THE BEE FAMILIES USE AT SUN FLOWER POLLINATION

Valentina Cebotari[1*], I. Buzu[1]

[1]Zoology Institute of Science Academy from Moldova, Republic of Moldova

Abstract

The purpose of the work was to research various systems of bee families placement at the sunflower pollination, to distinguish the advantages of this crop conducted pollination, with the help of the bees and to develop some streamline suggestions to increase the amount of seed production.It was conducted an experiment to test three systems (scheme) of bee families exploitation at the pollination of early hybrid sunflower "El Passo 199" on three agricultural land of 30 hectares each, which were placed at a distance of over 600 - 1000 m from each other. The load of bee families at the pollination was 1 ha per each family. In the first scheme (batch I, witness) – the hives with bee families were placed traditionally in a hearth, at one side (edge) of the field with blooming plants. In the second scheme (batch II) – the bee hives were placed in two hearths at the two opposite sides of the field. In the third scheme (batch III) – the bee hives were placed in four hearths, proportionally at the four sides of the field.The research results have shown that the bee hives placement at the sunflower pollination, proportionally at those 4 symmetrically opposite sides of the field, provides a significant increase of bee visits to the flowers, compared to the witness batch – with 1.4 bees/ 5 min, or 82.5 % (td = 14.2; P < 0.001) and, compared to batch II – with 0.4 bees/ 5 min, or 14.8 % (td = 2.8; P < 0.01). By the total pollen amount collected in the nest daily, on average, bee families from batch II exceeded their fellows of witness batch with 25 g/day, or 16.8 % (td = 4.3; P < 0.001), and those of batch III exceeded their fellows of batch I - with 46 g, or 30.9 % (td = 5.9; P < 0.001). By flight intensity, the bees without pollen balls of batch III exceeded their fellows of witness batch with 46 bees/10 min, or 9.5 % (td = 2.1; P < 0.05), and those with pollen balls – with 35 bees/10 min, or 17.8 % (td = 3.1; P < 0.01). The seeds fertilization degree, in case of isolated pollination was very low, and was 13.1 – 15.8 %. In case of free pollination (entomophilous), contrary, the most sun flower inflorescence seeds were fertile (full), The number of fertile seeds, in this case, exceeded 5.7 – 7.2 times compared to the isolated pollination (P < 0.001). The seeds pollination degree, in case of free pollination, was 88.6 – 92.1 %. The seeds pollination degree from batch III, was higher, compared with witness batch– with 3.5 percentual units, or 4.0 % (td = 2.6; P < 0.01). The total weight of harvested seeds, on average, at one sun flower inflorescence, in case of entomophilous pollination, exceeds compared to the isolated pollination, in all batches and examined sectors 1.8 – 2.2 times more (P<0.001), and by fertile seed weight–2.3 – 2.6 times (P < 0.001). By the quantity (weight) of fertile (full) seed production, sun flower inflorescences of batch II exceeded their fellows of batch I with 11.9 g, or 18.5 % (td = 5.6; P < 0.001), and the sun flower inflorescences of batch III exceeded their fellows of batch I with 16.1 g, or 23.8 % (td = 6.7; P < 0.001). From the obtained information, were deduced the conclusions that the conducted pollination of early sunflower hybrid El Passo-199 with the help of the bees, provides, compared to the isolated pollination, an increase of seeds fertilization degree and of the seed production weight with 2.3 – 2.6 times. The proportional placement of the bee hives at the pollination, as close to the picking source, at the four opposite sides of the sunflower field, contributes to a significant increase of the bees visits frequency to the flowers – with 82.5 %, of the flight intensity of the bees without pollen balls – with 9.5% and of those with pollen balls – with 17.8 %, of the collected pollen amount – with 39.6 %, of the seeds fertilization degree – with 4.0%, and of the seeds production – with 23.8%.

Key words: pollination, conducted, sunflower, bees, systems, placement, hives

INTRODUCTION

The sunflower (*Helianthus annuus L.*) represents one of the most important agricultural oleaginous crops in Republic of Moldova, which is grown on an area of about 300 hectares, obtaining a total production of about 300 thousand tons, with a harvest of approximately 10 quintals per hectare. The farmers cultivate this crop largely, because of

*Corresponding author: valentinaceb@yahoo.com
The manuscript was received: 20.11.2014
Accepted for publication: 20.01.2015

the high profitability compared to other similar field crops.

The sunflower is considered an entomophilousallogam plant, whose pollination with the insects help is required. Although, sunflower flowers are hermaphrodite, they act as if they were unisexual, because there is a maturing gap between the male and female organs, so that the stamens with anthers develop and mature before the stigma, which means that the pollen is released long before the stigma is receptive [4]. In addition, the sunflower pollen is heavy and sticky, in order to be transported by wind [12].

Therefore, the insects, primarily the honeybees remain the main agents responsible for carrying the sunflower pollen from the anthers of some flowers to the stigmas of other flowers, either of one and the same inflorescence head, or of the flower anthers of an inflorescence to the flowers stigma of another inflorescence head (cross pollination). It is generally considered that, empty seeds (sterile), rather those lacking the core of the seed coating, are caused by the pollination absence, especially of the cross pollination.

However, the sunflower auto pollination takes place. During maturation, the stigma lengthens and is pushed out of the anther tube, then (if the fertilization does not occur with the pollen of other flower, due to the lack of insects), the tip of the stigma opens into two bifurcations, that turn a lot outward, until they reach the anthers of neighbouring flowers, thus achieving the self-pollination. The auto fertilization percentage varies at different sorts and hybrids of sunflower, between 18 and 98 % [4].

The knowledge of biological features of growth and development of different sorts and hybrids of sunflower is an actual problem, as for the crop growers as well for the beekeepers [7].

Multiple studies in this direction [1-4, 7, 12], performed in different countries and different sorts and hybrids of sunflower have shown that the pollination of this agricultural crop, with the help of the bees, contributes to increase the seed production harvest with 16-105 %.

Free and Simpson (1964), quoted by Furgala B. [3], have shown, that the most frequent movements of the bees from a head inflorescence to another, favoured the pollination between the head inflorescences of both plants, with the result of a higher seed production, compared to when the pollination occurred between the flowers of same head inflorescence. Some researchers [2] have demonstrated that the cross-pollination of the sunflower with the help of the bees has as result a significant increase not only of the seeds weight, but also of the oil concentration.

Generally, it would seem that the advantages of sunflower entomophilous pollination are well known, but particularly, the bee families are used (especially in our country) in order to collect the nectar, but not for pollination.

The well known American specialist Furgala Basil [3] mentioned that "the achievement of an appropriate sunflower pollination is prevented, not because of the knowledge lack, but because of the thorough relative knowledge lack on this question, ... the beekeepers need to think about seed production, but not only about honey production, ...the pollination plans must be based on the bee preference criteria, on the bee families situation, on the appropriate bee hives placement and reasonable pricing for pollination services". According to the Australian specialist White Bruce [11], the conducted use of bee families at the oleaginous crops pollination, is not practiced in shoal, because the main reason is education – the pollination benefits must be demonstrated to farmers in dollars and cents.

Such a situation persists also in Moldova, so the benefits of sunflower pollination with the help of the bees are not realised, first of all – by the farmers, who believe that the contemporary sunflower hybrids are all auto fertilising, that is why they are not intending to pay the pollination services, and secondly – by the beekeepers, who do not think to the seed production and to improve the technology of conducted pollination with the help of the bees, but are pleased with the honey production collected from this meliferous culture.

In this context, this work proposed to examine various systems of bee hives placement at a hybrid sunflower pollination, in order to emphasize the advantages of this crop

conducted pollination with the help of the bees and to develop proposals for streamline the process of seed production increase.

MATERIAL AND METHODS

The work was performed in the institutional applied: code - 11.817.08.17A „The performing technology elaboration for growth and varied exploitation of bee families *ApismelliferaCarpatica*".

It was done an experiment in order to test various bee families' exploitation systems at the pollination of an early sunflower hybrid, during the period of 23 June – 12 July, on the farm land of GŢ „Turtureanu", Sângerei district. The experiment included three fields with sunflowers each of 30 ha, that were at a distance of more than 600-1000 m from each other. The bees transportation to the pollination, was done at the beginning of the field flowering (about 10% were already blooming). The load of the bee families to the sunflower pollination constituted one family with a capacity of 14-16 Dadant frame intervals of bees per hectare, in all experimental batches. Were tested three systems (schemes) of bee hives location on the field for pollination.

First scheme (batch I) – the hives with bee families were placed ordinary (traditionally) into a hearth, on a single side of the bloomed field, which served as the *witness batch*.

Second scheme (batch II) - the hives with bee families were placed into two hearths, on the two opposite sides of the field.

Third scheme (batch III) – the hives with bee families were placed into four hearths on the four proportional sides of the field. The hives from each hearth were placed for pollination, at the distance of 20 m from each other.

In this experiment, in each sunflower field were studied:

- the bees frequency intensity to the one inflorescence flowers during 5 minutes, examining every 30 inflorescence from each experimental field (batch), taken proportionately from different parts of the field;

- the quantity and types of pollen collected by each bee family, per a day, during the experiment, examining every 10 bee families from each experimental batch, assessing at the same time, the bees flight intensity, by the bees number (with or without pollen balls) arrived in the hive during 10 minutes;

- the entomophilous pollination share of inflorescences flowers, in the pollination total, was determined by examining in each experimental batch of 10 pollinated inflorescences, with the free access of insects and 10 inflorescences pollinated isolated . For this, in every experimental batch, were isolated 10 inflorescences, by covering them with a gauze;

- the amount of fertile and sterile seed number, fertilization percentage, as well as the seed weight in a head, was determined at the stage of seed maturation (August 10, 2013), by examining in each experimental batch of 10 isolated pollinated heads and 10 heads pollinated with the free access of insects.

The data obtained, in all experiences, were processed statistically using computer software „STATISTICS – 6" and appreciated their certainty, according to the biometric variation statistics, by the methods of Плохинский Н.А. 1969 [13].

RESULTS AND DISCUSSIONS

The research results have shown, that at the beginning of the sunflower heads flowering, the bees visits frequency to the flowers was quite low, in all experimental batches, different, depending on the batch, from 1.4 ± 0.2 bees/5 min in batch I, up to 2.5±0.1 in batch III (tab. 1).

With the expansion of the flowering degree of the sunflower heads and its transition to the in shoal flowering stage, the bees' visits frequency on a sunflower head increases significantly.

Thus, in the middle of full swing flowering of the sunflower heads, the bees visits frequency to the flowers increases on average, in the batch I - from 1.4 ± 0.2 up to 2.0 ± 0.1 bees/5 minutes, so with 0.6 bees/5 minutes, and 42.8% (td = 2.7, P <0.01) in the batch II - from 1.8 ± 0.1 up to 3.1 ± 0.1 bees/5 minutes, so with 1.3 bees /5 minutes, and 72.2% (td = 9.2; P <0.001) and in the batch III – with 1.0 bees/5 minutes, and 40.0% (td = 4.5; P <0.001).

Table 1 The bees visits frequency on a sunflower head, bees/5 minute

The examination period	Batch I (N=30 heads)	Batch II (N = 30 heads)			Batch III (N = 30 heads)		
	M ± m	*M ± m*	*d*	*td*	*M ± m*	*d*	*td*
In the beginning of blooming	1.4 ± 0.2	1.8 ± 0.1	+0.4	1.8	2.5 ± 0.1	+1.1***	4.8
In the middle of blooming	2.0 ± 0.1	3.1 ± 0.1	+1.1***	7.8	3.5 ± 0.2	+1.5***	6.5
At the end of blooming	1.8 ± 0.2	2.9 ± 0.2	+1.1***	3.9	3.2 ± 0.2	+1.4***	5.0
Average	1.7 ± 0.1	2.7 ± 0.1	+1.0***	7.1	3.1 ± 0.1	+1.4***	10.0

*Note: *** P < 0.001*

The dynamic of the bees visits frequency can be seen better graphically (Fig. 1).

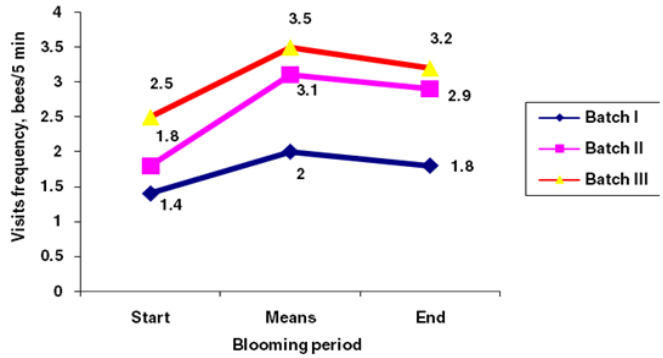

Fig. 1 The bees' visits frequency on a sunflower head, bees/5 min

At the end of heads flowering, the bees' visits frequency to flowers decreased proportionally in all experimental batches, but still remained, at a higher level compared to the bees visits frequently level registered at the beginning of sunflower heads.

We found that bees' visits frequency to the sunflower was most influenced by the system (modality) of bee hives placement on the land.

Thus, the lowest bees' visits frequency to sunflower was recorded in batch I, where the bee hives were placed at one side of the field with the plants bloomed in the initial phase.

The placement of the bee hives at two opposite sides of the field, the bees visits frequency to the flowers increased at all stages of sun flower heads blooming, on average, from 1.7 ± 0.1 bees/5 minutes in batch I, up to 2.7 ± 0.1 bee/5 minutes in batch II, so with 1.0 bees/ 5 minutes, or with 58.8% (td = 7.1; P < 0.001).

The highest bees visits frequency to the head flowers was recorded in the experimental batch III, where the hives were placed uniformly, on the four symmetrically opposite sides of the field. This system (method) to place the bee hives for the sunflower pollination, provides a substantial increase of the bees visits frequency to the flowers of plants compared to the witness batch – with 1.4 bees/5 minutes, or 82.5% (td = 14.2; P < 0.001) and compared to the batch II – 0.4 bees/5 minutes, or 14.8 % (td = 2.8; P < 0.01).

Thus, we can conclude, that the uniform placement of the bee hives at all sides of the sunflower field, provides a substantial increase of bees visits frequency to the flowers, which is due to shortening the distance between the bee hive and flowers, as well as the access relief of the bees to the head flowers.

The increase of bees visits frequency to flowers, contributes to the improvement of

sunflower pollination quality. It can be found from the analysis of the amount of collected pollen by the bees and their flight intensity (Table 2).

Table 2 The pollen quantity collected by a bee family and the bees flight intensity during sunflower heads blooming

Indicators	Batch I (N=10 families)	Batch II (N = 10 families)			Batch III (N = 10 families)		
	M ± m	M ± m	d	td	M ± m	d	td
The total collected pollen quantity, g/day/family	149 ± 5	174 ± 3	+25***	4.3	195 ± 6	+46***	5.9
inclusive: of sunflower	116 ± 5	140 ± 3	+24***	4.1	162 ± 7	+46***	5.3
The sunflower pollen share of total pollen quantity, %	77.9 ± 2.2	80.5 ± 1.5	+2.6	1.0	83.2 ± 3.8	+5.3	1.2
The flight intensity, bees/10 minute /family:	x	x	x	x	x	x	x
Without pollen balls	482 ± 18	505 ± 18	+23	0.9	528 ± 13	+46*	2.1
With pollen balls	197 ± 5	216 ± 10	+19	1.7	232 ± 10	+35**	3.1
The correlation of the bees with pollen balls towards those without pollen balls, %	41.2 ± 1.5	43.0 ± 2.0	+1.8	0.7	44.1 ± 1.7	+2.9	1.3

*Note: * P < 0.05; ** P < 0.01; *** P < 0.001;*

It was found that the bee hives placement for sunflower pollination influences all the characters related to the quantity and quality of the pollen collected by the bees, and their flight intensity.

Thus, the smallest pollen quantity, collected by the bee family, on average, per day, at the sunflower pollination, was recorded in batch I, where the bee hives were placed on one side (edge) of the experimental field (sector). By a more uniform and proportional placement of the bee hives on the land, the pollen amount collected daily by a family increases from 149 ± 5 g/day in the batch I, up to 174 ± 3 g/day in the batch II, so with 25 g/day or 16.8 % (td = 4.3; P < 0.001). The largest pollen amount gathered by bees in the nest, in this experiment, was found in batch III, where the bee hives were placed proportionally, on the four sides of the field. Thus, by the total pollen amount gathered daily in the nest by the bee families from the batch III, at the sunflower pollination, exceeded their fellows from batch I (witness) – with 46 g, or 30.9% (td = 5.9; P < 0.001), and those from the batch II – with 21.0 g or 12.1 % (td = 3.1; P < 0.01).

The collected pollen amount can be better viewed in the histogram (Fig. 2).

It is important to note that bee families from batches II and III provide the total increase of the collected pollen amount, mainly, on account of the main culture pollen quantity (sunflower), submitted to the conducted pollination with the help of the bees. Thus, by the sunflower pollen amount, accumulated in the nest by the bee families from batches II and III exceeded their fellows from the witness batch, respectively, with 24 g, or 20.7% (td = 4.1; P < 0.001) and 46 g or 39.6 % (td = 5.3; P < 0.001). The biggest pollen amount of this type, gathered by the bees in the nest, was found in batch III, where the bee hives were placed proportionally to the four sides of the field. Thus, by the sunflower pollen amount gathered in the nest daily, at this crop pollination, the bee families from batch III exceeded their fellows from batch I (witness) – with 46 g, or 30.9% (td = 5.9; P < 0.001), and those from batch II – with 22.0 g, or 15.7% (td = 2.9; P < 0.01).

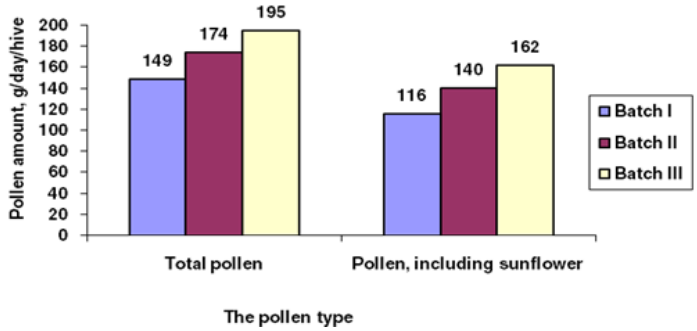

Fig. 2 The pollen quantity collected daily by a bee family at the sun flower pollination

Despite the fact, that most of the pollen amount gathered in the nest is of the main culture, however, a part of the pollen (22.1 – 16.8 %) is collected from the polyfloral land surrounding the sunflower field.

At the same time, in the experimental batches II and III, there is a growing tendency, of the main culture pollen share in the total pollen amount gathered in the nest. This explains the fact of the more qualitative pollination in batches II and III, of the main agricultural crop taken in the experiment.

The research results have shown that the pollination volume of the sunflower crop, realised by the bees, as well as its quality is determined by the bees flight intensity, both of those without pollen balls, that are bringing nectar, and those with pollen balls, who specially visited flowers to collect the pollen.

The data obtained in the experiment demonstrates that the bee families from the batch II had a higher tendency of flight intensity compared to the witness batch (td = 0.9 and 1.7), and the bee families from batch III, both with pollen balls and those without pollen balls, had a certain higher flight intensity compared to the witness batch. Thus, by the flight intensity, the bees without pollen balls from batch III exceeded their fellows from the witness batch with 46 bees/10 min, or 9.5 % (td = 2.1; $P < 0.05$), and those with pollen balls – with 35 bees/10 min, or 17.8 % (td = 3.1; $P < 0.01$).

The results obtained in the experiment shows that the most of the bees were flying to the sunflower to collect the nectar, as they return into the hive, mostly without pollen balls. However, it was found that at the sunflower crop, pollinated by the bees in the experiment, in the batches II and III, where the bee hives were placed more uniform on the pollinated crop land, was expressed an increasing tendency of the correlation between the bees with the pollen balls and those without pollen balls. This shows the fact that the bee hives placement systems, tested in the batches II and III, contributes to improving the quality and quantity of pollination, as well the gathering of a bigger amount of commercial pollen.

Considering, finally, the sunflower pollination results and its efficiency, depending on the bee hives placement system on the pollinated crop field, we identified the impact size of the entomophilous pollination at the above-mentioned crop, and its dependence on the bee hive placement method on the field (Table 3).

We have found that fertilization degree of the sunflower seeds of EL PASSO hybrid varies depending on the pollination type, and the bee hives placement on the field.

Thus, in the case of isolated pollination, in all the experimental batches, the most seeds of the inflorescence head (84.2 – 86.9%) were sterile (empty). The fertilization degree of the seeds, in case of isolated pollination, was very low, representing only 13.1-15.8%. In case of the free (entomophilous) pollination, contrary, the most seeds of the inflorescence head were fertile (full). The number of fertile seeds in the inflorescence head, in this case, exceeded 5.7 – 7.2 times the number in case of isolated pollination ($P<0.001$). The fertilization degree of the seeds from the inflorescence head, in case of free pollination (entomophilous), represented 88.6 – 92.1%.

Table 3 The assessment results of the sunflower seeds quantity and quality after the conducted pollination of the yearly sunflower sort *EL PASSO – 199*

Indicators (on average at 1 head inflorescence)	Pollination type	Batch I (N=10 heads)	Batch II (N = 10 heads)			Batch III (N = 10 heads)		
		M ± m	M ± m	d	td	M ± m	d	td
Seeds number in the head, total	Isolated	1219 ± 18	1262 ± 20	+43	1.6	1238 ± 14	+19	0.8
	Free	1254 ± 41	1273 ± 30	+19	0.4	1281 ± 27	+27	0.5
	% L/I	102..9	100.9	x	x	103.5	x	x
inclusive: fertile seeds	Isolated	195 ± 28	171 ± 16	-24	0.7	163 ± 13	-32	1.0
	Free	1109 ± 26	1157 ± 34	+48	1.1	1183 ± 25	+74*	2.0
	% L/I	568.7	676.6	x	x	725.8	x	x
sterile seeds	Isolated	1024 ± 19	1091 ± 27	+64*	1.9	1075 ± 17	+51*	1.9
	Free	154 ± 18	116 ± 12	-38	1.7	112 ± 13	-42*	1.9
	% L/I	15.0	10.6	x	x	10.4	x	x
seeds fertilization degree, %	Isolated	15.8 ± 2.0	13.6 ± 1.3	-2.2	0.9	13.1 ± 1.0	+2.7	1.2
	Free	88.6 ± 1.1	90.8 ± 0.9	+2.2	1.5	92.1 ± 0.8	+3.5**	2.6
	% L/I	560.7	667.6	x	x	703.1	x	x
Total weight of the seeds, g	Isolated	36.7 ± 0.8	38.3 ± 1.0	+1.6	1.2	38.2 ± 0.5	1.5	1.6
	free	67.5 ± 1.3	78.9 ± 1.8	+11.4***	5.1	83.6 ± 2.0	+16.1***	6.7
	% L/I	183.9	206.0	x	x	218.8	x	x
The weight of fertile seeds, g	Isolated	28.3 ± 0.9	31.6 ± 1.3	+3.3*	2.1	30.7 ± 0.9	+2.4*	1.9
	Free	64.2 ± 1.1	76.1 ± 1.8	+11.9***	5.6	80.8 ± 2.0	+16.6***	7.2
	% L/I	226.8	240.8	x	x	263.2	x	x
The weight of sterile seeds, g	Isolated	8.4 ± 1.1	6.6 ± 0.6	-1.8	1.4	7.0 ± 0.5	-1.4	1.1
	Free	3.3 ± 0.3	2.8 ± 0.2	-0.5	1.4	2.8 ± 0.2	-0.5	1.4
	% L/I	39.3	42.4	x	x	40.0	x	x

*Note: * P < 0.05; ** P < 0.01; *** P < 0.001;*

The lowest seed fertilization degree was recorded at the inflorescence heads of the batch I (witness), where the bee hives were placed at a single side of the field. The more uniform and proportional placement of the bee hives, at the field sides, the seeds fertilization degree has an increase tendency in the experimental batch II, where the bee hives were placed on two opposite sides of the field, and significantly increases in the experimental batch III, where bee hives were placed on the four proportional sides of the field. The highest seed fertilization degree, in case of free (entomophilous, cross) sun flower pollination, was recorded in the batch III, where the bee hives were placed uniformly on the four sides of the field, and it is higher compared to the witness batch, with 3.5 percentage points, or 4.0% (td = 2.6; P < 0.01).

Given that, the final result of the sunflower crop pollination is the seed weight (harvest), this character serves as the basis for assessing the efficiency of bee pollination.

The research results have shown that the total seed weight harvested on average from a inflorescence head, after the entomophilous (cross) sunflower pollination exceeds that of isolated pollination (auto pollination) in all the batches and examined sectors - with 1.8 – 2.2 times , and by fertile seed weight – 2.3 – 2.6 times (P < 0.001). This research result is the most extensive argument for entomophilous (cross) sunflower pollination in order to overcome scepticism of some agronomists who, until now, doubt the need of entomophilous pollination of sunflower hybrid sorts.

The seed weight variability, depending on the pollination type and bee hives placement system on the field is reflected in the histogram in Fig. 3.

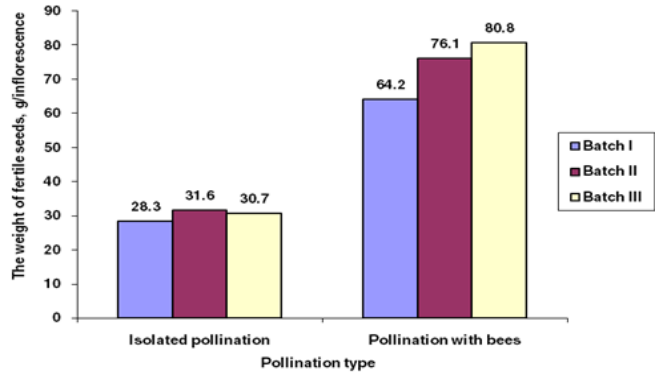

Fig. 3 The weight of sunflower fertile seeds, depending on the pollination type

We found that, at the sunflower entomophilous pollination the total seed weight of the batch II, where the bee hives were placed on two opposite sides of the field, exceeded that of the witness batch with 11.4 g, or 16.9% (td = 5.1; P<0.001), including fertile seed weight of this batch was bigger with 11.9 g, or 18.5% (td = 5.6; P<0.001).

In the experimental batch III, where the bee hives were placed uniformly on the 4 sides of the sunflower field, the total seed weight was bigger compared to the witness batch – with 16.1 g, or 23.8 % (td = 6.7; P<0.001), with an overcome tendency, compared with batch II. As well, the fertile seed weight from the batch III significantly exceeded the weight from the witness batch - with 16.6 g, or 25.8% (td = 7.2; P<0.001), with an overcome tendency, compared to the batch II.

Generalizing the results of scientific experiment, we conclude that the more uniform and proportional placement of the bee hives at the edges of the field, contributes significantly to the increase of both - fertile seed weight as well the total seed weight, so enhancing the harvest per hectare. This is due to the fact that the bees are closer to the picking source, making less effort to fly in search of food and making more flights per unit time.

CONCLUSIONS

1. The free entomophilous pollination, mainly, with the help of the honey bees, of the sunflower early hybrid *EL PASSO-199* provides, compared to the isolated (self-pollination) pollination, an increase of the seeds fertilization degree from inflorescence heads – 5.6 -7.0 times more, and of the seed production weight (harvest) – 2.3 – 2.6 times more.

2. The bee hives placement for pollination as closest to the picking source, and as more uniform and proportional, at the four size of the sunflower field, contributes to a significant increase of the bees visits frequency to the flowers – with 82.5 %, of the flight intensity of the bees without pollen balls – with 9.5 % and of those with pollen balls – with 17.8 %, of the collected pollen amount – with 39.6 %, of the seed fertilization degree – with 4.0%, and of the seed production – with 23.8%.

REFERENCES

Journal articles:
[1] Falaleev N.A. şi colab.: Sporirea producţiei de floarea-soarelui în Kazahstanul de Est cu ajutorul deplasărilor în pastoral ale stupinelor în vederea culesului şi a polenizării. //Polenizarea cu albine. APIMONDIA, Bucureşti, 1973, p. 230 - 233.
[2] Frediani Danilo: Rolul albinelor în polenizarea florii-soarelui (Helianthus annuus L.) în Italia Centrală. // Polenizarea cu albine. APIMONDIA, Bucureşti, 1973, p. 228 - 230.
[3] Furgala Basil: Polenizarea florii-soarelui – un domeniu de cercetare neglijat (în SUA).// Polenizarea cu albine. APIMONDIA, Bucureşti, 1973, p. 233 - 237.
[4] Ion Nicoleta: Resursele melifere ale României. Apicultura – manualul cursantului. ACAR, ICDA, România. Ed. „LVS Crepuscul", Ploieşti, 2012, p. 12 - 48.

[5] Ion Nicoleta, Ion V., Fota G., Coman R., Ştefan V.: Scientific data regarding the honey phasing in sunflower crops. International Apiculture Symposium Durable Management of Beekeeping Activity According to EU Demands, Romînia, Tulcea, Ed. CITDD-TULCEA, ISBN 978-973-88117-3-7, 2008, p. 27 – 30.
[6] Ion Nicoleta, Fota G., Coman R., Ştefan V., Ion V.: Rezultate privind caracteristicile melifere ale hibrizilor străini de floarea-soarelui cultivaţi în România. Lucrări Ştiinţifice Zootehnie şi Biotehnologii, vol. 40(2), România, Timişoara, 2007, p.80–90.
[7] Ion V., Ştefan V., Ion Nicoleta, Roman G., Dumbravă M.: Date privind înflorirea la un sortiment de hibrizi străini de floarea-soarelui admişi pentru cultivare în România. Simpozionul Internaţional de Apicultură „Managementul durabil al exploataţiilor apicole în concordanţă cu cerinţele UE. România, Tulcea, 2006, 7-8 octombrie (lucrare publicată pe CD, 9 pag. 26).
[8] Katarov G.: Eficienţa economică a polenizării florii-soarelui de către albine, în Dobrogea (Bulgaria). // Polenizarea cu albine. APIMONDIA, Bucureşti, 1973, p. 225 - 227.
[9] Pătruică Silvia: Polenizarea culturilor agricole. // Revista ferma, anul XI, nr. 73, România, Timişoara, 2009, ISSN 1454-7732 p. 97.
[10] Ponomareva E.G.: Dirijarea activităţii polenizatoare a albinelor. // Polenizarea cu albine. APIMONDIA, Bucureşti, 1973, p. 220 - 224.
[11] White Bruce: Polenizarea culturilor de plante oleaginoase de către albinele melifere şi efectul pesticidelor aplicate pe aceste culturi. // Polenizarea cu albine. APIMONDIA, Bucureşti, 1973, p. 240 - 249.
[12] Yadav R.N., Sinha S.N., Singhal N.C.: Polenizarea de către albinele melifere (Apis sp.) şi producţia de seminţe hibrid de floarea soarelui: efectul tipului de plantare asupra mişcărilor albinelor melifere şi aria lor de acţiune. Lucrările ştiinţifice ale XXXVI-lea Congres Internaţional al Apicultorilor din APIMONDIA. Lyubljana, Slovenia, 2003, 24-29 august, p. 248 – 233.
Book:
[13] Плохинский Н.А. Руководство по биометрии для зоотехников. Изд. «Колос», Москва, 1969, 256 с.