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THE IMPACT OF SOIL PREPARATION TECHNOLOGIES ON GROWTH AND DEVELOPMENT OF SAFFLOWER CULTIVARS

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Safflower *(Carthamus tinctorius L.)* is an annual plant belonging to the Compositae family, has been widely used in many industries. It is a multipurpose crop that is used as food dyeing spice, livestock feed, biofuels and medicinal applications in many areas of the world. However, safflower is most commonly known as oilseed crop, because its seed contains 32 to 39% of semidrying oil (50-56% in the nucleus). Safflower does not belong to the group of crop, which is widely used in oil production. But it is cultivated in many parts of the world, such as Spain, Portugal, Austria, Hungary, France, Turkey, Iran, Argentina, USA, Brazil and Mexico. It is more drought-resistant, heat-resistant and tolerant to salt stress; therefore, it is more reliable crop than sunflower [1].

Safflower is a deep-rooted annual plant which utilizes moisture to a depth of 1-1,5 meters and leaves rather poor crop residue (compared to wheat) to catch snow and protect the soil from wind erosion. The utilizationof cultural practices for safflower which will minimize water loss and maximize soil protection are necessary for successful production [2].

The objective of our study was to evaluate the impact of different soil preparation technologieson growth and development of various safflower cultivars. This paper reports research results of a 1-year study of safflower cultivars under different soil preparation technologies. The field experiment was established in the experimental plot of “Fermer 2002” LLP, which is located in Astrakhan district of Akmola region in 2016. In this experiment, we studied the impact of different cultivars of oilseed crops on their productivity and quality. Various cultivars Akmai, Irkas, Center 70 were sown in different variants, which tilled differently. Above-mentioned cultivars were tested in comparison with different technologies of soil preparation in four backgrounds: *Minimum 1* (herbicide+ 1 noninversion tillage in 10-12 cm, and direct drilling) compared to *Zonal* (1 noninversion tillage in 8-10 cm + 2 noninversion tillage in 10-12 cm and loosening the soil in 25-27 cm).

The objects of the study were safflower cultivars of Kazakhstani breeding Akmai, Irkas and Center 70, all plots were placed in series in three replications. The best sowing time for safflower during the warming up the soil is 15-20th of May. Sowing method is broadly-line and linearly and seeding rate was which recommended for local zone. Activities to control weediness carried out during the 1-3 true leaves. Spraying of crops was conducted with Fusilade Forte 0,75-2,0 l/ha against annual grass weeds.

During May in 2016 year, the precipitation was 17 mm, which was lower than long-term performance by 18 mm, however daily mean temperature was higher than average annual rate by +0,7^{0}C. In the first and third decades of June there were rains, especially in the first decade (30 mm), and the average daily air temperature was lower compared to the long-term rates by -0,8^{0}C (Fig. 1).

July month was characterized by a low temperature (deviation from the mean annual rate was -2,2^{0}C). Meanwhile, July was rainy (dropped 70 mm of rain), especially rain fell in the second decade, in the period of "budding" of safflower varieties, which was favorable for the growth and development of generative plant organs. August and September months of 2016 were dry and warm that promoted prosperous grain maturity of oilseed crop (Fig. 1).

Figure 1 – The amount of precipitation, mm (a) and the average monthly air temperature during the vegetative period of safflower in the research year, ^{0}C (b)

It is known that even emergency and uniformity of plants with a given density is the essential for the formation of high-yield grain of field crops. Numerous studies confirmed that field emergency depends on the preceding crop, tillage and fertilisation systems, sowing time, sowing rate and seeding depth and crop care methods. In 2016, the field emergencies of Kazakhstani saflower cultivars were, Akmai – 72-80%, Irkas – 76-84% and Center –76-88% (Tab. 1).

Table 1 – Field emergency and plant preservation of different safflower cultivars in 2016

Soil preparation technology	Cultivars	Field emergency, plant per m^2				Plant preservation, plant per m^2			
		replication			%	replication			%
		I	II	average		I	II	average	
Zonal (control)	Center 70	18,0	20,0	19,0	76	17,4	17,8	17,6	92,6
	Akmai	17,0	19,0	18,0	72	16,0	16,6	16,3	90,5
	Irkas	21,0	17,0	19,0	76	17,4	17,2	17,3	91,1
Minimum I	Center 70	23,0	21,0	22,0	88	22,0	22,0	22,0	100,0
	Akmai	19,0	21,0	20,0	80	19,5	18,5	19,0	95,0
	Irkas	23,0	19,0	21,0	84	17,0	21,0	19,0	90,5

The formation features of yield structure elements relative to the different technologies for soil preparation was studied. The yield structure index "Number of plant sper unit of harvest area" is playing certain role for obtaining high safflower grain yield.

In our research, this index was higher with cultivar named Center 70 and

between the technologies of soil preparation – the variance Minimum 1 was greater than others. Thus, on an average in 2016 by harvest time there were preserved 100% of plant with above-mentioned cultivar under Minimum tillage. As analyses showed there were not significant differences between the yield structure of safflower cultivars within the number of seeds per inflorescence and mass of 1000 seeds, only negligible advantages of the Center 70 cultivar within the number of plants per m^2 was established (Tab. 2).

The same research was conducted by Esfahani et. al in Isfahan province of Iran in 2014, where analysis of variance showed the significant difference among **tillage** methods and **safflower** cultivars for 100-seed weight and seed yield per plant. Interaction effect between **tillage** methods and cultivar was significant only for 100-seed weight. The findings revealed that low **tillage** method had the highest growth physiological indices, whereas no **tillage** had the lowest. Therefore, conventional **tillage** method showed the best results for cultivation as well as improving sustainable agriculture in **safflower [3]**.

Table 2 – Yield structure elements of safflower cultivars depending on the soil preparation technologies

Soil preparation technology	Cultivar	Number of plants per m^2	Number of heads per one plant	Number of seeds per head	Mass of 1000 seeds, g	Biological productivity, d/ha
Zonal (control)	Center 70	17,6	10,0	23,0	39,4	15,9
	Akmai	16,3	10,0	23,0	39,1	14,8
	Irkas	17,3	10,0	23,0	39,4	15,1
Minimum I	Center 70	22,0	9,0	22,0	39,2	17,3
	Akmai	19,0	9,6	22,0	40,6	16,3
	Irkas	19,0	10,0	22,6	39,3	16,8

Another field experiment that was conducted in Iran, in order to determine the interactions between the **tillage** system and crop rotation on weed seedling populations and crop yields from 2002 to 2005. No **tillage**, shallow **tillage** and deep **tillage** were the main plots and three crop sequences comprising continuous wheat (W-W), wheat-canola-wheat-canola (C-W) and wheat-**safflower**-wheat-**safflower** (S-W) were the subplots. In conclusion, the crop sequence in combination with **tillage** would help to control troublesome weed species. **Safflower** and canola were determined to be effective in reducing the grass weeds [4].

In our research in 2016 among the safflower cultivars the highest grain yield was marked with Center 70, its yield was at zonal soil preparation technology - 13,6 c/ha, under Minimum 1 tillage - 14,9 c/ha, whereas the yield of the cultivar Akmai was 13,0 and 14,5 c/ha, Irkas was 13,1 and 14,6 c/ha respectively.

The soil preparation technologies did not significantly affect on the productivity of safflower. From our point of view there were the same conditions of water supply and weediness after different soil preparation technologies. In summer period, temperature during the major phase of growth and development was favorable and water capacity in soil was in enough amounts. September 2016 was dry and warm, and lead to the favorable maturity of oilseed crops

“Minimum 1” soil preparation technology was characterized with the highest yield among the different technologies of soil preparation,where safflower yield was 14,6-14,9 c/ha.

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