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ENCAPSULATION OF OIL SEEDS AS A SAFE SYSTEM FOR THE APPLICATION OF NON-TOXIC PLANT PROTECTION

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One of the urgent problems of the agricultural industry in Kazakhstan is the low yield of oilseeds, depending on various factors. The primary factor is the vulnerability of sunflower seeds to different phytopathogens and pests. Diseases develop during almost the entire growing season, starting from the moment of seed germination. In order to avoid mass infection, a large number of fungicides are used, which requires additional financial costs and, on the other hand, worsens the ecological state of the environment, also contradicts the principles of organic farming. In this regard, much attention of researchers is attracted by the development of new technologies for pre-sowing treatment of agricultural seeds, which provide: improving the sowing qualities of seeds, stimulating the physiological and biochemical processes of growth also development of seedlings, reducing the consumption of seed material and increasing the resistance of seedlings to pathogenic microorganisms. Encapsulation or drageeing of seeds solves the problem of their morbidity and death under adverse soil-climatic also extreme conditions of cultivation. Of particular relevance are the tasks of insecticidal and fungicidal activity of encapsulation, the solution of which would increase crop yields by including in its composition the substances necessary for active plant growth (growth regulators, microelements, drugs against fungal diseases). The high cost of the constituent components of polymer shells is noted and, accordingly, the actual problem is to find methods to reduce their cost.
This work is devoted to the selection of the optimal encapsulating composition from gelatin (G) and polyvinyl alcohol (PVA), in a combination of fungicides “Maxim” and “Kruizer” to obtain an encapsulating composition of sunflower seeds.

Keywords*: encapsulating composition of fungicidal action, gelatin, polyvinyl alcohol, seeds, germination, biometric and agrotechnical indicators.*

1. INTRODUCTION

Sunflower (*Helianthus annuus L.*) is one of the important agricultural products among vegetable oilseeds, which performs good in various climatic and soil conditions. In addition, low cholesterol and a high content of unsaturated fatty acids in sunflowers contribute to the widespread usage of the oil of this crop not only in the food industry, but also for medical purposes [1–2]. Therefore, one of the leading places in the economy of Kazakhstan is the production of sunflower and products of its processing.

Kazakhstan, like other CIS countries, is characterized by an unfavorable phytosanitary state of crop production, the widespread distribution of pests, pathogens and weeds on agricultural lands [3]. One of the main reasons for the shortage of sunflower yields is the activity of various pests due to the weediness of fields, violations of the tillage system and unfavorable phytosanitary conditions [4]. Sunflower seeds infected with pathogens and damaged by soil pests lose their germination capacity up to 60–70% [5–6]. It has been established that the decreasing in seed oil yield in the conditions of the East Kazakhstan region due to susceptibility to various phytopathogens and pests is 15–20% [7–8]. At the same time, the decrease in sunflower yield is directly proportional to the field germination of sunflower seeds.

One of the most promising and innovative technologies for protecting seeds from diseases with minimal environmental impact is the creation of a protective and stimulating polymer shell that provides protection and development at early stages of development [9–14]. The advantage of this method is that the polymer can be used to apply fungicides, growth regulators and other physiologically active compounds without much harm to the environment and human health. Science-based pre-sowing seed treatment increases the field germination of sunflower seeds, reduces the susceptibility of plants to pests and diseases [9–10], allows you to increase the number of seedlings [15–16], increases seed viability at low temperatures [13], soil permeability and aeration [11], has a positive effect on plant productivity [17].Currently relevant for usage in agricultural chemistry is the material that combines such properties as non-toxicity, complete biodegradability, fungicidal activity and environmental friendliness. Therefore, intensive research is being carried out to obtain optimal encapsulating composites that are effective at minimally low consumption rates,

while at the same time being biodegradable in natural conditions to ensure toxicological and environmental safety. These factors necessitate the production of composites based on raw materials, which can be polymers of natural origin. Such types of polymers as cellulose derivatives, starch, gelatin, alginate, chitosan, agar, etc. have found wide application [12]. The matrix of natural biopolymers does not always meet the requirements for obtaining a protective and stimulating shell for seed encapsulation [12, 18]. Sunflower sprouts were encapsulated in an alginite medium with sucrose and salicylic acid [13]. The influence of storage time and temperature on the viability of sunflower sprouts has been studied. The wheat, cabbage, basil, and radish seeds pretreated in calcium chloride solution were successfully encapsulated with sodium alginate [19]. This procedure showed that this matrix is optimal for encapsulating various nutrients. The use of a 1% solution of carboxymethyl cellulose (CMC) with a 4–10% solution of cytisine and 3–10% N-oxyquinoline found that the energy of seed germination increases by 13 and 6%, respectively [20]. Cytisine in combination with CMC increased field germination by 9%, yield – by 4 c/ha, N-hydroxy-quinoline with CMC slightly reduced these indicators. In another study, CMC in combination with gellan found an increase in field germination and planting density of sugar beets before closing, compared with control samples [16].

Biodegradable synthetic polymers include polyvinyl alcohol (PVA), due to the presence of numerous hydroxyl groups, which easily form a hydrogen bond. In addition, PVA belongs to the category of materials that are recyclable, biocompatible, non-toxic and cheap. PVA is also characterized by chemical resistance and good mechanical properties. These properties make PVA widely used for the preparation of composites with biopolymers, in particular with polysaccharides [9, 21–25]. Among the polysaccharides, gelatin is a valuable polymer for obtaining a biodegradable film due to its unique properties, incl. easy availability, biocompatibility, biodegradability, good film-forming ability, stability and flexibility [26–31]. Due to the poor solubility (thermodynamically) of gelatin, it is difficult to obtain an optimal encapsulation formulation. A good combination of gelatin with PVA has been established to obtain a homogeneous composition [32].

This work is devoted to the study of the encapsulating properties of gelatin and PVA in combination with fungicides and the study of their effect on the germination, growth and development of sunflower seeds.

2. Materials and Methods

2.1 Materials

In order to prepare the encapsulation formulation, PVA molecular weight 89,000–98,000 having a degree of hydrolysis in the range of 99+% and gelatin from cold water fish skin with a molecular weight of ~60 kDa, solubility in water 40–50% was used (Sigma-Aldrich). All reagents were used without additional purification. For encapsulation of seeds, hybrid sunflower seeds “Kazakhstan 2011 F1465” were chosen. Two fungicides widely used in the cultivation of sunflower in the East Kazakhstan region were chosen as protectants. The first of them is the fungicidal disinfectant Maxim KS (LLC, Syngenta) with the active ingredient 25 g/l fludioxonil with fungicidal and insecticidal properties (chemical class – phenylpyrroles). The second is a systemic insecticidal seed disinfectant for cereals, sunflower, rapeseed and potato tubers “Cruiser KS” (LLP, “Syngenta”) with the active ingredient 350 g/L thiamethoxam (chemical class neonicotinoids).

2.2 Method for obtaining an encapsulating composition

In order to obtain an optimal encapsulating composition, PVA with a concentration of 5% and Gelatin 0.5% concentrations were prepared in five ratios: [PVA]:[Gelatin] = 20:80, 40:60, 50:50, 60:40 and 80:20 % (vol.), respectively. Fungicides “Maxim” and “Kruizer” were taken in three concentrations of 1%, 5% and 5%. Further, depending on the volume fraction of gelatin, the ratios of polymers were designated as G20, G40, G50, G60 and G80, indicating the concentration of fungicides 1M, 5M and 10M (Maxim) and 1K, 5K and 10K (Cruiser) (table 1).

Table 1. Compositions of Gelatin/PVA blends

Code sample	Gelatin, vol.%	PVA, vol.%	Maxim (M), wt.%	Kruizer (K), wt.%
G20/1M(5M;10M)	20	80	1 (5; 10)	0
G40/1M(5M;10M)	40	60	1 (5; 10)	0
G50/1M(5M;10M)	50	50	1 (5; 10)	0
G60/1M(5M;10M)	60	40	1 (5; 10)	0
G80/1M(5M;10M)	80	20	1 (5; 10)	0
G20/1K(5K;10K)	20	80	0	1 (5; 10)
G40/1K(5K;10K)	40	60	0	1 (5; 10)
G50/1K(5K;10K)	50	50	0	1 (5; 10)
G60/1K(5K;10K)	60	40	0	1 (5; 10)
G80/1K(5K;10K)	80	20	0	1 (5; 10)

The preparation of encapsulating films was carried out according to the procedure [9].

2.3 Physical and chemical methods for studying the encapsulating composition

The viscosity of polymers was measured on Ubbelohde viscometer at 25±0.1 ºC.

IR-Fourier analysis was carried out on an FT-801 spectrometer (Russia) at a resolution of 1 cm^{-1} and a wavelength of 450–4700 cm^{-1} according to the standard method using a universal holder for solid samples of various thicknesses and films at a temperature of 25 °C.

2.4 Mycological characteristics

Mycological characteristics were determined on a monocular microscope “Micros” OVE-MG 8751/1 (Austria).

2.5 Laboratory and field tests of the encapsulating composition

The germination of encapsulated sunflower seeds under laboratory conditions was determined according to state standard (STST 12038-84) [33].

Small plot experiments were carried out on the basis of the East Kazakhstan Research Institute of Agriculture (Republic Kazakhstan) according to the methodology described in Kabdrakhmanova et al. (2018) [9–10]. Sunflower seeds were treated with encapsulating compounds G50/1K (5K, 10K) and G50/1M (5M, 10M) with polymer solutions of optimal concentrations in combination with fungicides of different concentrations (table 1). After treatment, the seeds were dried and sown in triplicate, 5 seeds in each cell. The harvesting of the experiments was carried out in 2 stages, cutting the heads, pricking them on their own shortened stem, in the phase of biological or economic seed ripeness. The economic ripeness of sunflower was determined by the ripeness of the heads – when about 10% of plants with yellow heads remained in the array and the rest with yellow-brown, brown and dry.

Phenological observation of the development of sunflower in the field was carried out taking into account the following characteristics: seedlings – when cotyledon leaves appear on the soil surface; the beginning of flowering (10%) – when at least one straightened and colored reed flower is visible; full bloom (75%); beginning of maturation (10%); full ripening (75%) – at the time of yellow ripeness on the back of the basket. The beginning of the phase was taken as the day when at least 10–15% of the plants have entered this phase and the full onset of the phase was taken when it has spread to at least 75% of the plants. For this purpose, in 2 repetitions, all plants were counted without a choice and for these plants, how many of them have entered this phase were taken into account.

The nature, humidity and oil content of sunflower seeds grown in the field were determined on the oil content and moisture analyzer VMTL-12 (Russia) at a temperature of +25 °C. The measurement range was within: humidity: 6–12%±1.0%; oil content: 40–60%±2.5%; nature: 300–500 g/l.

Determination of the weight of 1000 seeds was carried out as follows: from the fraction of pure seeds after their analysis for purity, two samples of 500 seeds were counted. In this case, the seeds were taken in a row without a choice. The selected seed samples were weighed with an accuracy of 0.1 g. If the discrepancy between the average weights of 1000 seeds did not exceed 3%, then the weight of 1000 seeds was calculated as the arithmetic mean of these two samples with an accuracy of 0.1 g. If the discrepancies between the weights of two samples more than 3%, then the 3rd sample was counted and weighed, after the weight of 1000 seeds was determined by those two samples that have the smallest discrepancy.

In order to determine the harvest, the harvested crop from the plot was weighed and at the same time samples were taken to determine the moisture content of the seeds and an average sample for laboratory analyzes (mass of 1000 seeds, nature, moisture and oil content) and determine the percentage of purity. The yield was determined by the formula:

$$Harvest = \frac{\text{net seed weight} \times \text{number of plants} \times S \text{ coefficient}}{\text{number of baskets removed}}.$$

To conduct a biometric measurement of sunflower, two weeks before ripening in the field, measurements were taken on five consecutive plants (the height of a straightened plant from the soil surface to the point of attachment of the basket to the stem; the height from the soil surface to the central basket in the natural standing of the plant and the diameter of the main basket). Calculate the average.

3. RESULTS AND DISCUSSION

3.1 Establishing the optimal concentration of encapsulating agents

Preliminary studies on the viscosity of PVA showed that the average value of the flow time is $\Delta\tau$=1015.77 sec., and the maximum increase in viscosity with the formation of a viscous gel occurs already at 4–5% PVA solution [9]. In gelatin, the increase in viscosity with the formation of a viscous gel was carried out at a concentration of 0.5–0.75 (figure 1).

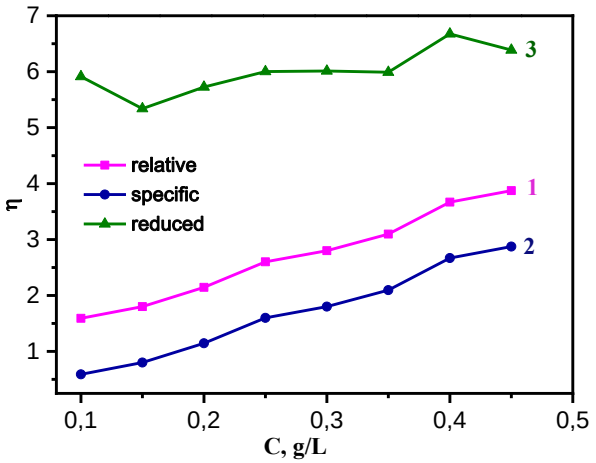

Figure1. Viscosity of gelatin at various concentrations

An increasing in the concentration of gelatin leads to higher value in viscosity, therefore, the possibility of obtaining encapsulating films by the casting method decreases. Therefore, to obtain encapsulating films, a gelatin solution with a concentration of 0.5% and a 5% PVA solution in various volume ratios were used (table 1).

3.2 FTIR Characterization of encapsulating composition

As can be seen from figures 2, 3, 4, the original gelatin has an absorption band at a frequency of 3373 cm^{-1}, characteristic of vibrations of the –NH group

(amide A) and 3271 cm^{-1}, indicating the presence of CH groups of the aromatic ring. Peaks in the region 2920–2850 cm^{-1} are associated with S-H stretching. The absorption frequency at 1650 cm^{-1} is inherent in the stretching vibrations of the C=O and CN groups (Amide I). The absorption bands in the region of 1540 cm^{-1} and 1238 cm^{-1} correspond to the N-H, CN (amide II) and CN, N-H (amide III) vibrations, respectively [28, 34]. 1442 cm^{-1} characterizes the absorption bands of NH_2 in the NH group.

The incorporation of fungicides “Maxim” and “Kruizer” into the volume of the encapsulating composition in various concentrations did not affect the chemical structure of Gelatin:PVA, which is clearly visible from the IR spectra (figures 3–4).

The incorporation of PVA into the gelatin composition leads to the appearance of absorption bands at 3486 cm^{-1}, which indicates the presence of the PVA hydroxyl group and a secondary amide (figure 2). The absorption band that appeared at 2942 cm^{-1} is more indicative of the presence of a hydrocarbon chromophore in the esterified Gelatin:PVA product [30]. The esterification of carboxyl groups of gelatin is indicated by the shift of the absorption bands characteristic of C=O stretching to a higher frequency region up to 1674 cm^{-1}. The weak band appearing at 2127 cm^{-1} is associated with the combined absorption frequency of CH−C≡C. The absorption spectra at 852–1093 cm^{-1} are due to the C−O−C stretching vibration, which indicates the formation of ether bonds between gelatin and PVA.

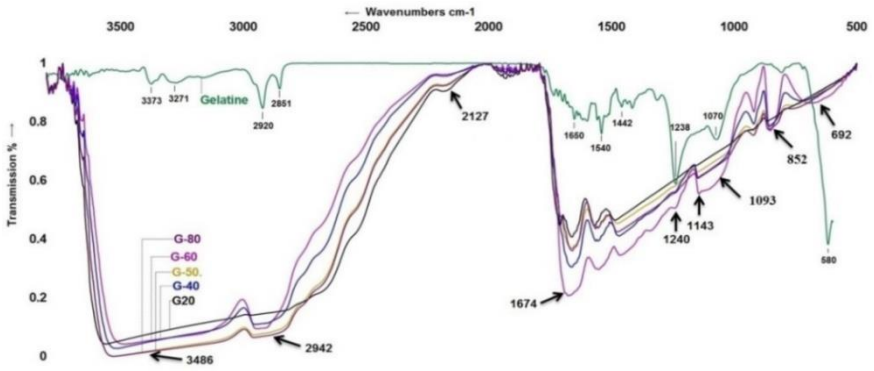

Figure 2. FTIR of Gelatin and Gelatin-co-PVA G20, G40, G50, G60, G80

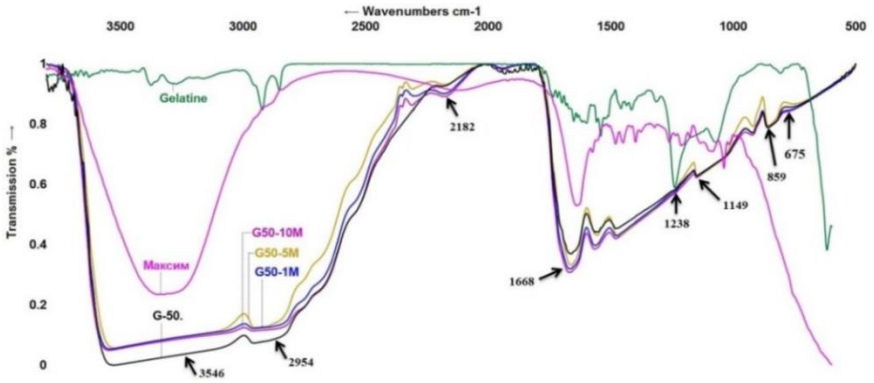

Figure 3. FTIR of Gelatin; Maxim and Gelatin-co-PVA/Maxim G50/1M; G50/5M; G50/10M

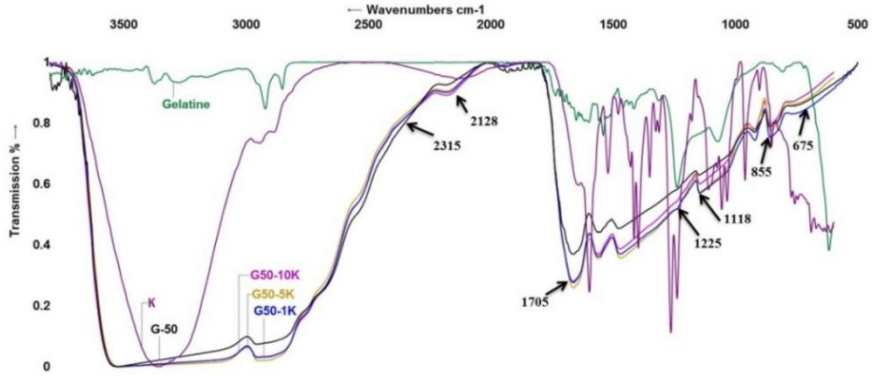

Figure4. FTIR of Gelatin; Kruizer and Gelatin-co-PVA/Kruizer G50/1K; G50/5K; G50/10K

3.3 Study of the encapsulating composition effect on seed germination, growth and development of plants in laboratory and field conditions

The germination of sunflower seeds encapsulated [PVA]:[Gelatine] = 50:50 in combination with fungicides "Maxim" and "Kruizer" were tested in laboratory and field conditions (table 2, figures 5–6). It was found that increasing the concentration of both fungicides promotes the growth of germination with high germination, reducing the number of germinated, but diseased seeds. As can be seen from figures 5–6, the application of the encapsulating composition greatly affects the germination of sunflower seeds in laboratory conditions, increasing the proportion of seeds with high germination by 1.5 times with both fungicides at a concentration of 10% (table 2). Germination remained at high and medium levels when used encapsulating formulations G50/1K, G50/5K, G50/5M and G50/10K (figures 5–6). At the same time, the usage of G50/1K and G50/10K gave a good germination in the field (table 2). There is a complete absence of germinated, but diseased sunflower seeds in favor of non-germinated seeds (36.6% – in laboratory conditions) and 32.6 – in field conditions when used the G50/10K encapsulating composition. Given this fact, it can be concluded that 5% and 10% solutions of fungicides are acceptable for the destruction of fungal diseases both in laboratory and in the field. Of the two types of fungicides, the systemic insecticidal seed treater "Kruizer" turned out to be optimal for the usage of sunflower in combination with an encapsulating composition.

3.4 Phytosanitary characteristic

Among the most common and harmful sunflower diseases transmitted by seeds are downy mildew, white, gray, dry and ashy rot, *Fusarium, Alternaria, Phomopsis, Verticillium* and some others [35]. It was found that the highest occurrence on control sunflower seeds when grown under laboratory conditions was noted in pathogens of *Alternaria (Alternaria)* (figure 7a). The gray mold pathogen *Botrytis cinerea,* which is the most common and harmful disease, was found (figure 7b). In addition to phytopathogenic fungi, sunflower seeds were attacked by saprotrophic molds, including *Mucor* (figure 7c). Perhaps this is due to the fact that mucosal fungi are easily isolated and develop well in pure culture on agar media and a favorable condition for their development is a humid environment, which occurs with the roll method for determining germination. This assumption is also confirmed by the fact that mucor fungi were not found in the field, where moisture enters in a moderate amount. In general, the infestation of control seeds by all pathogens in laboratory conditions is 15.65% (table 2).

Table 2. The average indicator of laboratory and field germination of sunflower seeds when using an encapsulating composition, %

Code sample	High germination		Not sprouted		Sprouted, but sick	
	lab	field	lab	field	lab	field
Control	46.2±10	48.2±10	38.15±10	32.9±10	15.65±10	18.89±10
G50/1M	58.9±8	51±8	20.5±8	20.3±8	20.5±8	28.7±8
G50/1K	68.2±9	65.7±9	28.4±9	34.3±9	2.2±9	0
G50/5M	70.8±7	51±7	14.4±7	17±7	14.8±7	32±7
G50/5K	65.4±8	49±9	22.2±8	32.7±9	12.4±8	18.3±9
G50/10M	69.2±8	59.7±7	17.9±8	17±7	12.8±8	23.3±7
G50/10K	73.4±9	67.4±9	36.6±9	32.6±9	0	0

Conducting a mycological analysis of sunflower grown in the field also established the presence of pathogens of the species: *Alternaria (Alternaria),* and *Sepedonium chrysospeimum* in the cells of *Botrytis cinerea* in the amount of 18.89% (table 2). Damage to sunflower seeds after encapsulation with composites with the addition of fungicides is significantly reduced (table 2). In some cases, there were a complete absence of affected seeds.

a) G50 b) G50/1K c) G50/5K d) G50/10K

Figure 5. Germination of sunflower seeds in laboratory conditions

a) control sample b) G50/1M c) G50/MK d) G50/10M

Figure 6. Germination of sunflower seeds in laboratory conditions

a) *Alternaria* b) *Botrytis cinerea* c) *Mucor*

Figure 7. Types of pathogens found in sunflower seeds

a) sowing sunflower seeds b) sunflower seedlings and the appearance of cotyledon leaves c) the period of full flowering of sunflowers d) the period of full maturation of sunflowers

Figure 8. The results of phenological observations of the development of sunflower in the field

In general, the problem of the phytosanitary state of sunflower seeds is relevant, due to the multifactorial influence of the following indicators – genetic resistance to diseases and primary infection of seed material, storage conditions, weather, climate factors and harmful pathogens.

3.5 Phenological observation of sunflower development

The data of the phenological study of field experiments established that the growing season of the control samples lasts 55 days, until ripening – 98 days. It takes from 58 to 61 days for flowering, maturation was extended from 92 to 103 days for sunflower seeds encapsulated with polymer composites (figure 8).

3.6 Biometrics index of sunflower

Biometrics index of sunflower are shown in table 3. Seed encapsulation has been observed to affect biometrics, in particular the height, head diameter and tilt of the sunflower plant. If the plant height of the control trial is 189 cm, then the maximum height when using the encapsulating composition 0.5GL:5PVA/1M is 217 cm. composition 0.5GL: 5PVA / 1M, 1K, 10K (table 3).

3.7 Technological qualities of sunflower

It is known, that, when solving many issues of post-harvest processing, such indicators as high oil content, low mechanical strength of the shell, density, nature, windage, speed of soaring and increased graininess of sunflower seeds are very important. From these indicators, it was determined the oil content, moisture content, nature and weight of 1000 seeds (table 4). When using the encapsulating composition, there is a barely noticeable increase in the oil content of sunflower (up to 49.04) by 1.61% compared with the control experiment (47.43%) (table 4). Polymer composites also contributed to an increase in sunflower weight up to 385–405 g/dm^3. High quality compared to the control sample was found in virtually all samples of encapsulated seeds.

Equilibrium moisture content of sunflower seeds, it means the humidity at which the seeds do not give or absorb moisture depends on temperature, relative humidity of atmospheric air and oil content. The organic and weed impurities contained in the mass of sunflower seeds are highly hygroscopic and this contributes to a decrease in the productivity, quality of the equipment, as well as the safety of raw materials. The equilibrium moisture content of encapsulated sunflower seeds corresponded to the standard and ranged from 7.7–8.0% (table 4). The weight of 1000 sunflower seeds in the experiments was in the range from 74.08 to 79.9 g. The most full weight were encapsulated G50/1M seeds, more than 79 g.

Table 3. Biometrics index of sunflower

Name of samples	Height of plant, cm	Tilt of the sunflower plant, cm	Head diameter, cm
Control	189±2,5	174±5,6	18±3,7
G50/1M	217±5,6	199±6,7	21±3,2
G50/1K	189±4,9	175±4,9	21±4,1
G50/5M	187±5,8	172±5,1	19±3,5
G50/5K	190±5,6	170±3,9	20±2,9
G50/10M	200±4,8	182±4,9	19±2,4
G50/10K	205±5,4	192±3,8	21±2,5

Table 4. Physical, mechanical and technological properties of sunflower seed mass grown from encapsulated seeds

Sample name	Oil content, %	Humidity*, %	Mass of 1000 seeds**, g	Nature, g/dm³
Control	47,43	7,8 (0,18)	79,42 (3,5)	380±2,6
G50/1M	49,04	7,8 (0,16)	79,39 (2,35)	390±1,9
G50/5M	47,76	7,8 (2,1)	74,08 (2,25)	390±1,7
G50/10M	47,76	7,8 (1,86)	74,08 (2,56)	390±2,4
G50/1K	47,76	7,7 (1,97)	75,83 (2,31)	405±1,8
G50/5K	48,4	8 (1,93)	75,37 (2,28)	385±2,6
G50/10K	47,9	7,7 (2,34)	77,08 (2,32)	390±2,5

* difference between parallel determinations
** allowable difference between the weighing results of two samples

The effect of the encapsulating composition on the growth, development and yield of sunflower under field conditions are shown in table 5. The table shows values from 3 replicates for 65 plants. According to the data obtained, the yield of encapsulated seeds is 10.53 c/ha, with a control experiment of 9.97 c/ha. From the obtained results it follows that the proposed method of encapsulating sunflower seeds significantly improves growth and development, which leads to an increase in sunflower yield.

Table 5. The influence of the encapsulating composition on the growth, development and yield of sunflower in the field

Experiment options	Height of plant, cm	Sunflower yield c/ha
Control experience	189±2,5	9.97±1,5
Polymer encapsulated seeds with adding fungicides	198±5,35	10.53±1,8

It follows from the results of the experiments that the increasing in yield is primarily due to an increase in plant density, due to an earlier, more favorable regime for seedling germination. The obtained data once again confirms, that the resulting polymer film-forming composites do not only have a protective effect on seeds during their growth period, but also improve the technological performance of sunflower.

CONCLUSIONS

The optimal concentrations and ratios of gelatin:polyvinyl alcohol, as well as their combinations with fungicides, were determined. The viscosity of a gelatin solution of different concentrations was studied, and the chemical structure of the encapsulating composition gelatin:PVA and gelatin:PVA/fungicide was established by the IR spectroscopic method. Seed germination, growth and development of sunflower in laboratory and field conditions were determined. A phytosanitary study of encapsulated seeds was carried out. Obtained phenological, biometric and technological indicators of sunflower in the field.

It was found that in gelatin, the increasing in viscosity with the formation of a viscous gel was carried out at 0.5–0.75%, respectively, the optimal concentration of gelatin for the formation of a film with PVA was determined to be 0.5% solution. The formation of ester bonds between the molecules of gelatin and PVA was established by the IR spectroscopic method. The influence of the composition [Gelatine]:[PVA]=50:50 in combination with fungicides “Maxim” and “Kruizer” on the germination and formation of sunflower were studied.

An optimal composition has been developed based on gelatin and PVA in combination with the Maxim and Kruizer disinfectants for encapsulating sunflower seeds, which positively affects the germination of seeds, the formation and development of seedlings.

It has been established that the interaction between gelatin and PVA is due to the formation of ester bonds. The introduction of fungicides of the fludioxonil and neonicotinoid classes into the composition of gelatin and PVA do not affect the chemical structure of the composites. It was revealed that the usage of fungicides “Kruizer” and “Maxim”, with a concentration of 10%, increases the germination of sunflower seeds by 1.6 and 1.5 times in laboratory conditions and 1.4 and 1.2 times in the field, respectively. This, in turn, reduces the amount of protectants by 10 times and improves the harmful effects of chemical plant protection products on the environment. Carrying out a phytosanitary analysis of sunflower grown in laboratory and field conditions, established the presence of pathogens of the species: *Alternaria (Alternaria), Sepedonium chrysospeimum* in the cells of *Botrytis cinerea* and *Mucor*. The usage of G50/1K and G50/10K has been shown to be effective against fungal pathogens. G50/10K turned out to be the optimal composite that positively affects the germination of sunflower seeds, both in the laboratory and in the field. It is also observed that presowing treatment of seeds affects biometric parameters, in particular, plant height, head diameter and tilt of sunflower plants. It has been established that the yield of encapsulated seeds is 10.53 c/ha, with a control experiment of 9.97 c/ha.

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МАЙЛЫ ДАҚЫЛДАР ТҰҚЫМЫН КАПСУЛАЛАУ АРҚЫЛЫ ӨСІМДІКТІ ҚОРҒАУДЫҢ ҚАУІПСІЗ ЖҮЙЕСІН ҚОЛДАНУ

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Қазақстан ауыл шаруашылығы саласындағы өзекті мәселенің бірі – майлы дақылдардың әртүрлі факторларға байланысты төмен өнім беруі болып табылады. Оның негізгі себебі майлы дақылдардың әртүрлі фитопатогендер мен зиянкестерге төзімділігінің төмендігі екендігі белгілі. Ауру – тұқымның өну сәтінен бастап, бүкіл вегетациялық кезеңді қамтиды. Аурудың таралуын тоқтату мақсатында қосымша қаржылық шығындарды қажет ететін, қоршаған ортаның экологиясына кері әсер беретін, сонымен қатар органикалық егіншілік принциптеріне қайшы келетін фунгицидтер қолданылады. Осыған байланысты зерттеушілердің негізгі назарын тұқымның сапасын арттыру, өскіндердің өсіп-дамуының физиологиялық және биохимиялық үрдісін ынталандыру, тұқымдық материалдың шығынын азайту және олардың патогендік микроорганизмдерге төзімділігін арттыруды қамтамасыз ететін ауыл шаруашылығы тұқымдарын себу алдындағы өңдеу технологиясын дамытуға ден қойып отыр. Тұқымды капсулалау немесе дражирлеу қолайсыз топырақ-климаттық және өсірудің экстремалды жағдайларындағы олардың ауруға төзімділігі мәселесін шешеді. Тұқымды капсулалауда инсектицидтік және фунгицидтік белсенділігін арттыру, өсімдіктердің қарқынды өсуіне қажетті заттарды (өсу реттегіштері, микроэлементтер, саңырауқұлақ ауруларына қарсы препараттар) қосу арқылы дақылдардың өнімділігін жоғарылату мәселесін шешуге көмектеседі. Капсулалауда қолданылатын полимер қабатына қажетті материалдар құны жоғары болғандықтан, оны төмендету әдісін реттеу өзекті мәселе болып табылады.
Зерттеу жұмысында күнбағыс тұқымын капсулалау үшін желатин мен поливинил спиртін (ПВС) «Максим» және «Круйзер» фунгицидтері қатысында зерттеп, тиімді құрам алу мүмкіншілігі анықталды.

Түйін сөздер: *фунгицидтік әсері бар капсулалаушы құрам, желатин, поливинил спирті, тұқым, өну, биометриялық және агротехникалық көрсеткіштер.*

КАПСУЛИРОВАНИЕ СЕМЯН МАСЛИЧНЫХ КУЛЬТУР КАК БЕЗОПАСНАЯ СИСТЕМА ПРИМЕНЕНИЯ СРЕДСТВ ЗАЩИТЫ РАСТЕНИЙ

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Одной из актуальных проблем аграрной промышленности Казахстана является низкая урожайность масличных культур в зависимости от различных факторов. Основная причина – это подверженность семян масличных куль-

тур к различным фитопатогенам и вредителям. Болезни развиваются практически в течение всего вегетационного периода, начиная с момента прорастания семян. Во избежание массового заражения используется большое количество фунгицидов, что требует дополнительных финансовых расходов и, с другой стороны, ухудшает экологическое состояние окружающей среды, а также противоречит принципам органического земледелия. В связи с этим, особое внимание исследователей привлекает разработка новых технологий предпосевной обработки семян сельского хозяйства, обеспечивающих: повышение посевных качеств семян, стимулирование физиолого-биохимических процессов роста и развития проростков, снижение расхода посевного материала и повышение устойчивости проростков к патогенным микроорганизмам. Капсулирование или дражирование семян решает проблему их заболеваемости и гибели при неблагоприятных почвенно-климатических и экстремальных условиях возделывания. Особую актуальность имеют задачи инсектицидной и фунгицидной активности капсулирования, решение которых позволило бы повысить урожайность культур путем включения в его состав веществ, необходимых для активного роста растений (регуляторы роста, микроэлементы, препараты против грибковых болезней). Отмечается дороговизна составляющих компонентов полимерных оболочек, и соответственно актуальной проблемой является изыскание методов их удешевления.

Данная работа посвящена подбору оптимального капсулирующего состава из желатина и поливинилового спирта (PVA), в сочетании фунгицидов «Максим» и «Круйзер» для получения капсулирующего состава семян подсолнечника.

Ключевые слова: *капсулирующий состав фунгицидного действия, желатин, поливиниловый спирт, семена, всхожесть, биометрические и агротехнические показатели.*