THE ENERGY BALANCE FOR SUNFLOWER CROPS UNDER IRRIGATION AND DIFFERENT DOSES OF FERTILIZERS AND BASIC SOIL OPERATIONS

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ABSTRACT

This paper presents the energetic results of sunflower crops under different irrigation doses, fertilizers and soil operations.

The results regarding the energy (produced, consumed and energetic balance) and measured in Mcal/ha taking into consideration water supplies and the machines used for the soil reflect high values.

While the sunflower production was modest, the energetic balance was high for all the factors because of the energetic content of the products.

The value determined for the sunflower production confirms the fact that this crop is very profitable when the factors are offered at the level demanded by the crop, the energy volume is very high and the volume of the consumed energy is very low.

INTRODUCTION

In agriculture, the vegetable production is the only domain where the consumed energy (as work, fuel, electrical energy, fertilizers, pesticides and herbicides) has as result products generating energy.

This is due to photosynthesis, process which transforms the solar energy, carbon dioxide and water into vital energy and biochemical energy. These elements being offered by nature, the energy resulted from plant growing is always higher than the energy consumed to obtain it.

But, in this process, an important role is detained by leaf surface which is correlated with the total production of dry substance which for wheat, corn and sunflower with high density for hectare, with certain limits, insure a big leaf surface which determines high productions.

Sunflower is known as a plant that uses very well the used factors (irrigation, tillage, mineral fertilization) bringing a good energetic result, especially when using crop rotation.

MATERIAL AND METHOD

The experiment lasted for 3 years and was placed on a chernozemic baticalcaric soil which presented a moderate acid reaction and comprised the following factors :

Factor A - irrigation with 3 graduations :

a1 - medium irrigation (50% from IUA) ; a2 - limited irrigation (1/2 from a1) ; a3 - non-irrigated

Factor B - soil operations with 3 graduations :

b1 - plowing at 22 - 25 cm + harrowing and 2 disking + cultivator for preparing the seedbed

b2 - chisel at 22 - 25 cm + harrowing and chisel at 8 - 10 cm + harrowing for preparing the seedbed
b3 - chisel at 8 - 10 cm + harrowing

Factor C - nitrogen fertilization on fund of P80 with 4 graduations and the following doses :
c_1 – N_0; c_2 – N_{40}; c_3 – N_{80}; c_4 – N_{120}

Phosphorous fertilizers were applied every fall (as superphosphate simple with 20% P2O5) before plowing and the nitrogen as ammonium nitrogen with 33.5% N in the quantities established previously and it was applied after sowing.

In this context we analyzed the efficiency of the irrigation regime, tillage and fertilization applied through the energetic criterium.

We determined the produced energy (Mcal/ha), the consumed energy (Mcal/ha), the energetic balance (Mcal/ha) and also the energetic efficiency function of the water quantity and tillage.

RESULTS AND DISCUSSION

Although sunflower crop registered a smaller production (as quantity), the content of gross energy being larger, it presented a higher energetic balance.

- The energy production in condition of optimum irrigation was between 10226 and 20095 Mcal/ha with 3.52 higher than the consumed one, for the variants with limited irrigation (from 9835 to 17492 Mcal/ha) with 3.51 higher and 3.09 for the non-irrigated (7385 to 14272 Mcal/ha), as a rapport we produced with 3.09 - 3.52 Mcal per 1 Mcal consumed - table 1.

- The energetic efficiency rose from 2.60 for the normal irrigation to 2.68 for the limited and diminished to 2.27 for the non-irrigated crop.

- The analysis made regarding the produced, consumed energy and the energetic balance in Mcal/ha on the tillage in the 3 situations of irrigation for sunflower crop indicates important differences.

In the case of 50% water from IUA, the highest energy rate rate 16148 Mcal/ha was registered when working with chisel at 35 cm distance between rows and 22 - 25 cm depth + harrowing, for the consumed energy - 4499 Mcal/ha for the usual plowing and the highest energetic balance - 11774 Mcal/ha when using chisel at the same depth (fig. 1.1).

The use of a reduced water quantity of water (1/2 from the optimum dose) lead to the decreasing of the energetic parameters on tillage the consumed and produced energy is realized for the tillage made with the same machines as for the case of optimum irrigation (14572 and 4015 Mcal/ha) and the highest energetic balance was registered when using chisel at 22 - 25 cm depth + harrowing (10577 Mcal/ha) - table 1 and figure 1.2.

For the non-irrigated variants, the values diminished even more, the produced energy was 11195 Mcal/ha for normal plowing, the biggest consume at this tillage and chisel at the same depth (3625 Mcal/ha) and the highest balance at plowing was 7570 Mcal/ha - table 1, figure 1.3.

Table 1

Energetic balance and energetic efficiency (E.E.) for sunflower crop function of the experimented factors (medium values)

Water supply	Tillage	N dose	Production Kg/ha	Prod. energy Mcal/ha	Consumed energy Mcal/ha	Energetic balance Mcal/ha	E.E.	Medium E.E. For irrigation	Medium E.E. For tillage	Consum energy Mcal/kg prod
Optimum irrigation (50% from IUA)	Plowing at 22-25 cm	N_0	1965	11120	2874	8246	2.87	2.60	2.55	1.46
		N_{40}	2603	14730	3963	10767	2.72			1.52
		N_{80}	3086	17464	5042	12422	2.46			1.63
		N_{120}	3491	19756	6118	13638	2.23			1.75
	Chisel 22-25 cm	N_0	2062	11669	2851	8818	3.09		2.69	1.38
		N_{40}	2696	15257	3938	11319	2.87			1.46
		N_{80}	3105	17571	5014	12557	2.50			1.61
		N_{120}	3551	20095	6092	14003	2.30			1.71
	Chisel 8-10 Cm	N_0	1807	10226	2754	7472	2.71		2.54	1.52
		N_{40}	2645	14968	3851	11117	2.89			1.46
		N_{80}	2986	16898	4924	11974	2.43			1.65
		N_{120}	3304	18697	5996	12701	2.12			1.81
Limited irrigation(1/2 from optimum)	Plowing at 22-25 cm	N_0	1751	9909	2397	7512	3.13	2.68	2.58	1.37
		N_{40}	2347	13282	3482	9800	2.81			1.48
		N_{80}	2795	15817	4560	11257	2.47			1.63
		N_{120}	2897	16394	5621	10773	1.92			1.94
	Chisel 22-25 cm	N_0	1902	10763	2375	8388	3.53		2.81	1.25
		N_{40}	2475	14006	3459	10547	3.05			1.40
		N_{80}	2832	16026	4533	11493	2.53			1.60
		N_{120}	3091	17492	5612	11880	2.12			1.81
	Chisel 8-10 Cm	N_0	1738	9835	2283	7552	3.31		2.65	1.31
		N_{40}	2479	14029	3376	10653	3.15			1.36
		N_{80}	2670	15109	4441	10668	2.40			1.66
		N_{120}	2671	15115	5498	9617	1.75			2.06
Non-irrigated	Plowing at 22-25 cm	N_0	1305	7385	2008	5377	2.68	2.29	2.22	1.54
		N_{40}	1928	10910	3094	7816	2.53			1.60
		N_{80}	2158	12212	4161	8051	1.93			1.93
		N_{120}	2522	14272	5236	9036	1.78			2.08
	Chisel 22-25 cm	N_0	1434	8115	1985	6130	3.09		2.28	1.38
		N_{40}	1915	10837	3065	7772	2.54			1.60
		N_{80}	2150	12167	4132	8035	1.94			1.92
		N_{120}	2355	13327	5198	8129	1.56			2.21
	Chisel 8-10 Cm	N_0	1410	7979	1899	6080	3.20		2.29	1.35
		N_{40}	1797	10169	2975	7194	2.42			1.65
		N_{80}	2166	12257	4049	8208	2.03			1.87
		N_{120}	2297	12999	5111	7888	1.54			2.22

The energy balance presented a growth with some differences - figure 2.

Consequently, in the case of optimum and limited irrigation we noticed a constant growth of the efficiency for the first two soil operations (plowing and chisel) and decrease when we used chisel at small depth as a consequence of the fact that the consumed energy was bigger than the produced one.

For the non-irrigated variant, the energetic efficiency was bigger for plowing and chisel at 8 - 10 cm + harrowing and was determined by the reduction of the consumed energy.

The calculation made indicates different values but these values are growing with the reduction of the water supply and the increase of the nitrogen doses.

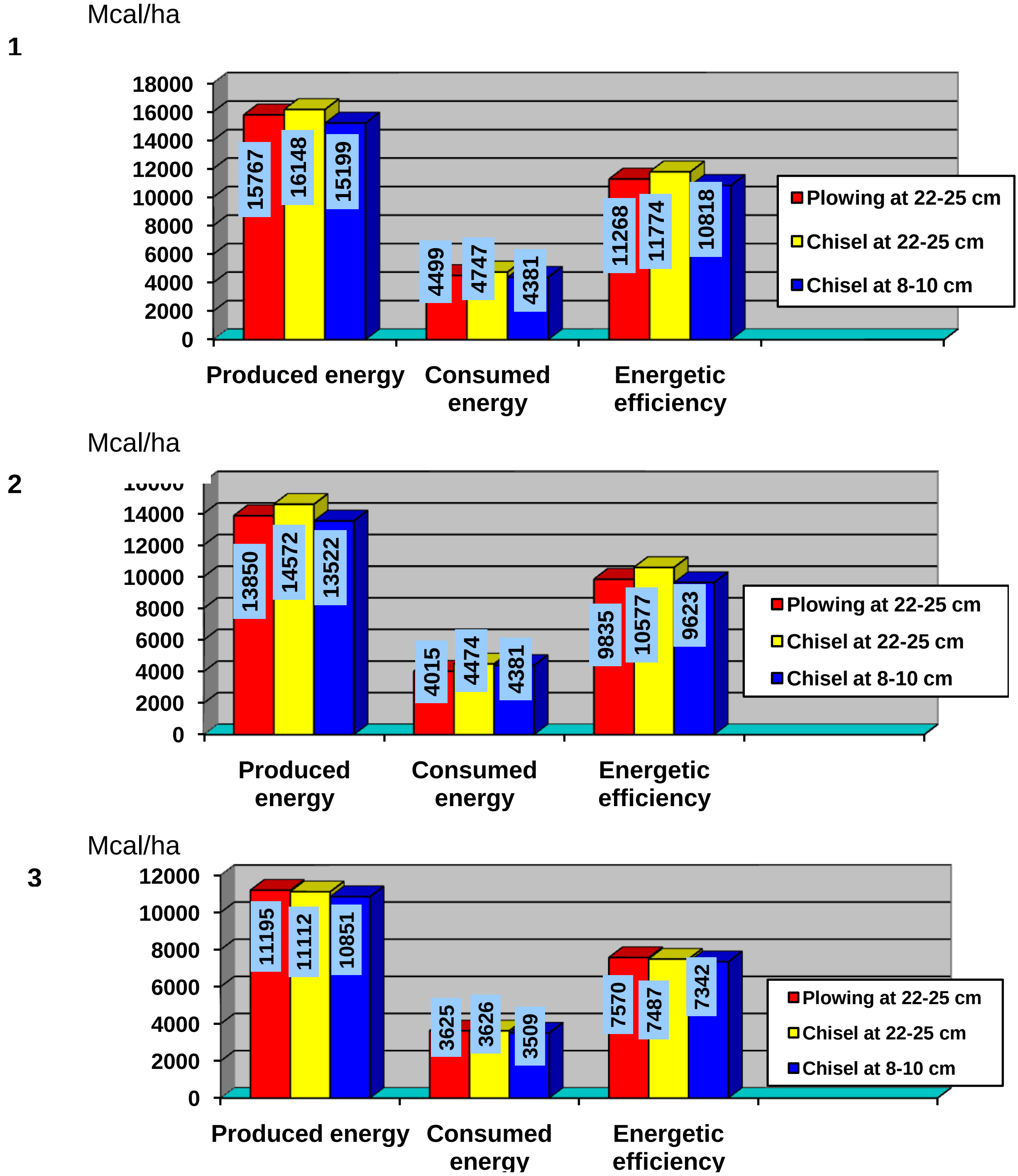

Figure 1. Produced energy, consumed energy and energetic efficiency in Mcal/ha for sunflower crops (average for the period 2003 - 2005) function of water supply.
1. Optimum irrigation (50% from IUA)
2. Limited irrigation (1/2 from optimum irrigation)
3. Non-irrigated

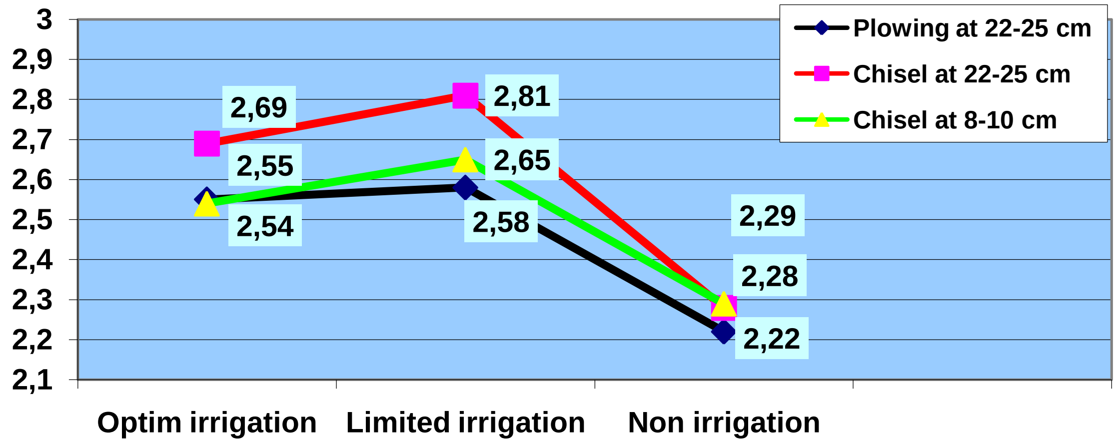

Figure 2. Energetic efficiency for sunflower crops function of water supply and soil tillage (3 years average).

In conditions of 50% irrigation from IUA (table 1 and figure 3.1), for plowing at 22 - 25 cm depth + harrowing, the energy consumed increased constantly from 1.46 Mcal/kg for the unfertilized variant to 1.75 Mcal/kg for the maximum dose of 120 kg/ha nitrogen, as a consequent of the growth of the consumed energy.

Using chisel at the same depth, because of the higher efficiency of the machine, of the produced energy and the diminished use of fuel, 1 kg of product was obtained with a consume smaller than 1.38 to 1.71 Mcal/kg of sunflower.

Soil preparation in fall using chisel at 8 - 10 cm + harrowing, as a result of a smaller volume of produced energy, registered values of consumed energy from 1.52 to 1.81 Mcal/kg of product.

The use of half of water supply (1/2 from optimum irrigation) and the decrease of the produced energy for tillage lead to a small increase of the consumed energy (table 1 and figure 3.2). Normal plowing determined the consume from 1.37 to 1.94 Mcal/kg product, the use of chisel at the same depth from 1.25 to 1.81 Mcal/kg product (the smallest in these irrigation conditions) and from 1.31 to 2.06 Mcal/kg sunflower when we used chisel at 8 - 10 cm + harrowing.

The growth in conditions of non-irrigation registered the highest increase of the consumed energy per unity of product function of the tillage and the doses of fertilizers as a consequence of the decrease of produced energy (table 1 and figure 3.3). Plowing at 22 - 25 cm depth + harrowing registered a consume from 1.54 to 2.08 Mcal/kg seeds, using chisel in the same conditions presented values of the consumed energy from 1.38 to 2.21 Mcal/kg and for the case of chisel at 8 - 10 cm we registered the biggest growth from 1.35 to 2.22 Mcal/kg sunflower.

These data confirm the fact that sunflower plants need sufficient water to value the fertilizers and determine a growth of produced energy.

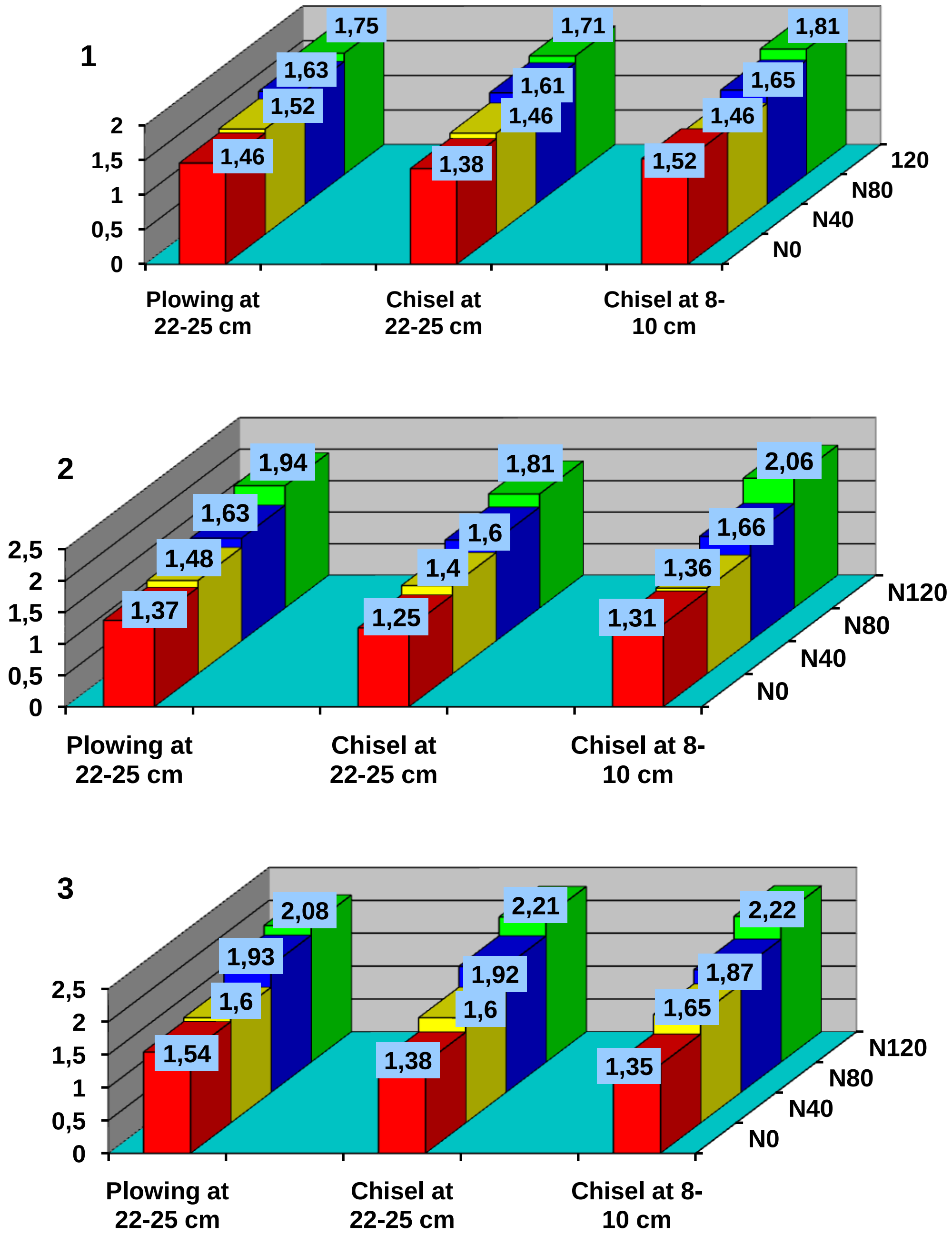

Figure 3. Energy consume Mcal/kg of sunflower (average for 3 years) in different irrigation conditions and function of tillage and applied fertilization with nitrogen on a fund of P_{80}:
- Optimum irrigation (50% from IUA)
- Limited irrigation (1/2 from optimum irrigation)
- Non-irrigated

CONCLUSIONS

For sunflower crops although the level of production was lower, because of the content of brute energy (brute energy of a product unity), the energetic efficiency was higher for the allowed factors.

The report produced/consumed energy presented higher values in the case of different irrigation levels, from 3.52 for optimum irrigation, 3.51 for limited irrigation and 3.09 for non-irrigation, producing more energy for 1Mcal consumed.

The energetic efficiency presented an increase from the optimum irrigation to the limited one but, it decreased in conditions of non-irrigation as a consequence of reducing the produced energy.

In the case of water levels, the results for the 3 basic soil operations highlighted the increased values of the produced energy for chisel at 22 - 25 cm + harrowing, followed by normal plowing and plowing at 8 - 10 cm + harrowing.

The consume of energy Mcal/kg of sunflower seeds (average for experimental period) in report with the allowed factors, indicates different values but increasing with the reduction of water levels and increasing nitrogen doses.

The presented values confirm the fact that sunflower needs sufficient water (although it is drought resistant) to use the applied fertilizers and determine a growth of the energy production in association with the most efficient tillage.

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