzae beetles have shown that the economic threshold of S. oryzae damage was 3 adults per 1 kg of grain (Table 2). With this density the cost of the grain losses is near the fumigation cost.

The researches of the grain losses from the different insect species allowed damage coefficients (C_d) relatively to S. oryzae damage to be calculated (Table 2). Using C_d, and knowing the density of the grain infestation from every species ($D_{sp.}$), we can calculate the summary infestation density (SID) resulting from S. oryzae damage : $SID = \Sigma (D_{sp.} \times C_d)$.

The use of SID is to unify the estimation of the infestation of different grain lots with different insect species and with their various densities.

It was determined by the Soviet researches E.A. Antonovitch and N.S. Syroed that wheat grain with more than 15 S. oryzea adults per 1 kg of grain could not be used for food purposes directly because of harm to people's health by insect waste products. The density of the infestation of upto 15 S. oryzea beetles per 1 kg of grain, was determined as the hygienic threshold of this insect's harmfulness.

Analogous hygienic researches have been carried out with other main insect species. Corresponding hygienic thresholds are shown in Table 2.

On the base of both the economic and hygienic thresholds the toleranses of pests in food grain were estimated (Table 2).

The protection of the grain must prevent insect numbers from increasing to the threshold values. Therefore, it is necessary to determine the presence of insects at a low density of the infestation (less than 1 insect par 10 kg of grain).

The traditional methods of the grain sampling and sifting are not suitable. This problem is solved by the determination of the grain infestation with special traps and without sampling.

The trap is the metallic cylinder with the perforated zone of the catch and the accumulator of insects where the attractant is placed. The attractant consists of the ground wheat grain and gyps ($CaSO_4$) 1:1 w/w. The traps are inserted into the bulk grain. The density of the insect infestation is calculated from the number of the insects in the trap by using of the spécial nomograms.

After the determination of the grain infestation it is necessary to make a prognosis of the increase in insects in the grain during the further storage. The prognosis is carried out by using of the special monograms (Fig.1). The nomograms have been developed for the main insect species. Knowing the grain stotage time and the grain temperature it is possible to estimate the coefficient of increase.

If the insect numbers do not reach the threshold value before the grain is used, it is unnecessary to disinfest grain.

If the insects exeed the economic threshold of damage or particularly the hygienic threshold of harmfulness during the storage, it is necessary to carry out control measures.

In the North of the USSR cold weather sets soon after the harvesting. That is why in these regions it is possible to cool grain to stop the development of insects.

They can not cool the grain in the South of the USSR because of the long hot season. In this case, the protection is conducted with the chemical methods and with using of different insecticides.

Organophosphorus insecticides are used generally for preventive purposes.

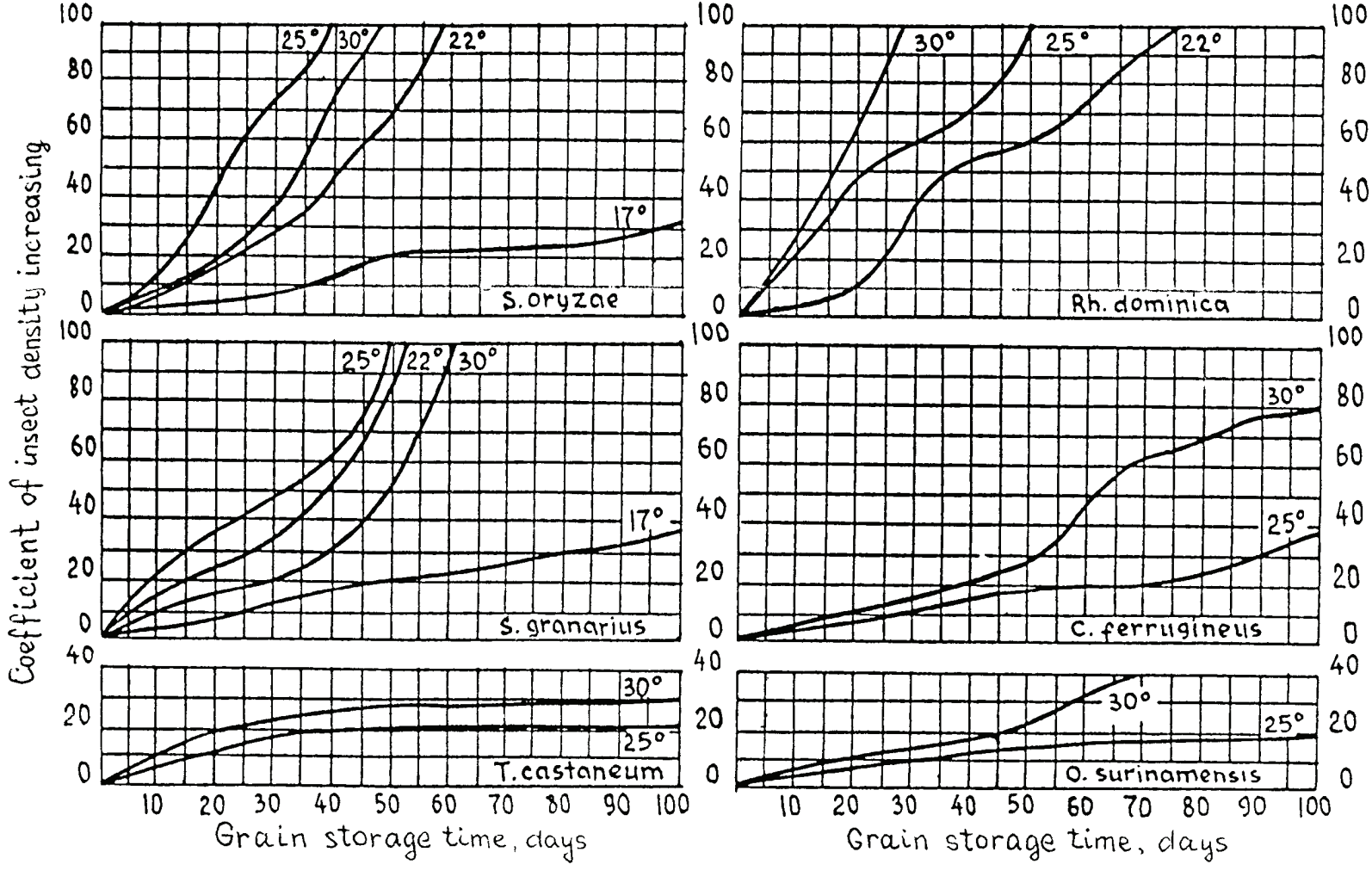

Fig. 1. Nomograms for insect prognosis in grain

Granaries are treated with insecticides before loading using an aerosol generator U1-UGT. Pulverized into drops less than 50 mkm by means of a special working head, the emulsion concentrate insecticide is spread uniformly over the treated horisontal or vertical surfaces object with the help of a heavy-duty fan.

The high capacity of the generator allows large stores to be treated in a short time. Two operators can treat a large grain elevator during 2 or 3 shifts. 10 to 15 minutes are required to process a flat storage.

Infested grain in storehouses is fumigated with methyl bromide or phosphine.

The grain delivered by water is disinfested in the industrial radiation disinfestor of grain (RDG).

In this case the grain contaminated with pests is transported with a set of transporting mechanisms to the upper bin (Fig. 2), and further to the grain transporting unit. Here it is accelerated in the special channel and passed through the irradiation zone in a thin homogeneous layer 7-9 mm thick at a velocity of 6-7 m/s. In RDG, a source of accelerated electrons, at an energy of up to 1.5 MeV, is used. The irradiation dose is a minimum of 0.2 kGy (20 krad). The radiation treated grain is passed to the lower bin and then transported to be stored at an elevator or to be loaded into railroad trucks.

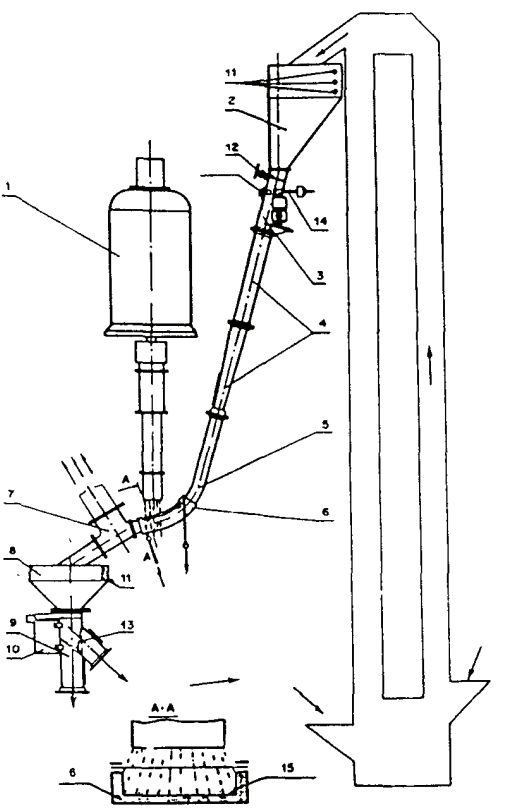

Fig 2. Functional diagram of RDG. 1—Electron accelerator; 2—upper bin; 3—grain flow distribution unit; 4—grain acceleration channel; 5—grain irradiation chamber, 6—water-cooled radiator; 7—aspiration chamber; 8—lower bin; 9—grain flow redistribution chamber, 10—device for grain level control in the low bin; 11—grain level control probes; 12—grain flow forming register; 13—regulator valve, 14—fast-action register, 15—grain flow

An industrial RDG facility was put into operation at the port elevator in Odessa in the USSR. The main components of the RDG are mounted in a tower between the elevator and the load berth of the port. The control cabinet is in a separate onestorey building. RDG has two technological lines with a total design capacity of 400 t/h.

The main researches to improve technology of pest control are aimed working at ecologically pure methods.

We attach great importance in this respect to biological active substances, which regulate growth, development and behaviour of insects. The tests of different substances are being carried out for the destruction of the insects in grain. These substances effect insects in the same way as juvenile hormones.

The researches of the sex feromones of the moths and the feromones of the insect agregation are being carried out to depress insect populations at the grain processing enterprises.

TECHNOLOGIES MODERNES DE PROTECTION DES STOCKS DE MAIS CONTRE LES RAVAGEURS EN URSS

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Résumé

Le seuil économique et hygiénique des nuisances dues aux insectes a été pris comme base de la protection contre les insectes ravageurs dans les conditions prévalant en URSS.

Les technologies modernes de protection du grain stocké visent à diminuer les pertes en les traitant comme un pollution due aux insectes et aux pesticides. Elles comprennent la désinfestation par aérosol et la détection des insectes grâce à des pièges spéciaux, ainsi que la prévision du nombre d'insectes, la prophylaxie par traitement insecticide et fumigations au bromure de méthyle et à la phosphine et, enfin, la désinfestation du grain par les radiations.

Les technologies de lutte contre les insectes par utilisation d'analogues d'hormones juvéniles et de phéromones sont encore à l'étude.