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WAYS OF RATIONAL USE OF AGROECOSYSTEM'S NATURAL RESOURCES UNDER RESOUCE- SAVING TECHNOLOGY

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Abstract- This article outlines the principles of rational use of rapeseed agroecosystem's natural resources (soil and biological) in foothill zone conditions of southeastern Kazakhstan. It was determined that the methods of resource-saving technologies provide restoration of agrophysical factors of soil fertility, allow significant reduction of energy costs per unit of produced products. Due to the proper placement of rapeseed crop by best predecessors in the short rotational crop rotation cycle and due to proper timing and seeding rate, the eco-phytosanitary condition stabilizes and yield significantly increases. It was determined that effectiveness of the resource-saving technology of rapeseed cultivation, where the conventionally net income from application of rational resource-saving methods is 44.8 thousand tenge / ha, which raises the level of profitability of rapeseed cultivation to 76.4 % and the need for running tillage equipment is twice less. Use of resource-saving technology ensures the receipt of 25.1 thousand tons / ha of additional income per hectare. The possibility of rational use of resources and resource-saving in the agroecosystem has been determined for the first time. The research revealed recovered parameters of agrophysical values of fertility of soil resources, reduction of total energy expenses by 21.8-28.4% (fuel consumption) and obtaining 25.1 thousand tons / ha of additional income per hectare.

INTRODUCTION

Rapeseed, *Brassica napus* L. subspecies, napus, is a large winter or spring annual oil crop in the Brassica family and is also known as rape and oilseed rape, and for a specific group of cultivars, 'canola'. Rapeseed is related to mustard, cabbage, broccoli, cauliflower and turnip. Rapeseed plants grow from three to five feet tall and have yellow flowers with four petals. Rapeseed has a deep taproot and a fibrous, near-surface root system. Rapeseed is primarily grown for its oil. A big challenge of profitable rapeseed production is the limited use and markets for the meal remaining after oil processing. In some areas, rapeseed, which contains more than 40 percent oil, becomes more profitable than soybeans, which contain 18 percent oil. Rapeseed is is also beneficial as a cover crop and for annual forage. It provides good soil cover over winter to prevent soil erosion, produces large amounts of biomass, suppresses weeds, and can improve soil tilth with its root system. Rapeseed can also be grazed by livestock during the fall growth period (Smith, 2015). Water deficit is one of the most significant stresses of agriculturally important crops, affecting growth, development and yield (Shirani, 2013).

Optimization of agricultural technologies in private farms can not be conceived without sustainable development to be integrated in new technological elements, economically efficient and profitable and sustainable relationship with the environment. The purpose of this paper is to investigate the effect of sowing, fertilization and distance between rows, on the development and production of the rape culture or technology optimization of winter rape growing in the Carei plain. Research carried out leading to the recommendation that seeding in the Carei plain should be done in late August. The seeding era is of

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particular importance in relation to climatic conditions. Fertilization influence rapeseed production depending on the composition in the complex fertilizer. The best results are obtained when fertilization type b1- 8:24:24 + microelements, as well as fertilization type b2-7:10:32 + micro-elements. Fertilization is a centerpiece of technologies with the greatest impact on yield. The recommended distance between rows in the research area is 25 cm or 37.5 cm. Sowing density, provided by the number of grains per m2 germinable, provided in the field and the distance between rows of the rape, it is important because of its positive correlation with the number of plants/m2 present in the chain forming plant density and harvest. The distance between rows and the mass of a thousand grains acquis has influence also on weed control in the rapeseed crop. The consequences of rapid technical improvement and technological development of national economy under the modern civilization exacerbate the problems of ecological balance. The consumer attitude of mankind to the environment leads to multiple negative consequences, which dictate the need for rationalization of using natural resources, which shall balance human existence with unharmed natural resources (Wang *et al.*, 2011; Galperyn, 2003). Agriculture is among the first to undergo these negative anthropogenic changes. Agroecosystem, which is essentially a mechanism for sustainable cultivation of natural resources, is fundamentally different from natural ecosystems and takes a key part in fluctuating ecological equilibrium of this ecosystem (Vorobiev, *et al*., 2006; Chernikov, *et al.,* 2000).

Modern agroecosystem has biological productivity or biological capacity. The population size of certain species included in them fluctuates because of constant changes in abiotic and biotic factors. Factors affecting the density of species' population include competition among species in relation to food and space. Interspecific competition arises in case of different types of identical or similar requirements to environmental conditions. The competition intensifies with increasing shortage of means of subsistence between the components of agrophytocenosis. As a rule, the density of population of various groups of organisms in the agroecosystem is maintained at the optimal level by means of effective techniques of crop cultivation technology developed by taking into account the specificity of the agroecosystem. Our research is directed towards studying ecophytosanitar condition and productivity of agroecosystem applying methods of resource-saving technologies such as minimal soil tillage, placement of rapeseed in crop rotation, terms and rates of seeding.

At the same time, the main goal was to develop methods of rational resource-saving technology of rapeseed cultivation in foothill zone conditions of southeastern Kazakhstan, that shall provide rational use of agroecosystem's natural resources, stabilisation of phytosanitary condition, increase of yields and energy saving on the basis of resource-saving methods of cultivation.

To achieve this goal, the following tasks were scheduled - To study and reveal the influence of resource-saving technologies (minimizing soil tillage, predecessors, timing and seeding rates) of rapeseed cultivation to optimize soil structure and increase fertile soil resources;

- To determine influence of resource-saving technologies on ecophytosanitary condition and optimization of ecological conditions for formation of agrophytocenosis of rape.
- To determine ways of rational use of natural resources in agroecosystems in foothil zone conditions of south-eastern Kazakhstan;
- To give comparative estimation of ecological and economical rentability of rapeseed cultivation in conditions of irrigated zone of south- eastern Kazakhstan.

Today in our country, just like in the whole world, special interest is directed towards energy-saturated plants, which includes rape. It contributes to providing population of the Republic of Kazakhstan with vegetable oil, covering needs of livestock farming with fodder protein, and industrial needs with raw materials, which is the main task of entire agricultural production. Such priority direction of the state policy ensures an increase in the competitiveness of products sold in domestic and world markets. Achievement of this goal depends on correct choice of culture. High-yield products like rape obtained on the basis of the application of effective and new environmentally safe technology, taking into account the optimization of the ecophytosanitary state of the agro-ecosystem can be offered to the market.

In ensuring the ecophytosanitary state of the agroecosystem we researched the effect of minimal soil cultivation, placement of rape in a short rotational crop tillage, and timing of the seeding rate.

MATERIALS AND METHODS

Yarovoy rape (Maily variety), winter rape (Kazakhstan variety), short-rotational crop rotation, weeds and predecessors are the subjects of research. The field experiment was conducted in the territory of the educational-experimental station (EES) of Agrouniversity KazNAU, in the village Saimasai on the area of 2,1 hectares (Fig.1), GPS- coordinates 43 25/ 57,9//N 77019/50.7//, (Fig. 2).

Traditional technology of soybean (Fig.3) cultivation in accordance with the recommendations of the Agricultural Management System of the Almaty region (Khusainov, 2010; System of Managing Agricultural Farms in Almaty Region, 2005) was implemented as a control in the experiments.

Field experiments and experimental studies were carried out by conventional classical techniques: experiment and observation. Field experiments were perfomred in the research-and-experimental farm "Agrouniversity" located in typical territory of foothill zone of southeastern Kazakhstan (Fig. 4).

Obtained experimental materials were processed by method of statistical processing of dispersial, correlational- regressional analysis by (Alysheva, 2006; Dospehov, 1985).

The soil of the experimental field is a meadow-chestnut type with heavy mechanical composition. The humus content in the plow horizon is 4.3%, which gradually decreases with depth. The content of total nitrogen and total phosphorus is high - 0.258 and 0.211%, respectively.

The climate of the research area is characterized as sharply continental with low humidity, a lot of sunlight, a short but rather cold winter.

RESULTS AND DISCUSSION

At present, the problem of environmental protection and rational resource use in agroecosystems has become especially acute because agrarian production is particularly exposed to negative anthropogenic processes.

With regard to continuously developing activities of the agrarian sector, it is impossible to ignore transformation of natural resources aimed at fulfilling needs of crops when cultivating them for obtaining planned production. At the same time, methods of cultivating technology should reduce the negative impact of anthropogenic processes to a minimum, or promote, preserve, restore or reproduce natural potential on example of soil and biological resources. That is why existing environmental changes of the agroecosystem as a result of anthropogenic impact are the basics for the development of environmental measures for the development of rational technology for cultivating plants. One of such innovative technologies is the rational resource-saving technology of rapeseed agroecosystem that we are developing.

In the conditions of south-eastern foothill zone we determined the actual changes in agroecosystem resources' condition, determined by the methods of traditional and resource-saving technology of rape cultivation.

Under traditional cultivation technology, a variety of tillage methods are performed in a certain sequence, which lead to environmental problems, such as excessive spraying and desiccation of soil, increasing financial, energy and labor costs for carrying out more than 15 agricultural practices. The share of soil cultivation is 30-40 percent of all costs of cultivation. Emerging environmental problems of agroecosystem under traditional technology are associated with irrational choice of the soil preparation system for rape cultivation.

Therefore, we studied the influence of resource-saving technology of rape cultivation, such as minimal tillage technology, predecessors, timing and seeding rates, which ensure rational use of soil and biological resources of the agroecosystem and increase ecophytosanitary state of agrophytocenosis and the productivity of cultivated rape culture.

It is revealed that the minimal technology (Mini-till) ensures the stability of environmental conditions of the soil environment, improves the structure, increases water resistance of soil aggregate of agroecosystem, stabilizes the structure of soil's arable layer with optimal soil density. Influence of minimizing processing on dynamics of soil density at cultivation of rape, g/cm^3, during the research years (Fig. 5-10).

During years of researching rapeseed sowing, the density of rstudied meadow-chestnut soil studied is determined by bulk mass. The obtained results on the study of agrophysical soil parameters during rape cultivation in spring period before sowing show compaction in composition of

Fig. 1 General view of stationary experiment, "Agrouniversity" EES

Fig. 2 The study area

Fig. 3 Preparatory period of the research

the top 0-30 cm soil layer, where the bulk density is 1.21 g/cm^3 with the volume mass fluctuations from 1.19 to 1.22 g/cm^3 under traditional technology of rape cultivation. Depending on location of soil particles, lumps and structural aggregates, the lower part of the arable layer of soil density increases and the bulk density of 20-30 cm of the layer becomes 1.27 g/cm^3.

Under minimal soil treatment, the bulk mass of 0-30 cm of soil layer before sowing ranged from 1.23 to 1.26 g/cm^3. In case of flat-cut processing with a minimal depth of 12-14 cm the soil density increases and bulk density of the soil ranges from 1.28 to 1.30 g/cm^3 (average 1.29 g/cm^3). It is revealed that in case of soil treatment minimi-zation under resource-saving technology the stability of soil's ecological condition improves, and structure of arable (0-30 cm) soil layer of 1.27 g/cm^3, stabilizes from 1.24 to 1.30 g /cm^3. Research has shown that rape crops with topsoil density (0-20 cm) under flat-cut soil treatment approaches optimal values (1,23-1,26 g/cm^3) and is more dense than when plowing (1.18 g/cm^3).

The agroecosystem has biological productivity or biological capacity. The populations' size of individual species included in them fluctuates because of constant changes in abiotic and biotic factors. Factors influencing population density of species include competition among species in relation to nutrients, water and space. This competition occurs when different plant species have the same or similar requirements to the

Fig. 4 Laying of field experiment and crops of rape

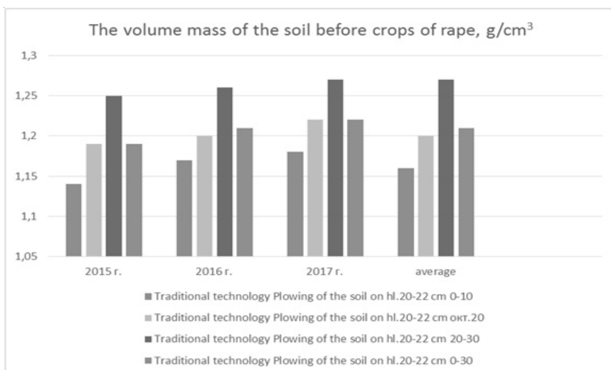

Fig. 5 Rape cultivation in traditional technology

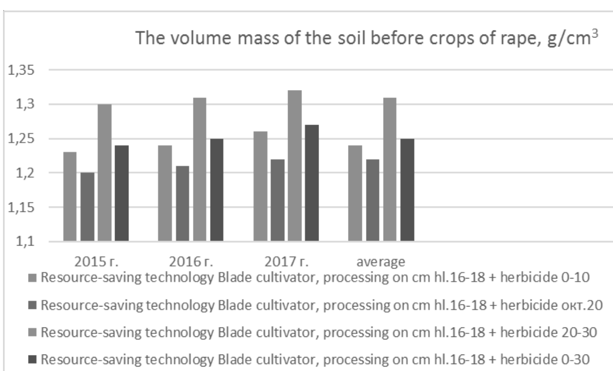

Fig. 6 Rape cultivation in resource-saving technology, (Blade cultivator)

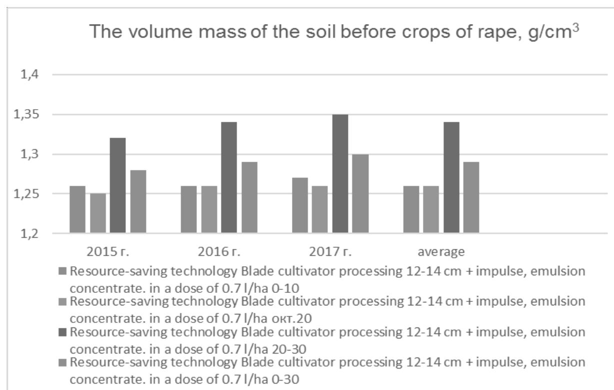

Fig. 7 Rape cultivation in resource-saving technology, (Blade cultivator processing)

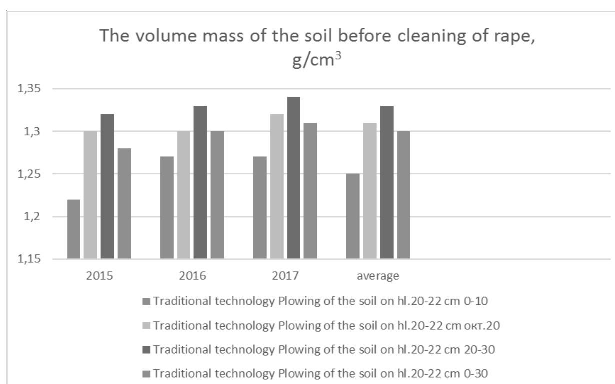

Fig. 8 The volume mass of the soil cleaning of rape (traditional technology)

environmental conditions in the agrophytocenosis (Fig. 11).

The competition intensifies with increasing lack of resources for formation of existence. Usually the populations' density of different groups of organisms in agroecosystem is maintained at optimal level, with effective methods of crop cultivation technology developed by taking into

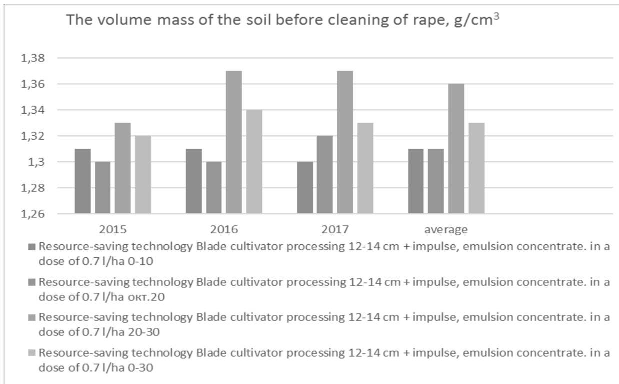

Fig. 9 Rape cultivation in resource-saving technology, (Blade cultivator processing)

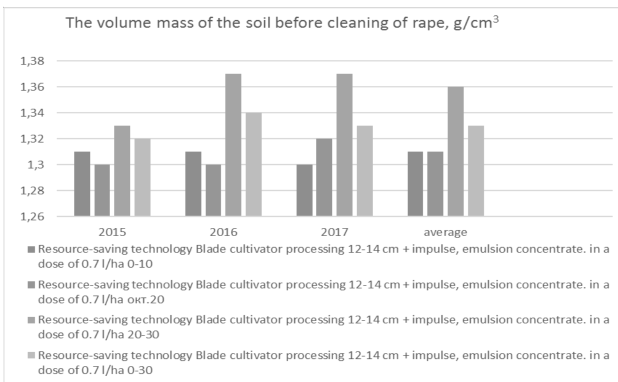

Fig. 10 The volume mass of the soil cleaning of rape (resource-saving technology)

account the specific features of the agroecosystem. The high weediness of rapeseed fields was revealed in case of traditional technology, where the quantity of weeds ranged from 66.2 to 81.8 pieces / m^2 at a mass of 224.1 g/m^2. With resource-saving technology in case of flat-cut tillage at a depth of 16-18 cm it ranges from 54 to 64.3 pcs / m^2, with a decrease in the depth of tillage to 12-14 cm and with use of herbicides the contamination reduces to 49.8-56.2 pcs/m^2 (Table 1).

We can see that weediness of rapeseed agroecosystem crops increases and the optimal ecological conditions are being created for culture's growth and development with yield output increase from 14.3 cwt/ha to 16.7cwt/ha.

Together with the minimization of soil cultivation, we studied the ecophytosanitary state of the agroecosystem depending on the location of the rapeseed planting. The alternation of crops in crop rotation has a special place in regulating the phytosanitary potential of the agroecosystem. The obtained results of the determination of the

Fig. 11 - Field factorial experiment, determination of rapeseed placement in crop rotation

Fig. 12 Crops of winter rape during the period of blossoming

ecophytosanitary state depending on the location of rapeseed in the short-rotation of fruits and crops testify that in case of traditional technology the amount of weeds after corn are 61.5 pcs/m^2 and after winter wheat 45,4 (Table 2).

The obtained results of determining the effectiveness of predecessors in repelling weeds showed that in case of traditional technology it is 44.6% after corn and 50.0% after winter wheat. In case of flat-surfaced tillage, the effectiveness of

Fig. 13 Determination of specific structure of weeds

Fig. 14 Harvesting

precursors in controlling weeds is 48.5-52.5% (after winter wheat) and- 36.9-47.3% (after corn).

The obtained results show that in case of traditional technology, the effectiveness of the precursors on weed control is 51.7% after winter wheat and 45.4% after corn. With resource-saving technology in case of flat-cut tillage at a depth of 16-18 cm, the efficiency of the precursors is lower and is 31.4% after corn and 33.8% after winter wheat, at a depth of 12-14 cm it is 33.8% after corn and 37, 1% after winter wheat.

The weediness of rapeseed sowing, depending on the minimization of soil cultivation and placement of rapeseed in a short rotational crop tillage, is the most important biological factor for increasing the ecophytosanitary state of the agroecosystem (Fig. 12).

Excellent (winter wheat) and optimal (soybean and corn) precursors of the cultivated rape crop have an intensely regulating effect on the abundance and species composition of the weed component of agrophytocenosis (Fig. 13).

Due to proper placement of the rapeseed crop for the best predecessors, the ecophytosanitary condition is stabilized in a short rotational crop tillage and the yield is significantly increased. The maximum yield of rape-16,7 centner/ha was obtained after the best predecessors of winter wheat that was placed on top of layer of perennial grasses - 18,3 centner /ha (Fig. 14) .

When determining the influence of planting timeframe and rapeseed seeding rates on the ecophytosanitary state of the agroecosystem by weed infestation, we monitored the ecological situation, where the degree of weediness, the species composition of the weeds and the structure of the agrophytocenosis of the rape have been identified. Early rapeseed plants have weak competitiveness and weeds recapture their vital growth factors, nutrients and soil moisture.

Table 1. Weediness of rapeseed agroecosystem crops depending on the minimization of tillage (during years of research)

Technology	During years of research	Quantity of weeds, pcs/ m2	Mass of weeds, g/m2	21 days later after using herbicides		Effectiveness by mass of weeds, %	Yield of spring wheat, cwt/ha
				Quantity of weeds, pcs/ m2	Mass of weeds, g/m2		
1.Traditional tillage	2015	81.8±3.15	224.8±8.61	53.4±2.18	67,3±3.66	St	14,3
with depth of 20-22cm	2016	66.2±2.97	171.0±6.47	58.0±2.31	70.8± 2.26		
	average	74.0	198.0	55.7	69.0		
2. Resource- saving flat-	2015	64.3±2.37	175.2±5.69	23.5±1.84	29.3±1.07	70,1	15,5
cut for depth of 16-18cm +	2016	54.0± 2.12	124.4±4.29	18.7± 0.74	38.9±1.38	68.7	
herbicide	average	59.2	149.7	21.1	34.1	69.4%	
3. Flat-cut tillage for depth	2015	56.2±2.61	165.1±6.58	16.4±1.02	21.2±1.53	87.2	16.7
$12\text{-}14_{CM}$ +herbicide	2016	49.8 ± 1,78	101,7±3,42	23,5 ±0,68	30,5± 1,34	70.0	
	average	63.0	133.4	15.2	25.8	78.6%	

Table 2. Weediness of rapeseeds' agro-ecosystems depending on predecessors

Cases	Predecessors of rape	Quantity of weeds, pcs/ m2		Effectiveness of predecessors resisting weeds, %
		Before harvest	Before harvest	
	1. Traditional technology, tillage for depth of .20-22cm			
1.	Winter wheat (on top of perennial's layer)	45.4	38.0	50.0
2.	Soy	75.0	56.3	26.0
3.	Rape (control)	81.8	76.0	St
4.	Corn	61.5	42.1	44.6
	2. Resource- saving flat-cut technology for depth of 16-18cm + herbicide			
1.	Winter wheat (on top of perennial's layer)	35.9	28.0	48.5
2.	Soy	52.1	36.1	33.6
3.	Rape (control)	72.2	54.4	St
4.	Corn	63.0	34.3	36.9
	3. Resource- saving flat-cut technology for depth of 12-14cm + herbicide			
1.	Winter wheat (on top the perennial's layer)	48.4	20.0	52.5
2.	Soy	37.3	27.1	35.6
3.	Rape (control)	79.1	42.1	St
4.	Corn	29.9	22.2	47.3

Table 3. Influence of sowing time and norm of seeding on an ecophytosanitary condition of an agroecosystem and productivity of summer rape in the conditions of the southeast of Kazakhstan

Rape sowing time	Norm of seeding, one million seeds/ha	Quantity of weeds, piece/sq.m		Efficiency against contamination, %	Productivity of rape on seeds in c/hectare
		Total amount	Long-term weeds		
Early sowing	2,0	58,0	24,0	-	12,1
	2,5	51,3	21,5	11,6	12,8
	3,0	47, 9	20,2	17,4	12,9
Average sowing					
	2,0	35,5	8,6	38,8	13,4
	2,5	32,6	4.9	43,7	15,9
	3,0	38,9	5.1	34,1	14,7
Late sowing	2,0	40,1	20,7	30,9	13,5
	2,5	37,8	18,2	34,8	14,2
	3,0	35,1	18,0	39,5	13,6
					HCP_{05} = 0,97 c/ha S_X = 1,11%

The rapeseed plantation is littered with numerous weeds. According to the monitoring that we perfrormed, agrophytocenosis of rapeseed is characterized by a wide spectrum of species composition of weeds. In rapeseeds, the weed component consists of 27 species, represented by various biotypes of weeds and the degree of weediness. Although the floral composition of weeds is quite diverse, only 8 of them are often found. These are such dominant weeds as: wild oats (*Avena fatua* L.), Ragwort ragweed (*Ambrosia artermisiifolia* L.), pink sow thistle, plainary thistle (*Cirsium arvense* Scop), lady's purse (*Capsella bursa* pastoris Medic), field thlaspi (*Tlaspi arvense* L.), common cinder (*Barbarea frvensis*) and field convolvus (*Convolvulus arvensis* L).

The research showed a high level of contamination in the early stages of sowing, the total amount of weeds is 58 pcs/m2, of which perennial weeds are 24 pcs/m2. In the average term sowing part the amount of weeds is reduced to 35.5 pcs/m2 of them 8.6 pcs/m2 are perennial weeds, and in case of late term sowing the amount of weeds increased to 40.1 pcs/m2 and is characterized by an increased content of harmful long-term weed plants (Table 4).

During the growing season, the weeds are quite harmful till the beginning of development phase of 4-6 rape leaves and reduce the yield of rapeseed by 10-20%. After the onset of this phase on average sowing term, the amount of weeds drops sharply to the level of the threshold of harmfulness of juvenile weeds. Therefore, an effective agrotechnique in optimizing the ecophytosanitary state of a rape ecosystem is the average term of planting rapeseed, where optimal conditions for resisting the contamination of agrophytocenosis are formed. By the average term of planting rape, there is sufficient time to implement effective and comprehensive measures to control weeds that create the prerequisites for the purity of the agronomist for sowing.

Thus its been determined that under the resource- saving technology of rape cultivation weediness of rape sowing is the most important biological factor for increasing the eco-phytosanitary state of the agroecosystem depending upon minimization of soil cultivation and optimal placement of rapeseed in a short rotational crop rotation. Due to the proper placement of rapeseed after the best predecessors in the short rotational crop rotation, the ecophytosanitary condition is stabilized and yields are significantly increased. Relatively highest productivity of rape - 14.3-16.7 centner/ha was obtained after the best predecessors of winter wheat which was placed on surface layer of perennial grasses, soya and corn.

The results of studying the impact of resource-saving rapeseed cultivating methods prove that under the conditions of foothill zone of the southeast of Kazakhstan the ecological basis for rational use of natural resources of the rapeseed agroecosystem is use of resource-saving technologies for its cultivation. The main effective methods of resource-saving technology in improving the ecophytosanitary state of the agroecosystem include the minimization of soil cultivation, selection of a scientifically based precursor culture, the sowing term period and the seeding rate, taking into account the specific soil and climatic conditions of the area, which ensure the optimization and conservation of soil and biological resources with subsequent increase in agroecosystem's productivity.

CONCLUSION

It is determined that effectiveness of the resource-saving technology of rapeseed cultivation, where the conventionally net income from application of rational resource-saving methods is 44.8 thousand tenge/ha, which raises the level of profitability of rapeseed cultivation to 76.4 % and the need for running tillage equipment is twice less. Use of resource-saving technology ensures the receipt of 25.1 thousand tons / ha of additional income per hectare.

The possibility of rational use of resources and resource-saving in the agroecosystem has been determined for the first time. The research revealed recovered parameters of agrophysical values of fertility of soil resources, reduction of total energy expenses by 21.8-28.4% (fuel consumption) and obtaining 25.1 thousand tons / ha of additional income per hectare.

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