EFFECT OF NUTRIENT SUPPLY ON QUANTITY AND QUALITY OF HEMPSEED

Ildikó IVÁNYI, Zoltán IZSÁKI

Szent István University Faculty of Water and Environtal Management
***Institute of Agricultural Science**, Szarvas, H-5541 P.O.B.3; Hungary*
Corresponding author: gergely.ildiko@mvk.tsf.hu

Abstract: *Hempseeds are a rich source of proteins, vitamins, minerals and essential fatty acids. Compared to hemp oil, little research has been conducted on hemp protein, but this subject will receive more attention with the increasing use of hemp foods. Industrial hemp fertilization field experiment have been conducting in 2000 on chernozem meadow soil in Hungary to determine the quantity and quality of hemp stalk and hempseed at different nitrogen (N) application rate and different soil phosphate (P) and potassium (K) levels with Chinese monoecious variety for dual utilization. In this paper we report about the influence of N supply on stalk and seed yield, oil content, protein content, amino acid content, 9 essential amino acid and 8 non essential amino acid content of hempseed. - Chinese monoecious hemp is suitable for dual usage. We can achieve 12-14 tha^{-1} good quality stalk yield and 0,6-1,2 tha^{-1} seed yield with 2,25 million germs ha^{-1} and with 80 kgha^{-1} N fertilization in 3,5 humus content chernozem meadow soil. - Hemseed had 32,8-33,6 % oil content, 24,8-26,9 % crude protein content and it contain all nine essential amino acids and eight non essential amino acids. - N-fertilization increased the oil content and crude protein content and amino acid content of hempseed till 80-160 kgha^{-1} rates. More N did not increased or decreased that tested parameters. - For dual usage Chinese monoecious hemp fertilization which take int consideration the plant requirements and environments also, is enough 80 kgha^{-1} N application on soil 140-200 mgkg^{-1} AL-P_2O_5 phosphorus (P_0, P_1) and 400-430 mgkg^{-1} AL-K_2O potassium (K_2, K_3) supply levels.*

Key words: *Industrial hemp, low-cost biological resource, dual utilization hemp, stem/stalk yield, seed yield, THC-content (tetra-hydro cannabinol), oil-content, protein-content, amino acid composition*

INTRODUCTION

Industrial hemp is a valuable, low-cost biological resource that can be grown in most climates. It is a hardy plant whose rapid growth and high resistance to diseases largely eliminate the need for costly herbicides or pesticides. Hemp can play an important role in rural economic development: new jobs and businesses can be created to produce hemp products, for both local consumption and marketing to other regions.

Its bast fibers, core, seeds, and flowers can serve as raw material for numerous products: food, paper, textiles, carpets, insulation materials, fiber-reinforced plastics, animal bedding, body-care products, aromatic essential oils, and many others. These products often have technical advantages over competing products, are cost-competitive, and provide environmental benefits.

Recently the phenomenal food and body-care products potential of its seed has received some attention. Dioecious vareities - because 50 % female and 50 % male plant - have low seed yield. So, monoecious varieties more suitable for seed production.

Whole and shelled hempseeds contain, respectively, around 25 and 35 percent protein. About 65 percent of the total protein in hempseed accurs as the easily digestible storage protein edestin. The limited data indicate that hempseed protein contains all nine essential amino acids and features a high content of the two sulphur-containing amino acids methionine and cysteine, usually underrepresented in vegetable proteins. It also contains high proportions of glutamic acid, an important neurotransmitter often in short supply under stress (GERO et al., 1999).

Compared to hemp oil, little research has been conducted on hemp protein, but this subject will receive more attention with the increasing use of hemp foods.

Traditional hemp production in Hungary happened for its bast fibre in plant stalk. Seed production was only for planting of seeds.

Monoecious varieties of hemp have never been cultivated in Hungary but some testing research in Kompolt showed that stalk yield and fibre yield per hectare remain lower than Hungarian dioecious varieties. The aim of the research were compared the stalk yield of monoecious and dioecious hemp varieties but they were not tested to seed yields of dual usage hemp (BÓCSA-KARUS, 1998).

So, after a long period (from 1990 to 1998) fertilization experiment with dioecious Kompolti hemp which aimed to determine the effect of nutrient supply on quantity and quality of stalk yield, from 1999 we continued our research with monoecious Chinese variety in respect of dual usage.

The goal of our research were to determine the influence of nutrient supply

- on stalk yield quantity and quality,
- on seed yield quantity, and quality:
- oil-, protein-content, amino acid composition of crude protein.

In this paper we report about the influence of N supply on stalk and seed yield, oil content, protein content, amino acid content, 9 essential amino acid and 8 non essential amino acid content of hempseed on the base the results of 2000 year experiment.

MATERIAL AND METHODS

Fibre hemp fertilization and experiment were undertaken in the south-east part of Hungary in 2000. Broad bean were grown prior to the hemp.

We applied four levels of N, P, K fertilizers in total combinations (4x4x4=64) to determine the stem and seed yields. N fertilizers were applied at rates of 0, 80, 160, 240 kgNha^{-1}. From P and K treatments the P_1, K_1 aimed at the maintenance of sufficient nutrient supply level in the soil, whereas the P_2, P_3 and K_2, K_3 aimed at the development of the different nutrient supply level (Table 1).

The total area of the basic plots was 20 m^2, in split-spit plots design and with three replicates.

In 2000 Chinese monoecious hemp planted seeding rate was 45 kgha^{-1} with a row space of 12 cm. In 2000 the annual precipitation was only 338 mm and it was 220 mm in the growing season in very uneven distribution.

RESULTS AND DISCUSSIONS

One year experiment shows that Chinese monoecious hemp is suitable for double utilization (Table 2).

We could achieve 12-14 tha^{-1} stem yield and 0,60-1,20 tha^{-1} seed yield with 0-80 kgha^{-1} N application rate (N_0,N_1) at 140-200 mgkg^{-1} AL-P_2O_5 phosphorus (P_0P_1) and 400-430 mgkg^{-1} AL-K_2O potassium (K_2K_3) supply levels. The stem length changed between 146-163 cm. This stem length is suitable for mechanised harvesting technique of seed yield. The stem diameter did not increase above 10 mm, which is acceptable for textile industry.

The Chinese monoecious hemp in couple leafs under flowers has low, 0,056 percent THC content on average. It seems to be N and P fertilization decrease the THC content, but there are some positive interaction in combinations of N, P, K fertilization. Need more investigation for determine the fertilization effect on THC changes in fibre hemp (Table 3).

Table 1

The applied treatments and their influence on the nutrient supplies of the soil (1990-1999, Szarvas)

Treatmens of „A" factor	N $kgha^{-1}$ Yearly	NO_3-N, $kgha^{-1}$ in 0-60 cm soil							
		1989	1990	1991	1992	1995	1996	1998	1999
N_0	N_0	72	57	50	70	68	25	12	20-22
N_1	N_{80}	72	84	74	102	95	34	20	
N_2	N_{160}	72	110	71	125	146	36	24	
N_3	N_{240}	72	144	79	119	208	35	25	
$LSD_{5\%}$		-	26	-	41	31	-	-	-
Treatmens of „B" factor	P_2O_5 $kgha^{-1}$ Shared	AL-P_2O_5 $mgkg^{-1}$ in 0-40 cm soil*							
		1989	1990	1991	1992	1995	1996	1998	1999
P_0	P_0	132	111	113	107	125	133	126	138
P_1	P_{100}/year	132	110	112	120	137	159	154	194
P_2	P_{500}/4 years in 1989 P_{500}/8 years in 1993	132	168	143	151	195	192	170	185
P_3	P_{1000}/4 years in 1989 P_{1000}/8 years in 1993	132	233	206	210	287	233	225	238
$LSD_{5\%}$		-	47	40	42	59	-	-	-
Treatmens of „C" factor	K_2O $kgha^{-1}$ Shared	AL-K_2O $mgkg^{-1}$ in 0-40 cm soil							
		1989	1990	1991	1992	1995	1996	1998	1999
K_0	K_0	296	280	281	268	246	254	272	248
K_1	K_{300}/year, from autumn 1993 100 kg/year	296	317	333	307	356	359	370	360
K_2	K_{600}/4 years in 1989 K_{1000}/8 years in 1993	296	360	353	289	406	408	402	403
K_3	K_{1200}/4 years in 1989 K_{1500}/8 years in 1993	296	388	391	318	466	436	442	428
$LSD_{5\%}$			-	56	49	35	67	-	-

* 0-40 cm = average of 0-20 cm and 20-40 cm

Table 2

Influence of nutrient supply on yield parameters of Chinese monoecious hemp (2000, Szarvas)

Treatments	Stem yield t ha^{-1}	Seed yield t ha^{-1}	Stem length cm	Stem diameter mm	Density at harvesting time million ha^{-1}
1. $N_oP_oK_o$	6,5	0,39	110	4,7	1,14
2. $N_oP_oK_1$	11,0	0,63	136	6,3	1,12
3. $N_oP_oK_3$	13,0	0,63	146	5,2	1,18
4. $N_1P_oK_o$	7,5	0,44	114	4,9	1,20
5. $N_1P_oK_1$	10,5	0,52	145	5,4	1,22
6. $N_1P_1K_2$	12,0	1,19	159	5,4	1,20
7. $N_1P_oK_3$	14,0	0,62	163	5,1	1,25
8. $N_1P_1K_3$	14,0	0,65	159	5,4	1,20
Average	11,06	0,63	141	5,3	1,18

Table 3

The influence of N, P, K supply on the % THC content of Chinese monoecious variety hemp (2000, Szarvas) (IVÁNYI-BÓCSA-MÁTHÉ 2000)

A, B K, P	C_1 N_0	C_2 N_{80}	C_3 N_{160}	C_4 N_{240}	$LSD_{5\%}$	Average
K_0P_0	0,072	0,024	0,026	0,017	$c_0a_0b_0$- $c_1a_0b_0d_0$:	0,035
K_0P_1	0,018	0,022	0,021	0,024		0,021
K_0P_2	0,035	0,025	0,024	0,026	0,034	0,028
K_0P_3	0,019	0,019	0,016	0.034		0,022
$LSD_{5\%}$: $b_0a_0c_0$- $b_1a_0b_0$: 0,035						
K_0P_0	0,072	0,024	0,026	0,017		0,035
K_1P_0	0,019	0,019	0,019	0,035	0,034	0,023
K_2P_0	0,144	0,116	0,101	0,113		0,119
K_3P_0	0,096	0,043	0,124	0,036		0,075
$LSD_{5\%}$: $a_0b_0c_0$- $a_1b_0c_0$: 0,038						

Hempseeds have unique nutrition composition. Their relative oil percentage changed between 32,8-33,6 %, crude protein 24,8-26,9 and the relative amino acids increased 6-8 percentage depending on N rates (Table 4).

Table 4

Effect of N supply on oil-, protein content and amino acid composition of hempseeds (2000, Szarvas)

Components	N_0	N_{80}	N_{160}	N_{240}	$LSD_{5\%}$
Oil %	32,8	33,6	33,1	33,2	-
Crude protein %	24,8	26,4	26,9	26,9	1,49
Amino acid %	-	106	108	108	-
Essential					
Arginine	2,23	2,38	2,45	2,44	-
Phenylalanine	0,92	1,01	0,99	1,01	-
Histidine	0,56	0,58	0,61	0,61	-
Isoleucine	0,81	0,84	0,86	0,87	-
Leucine	1,41	1,46	1,51	1,50	0,07
Lyzine	0,77	0,81	0,83	0,83	0,03
Methionine	0,089	0,102	0,108	0,11	-
Threonine	0,70	0,73	0,77	0,75	0,04
Valine	0,96	1,00	1,03	1,01	-
Total essential amino acids	8,44	8,91	9,15	9,13	-
Rel. %	100	106	108	108	-
Non essential					
Alanine	0,92	1,00	1,04	1,02	-
Aspertic acid	1,96	2,03	2,12	2,09	-
Cystine	0,24	0,25	0,24	0,26	-
Glycine	0,86	0,89	0,94	0,93	0,05
Glutamic acid	3,17	3,26	3,41	3,38	-
Proline	0,41	0,45	0,40	0,42	-
Serine	0,98	1,02	1,07	1,04	0,05
Tyrozine	0,52	0,56	0,58	0,58	-
Total non essential amino acids	9,06	9,46	9,80	9,72	-
Rel. %	100	104	108	107	-
Total amino acids	17,50	18,37	18,95	18,85	-
Rel. %	100	105	108	108	-

Oil and crude protein content increased till 80 $kgha^{-1}$ N rate, more N decreased the oil content and did not increase the protein content significantly. Hempseeds contain all nine essential amino acids and eight non essential amino acids in a sufficient quantity and ratio to meet the body's needs.

N fertilization increased the total amino acid content in hempseed with 6-8 relative percentages, significantly. The essential and non essential amino acids increased with 4-9 percentages on 80-160 $kgha^{-1}$ N rate in all case. From essential amino acids leucine, lizine and treonine, and from non essential amino acids glicine and serine increased significantly with 80-160 $kgha^{-1}$ N rates, compared to control. More N did not increased or decreased them.

CONCLUSIONS

- Chinese monoecious hemp is suitable for dual usage. We can achieve 12-14 tha^{-1} good quality stem yield and 0,6-1,2 tha^{-1} seed yield with 2,25 million germs ha^{-1} and with 80 $kgha^{-1}$ N fertilization in 3,5 humus content chernozem meadow soil.
- Hemseed had 32,8-33,6 % oil content, 24,8-26,9 % crude protein content and it contained all nine essential amino acids and eight non essential amino acids.
- N-fertilization increased the oil content and crude protein content and relative amino acid content till 80-160 N $kgha^{-1}$ rates. More N did not increase or decrease that tested parameters.
- For dual usage Chinese monoecious hemp fertilization, which takes into consideration the plant requirements and environments also, 80 $kgha^{-1}$ N application rate as wall as 140-200 $mgkg^{-1}$ AL-P_2O_5 phosphorus (P_0, P_1) and 400-430 $mgkg^{-1}$ AL-K_2O potassium (K_2, K_3) supply levels are sufficient.

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