

## Influence High Temperature, Drought and Long Vegetation Period on Phenology and Seed Productivity European Hemp Cultivars in Moinkum Desert

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**Abstract:** Instead 100 days European cultivars of hemp grow more then 150 days in hard conditions of Moinkum desert of Kazakhstan. As a result seed and fiber productivity became low and flowering occur several times during vegetation. Seed propagation is not perspective in these conditions.

**Key words:** Hemp • Cultivars • High temperature • Long vegetation • Seed productivity

### INTRODUCTION

Wild hemp is one of the most valuable technical plant floras of Kazakhstan. Generally, it is accepted that the most economically advantageous became from the cultivation of cultural fibre hemp varieties. The fibre hemp (*Cannabis sativa* L.) is grown for a multitude of end products derived from the cannabinoids, seed, fibre and wooden core. As a fibre crop, it is one of the oldest non-food crops world-wide [1]. Moreover, it is very high yielding compared with many other crops [2]. According to Struik [3] fibre hemp may yield up to 25 t above ground dry matter per hectare (20 t stem dry matter ha<sup>-1</sup>), which may contain as much as 12 t ha<sup>-1</sup> cellulose, depending on environmental conditions and agronomy. Its performance is affected by the onset of flowering and seed development.

Several physiological features, however, require special attention in breeding and crop management, because they are determinant for crop yield and quality. Firstly, hemp is a short day plant and the length of the day determines the productivity [5]. It is therefore attractive to prolong the growing season by selecting later cultivars for higher latitudes [4, 6, 7]. In southern Europe, genotypes should be selected with a longer critical photoperiod to profit optimally from the available growing season. The cultivars that are grown in Europe are usually of French origin and have a critical photoperiod between 14 and 15.5 h. Their behavior is therefore different in different eco-regions of Europe and they may not be bale to make full use of the potential

of the seasons all over Europe. Secondly, there is a large degree of heterogeneity in the crop [8]. This is partly caused by sexual dimorphism: the differences in rate of growth and development between male and female plants are large [9]. The male plants tend to flower and senesce earlier. Also within the same sex, large plants are suppressing smaller ones and thus plant-to-plant variation can become considerable and may even result in self-thinning [10]. Particularly in dense stands intra-specific competition generates a size hierarchy and thus increases variability [8]. In the world about 10 places where are hemp grows high in cannabinoids, particularly THC. One of them is the desert Moinkum in which the Valley of Chui. The land on which, meets Chui cannabis is about 2213 hectares. Continuous growing high cannabinoid hemp occupy in valley of Chui about 56-125 ha (depending on the source and characteristics of the years). These thickets almost impossible to destroy without damage to nature. In our view, perhaps, but there cultural displacements of non-narcotic varieties while the degeneration of wild drug cannabis. Cultivation of cultivars requires the creation of factories for their processing. Processing of technology is well developed in Europe, but we do not know the technical of characteristics of varieties in terms of extreme continental climate in Kazakhstan.

On the basis of this research is to test seed production and growth of over ground part from European fibrous varieties of non-narcotic hemp varieties in extreme desert conditions Moinkum.

## MATERIALS AND METHODS

The characteristic features of the climate of the desert Moinkum, in particular and valley of Chui where experiments are conducted considerable sunshine and continental aridity. Amount of sunshine hours is 2500. The value of total radiation, even in the winter months than in 4000 Kcal/cm<sup>2</sup> per month. In the summer, it is 4 times more - up to 700 Kcal/cm<sup>2</sup> per day. Usually winter starts at the end of November. In January the average of temperature is -5.1°C. Snow cover appears at the end of November, but is set only by the third week of December. Snow depth is 15 cm. In the first half of March, the snow is coming off everywhere. Spring is fast and friendly. The average of the temperature on March is +3.3°C and in April +12°C. In this period is in about 40% of annual precipitation. In middle on April, the rainfall decreases dramatically. In this time, the temperature rise, increased evaporation, soil loses moisture quickly – comes hot dry period. In July the temperature reaches a maximum. The average of temperature on July is +22.7°C and the maximum of temperature is +43- +44°C. The soil surface became very hot without vegetation (up to +65- +70°C).

The transition from summer to fall is gradual. Weather has long been sustainable. In late of August, the sun warms the day in summer, but the nights are getting cooler on September and in October already frosts begin. In October, the weather is less stable: increased cyclonic activity, increased cloudiness and more rainfalls. The grassy of the desert and of the semi-desert vegetation, is in the summer to rest, resumes his development: the plains and foothills of the young leaves are covered again. In general, rainfall in the valley falls of Chui is small: about 250 mm per year.

European varieties of cannabis seeds Futura 75, Lovrin 110, Fedora 17, Felina 34 were planted in Merke area, the traditional site of growing narcotic hemp Valley of Chui on the area of 78 hectares with in a highly rain fed. The wild hemp grows at the same fields. At the end of April and the again in early May field overgrown with weeds and various cannabis was plowed into the 30 cm depth. The seeding produced on 8-9 May. Planting depth was 5 cm and distance between seeds from 5 to 10 cm, between rows was 15 and 30 cm. The type of soil gray and brown and the humus layer after layer coup missing. Little nitrogen and a lot of potassium. To improve the nitrogen content, ammonium nitrate added to increase granules rate of 100 kg/ha together with the seeds. The observation of the growth and development of plants began with 7 days after inoculation and continued throughout the growing

season. The harvesting planned to start at the end of August, we held only in the second half of September. Further we could no delay cleaning because it has already begun to stiffen the stem and be difficult to mechanized mowing. Observations showed that the cultivated varieties of cannabis, especially in dense plantation, completely inhibited the growth of weeds and wild hemp.

## RESULTS AND DISCUSSION

Hemp is a commonly used term for varieties of the cannabis plant and its products, which include fiber, oil and seed. It is the usual phenophase – seedlings, vegetative growth, flowering and ripening. Moreover, there is a sequence of hemp 12-organogenesis phase. For a more detailed study of the biology of European cultural varieties of cannabis in the valley of Chui, in different phases of organogenesis, we were determined the duration of phonological stages of plant and the production of seed. From each option were selected 100 plants, which grew in the middle of the field. Since this part of the field specifically is not watered, then the data are averaged character. Analysis of the structural elements of the harvest shows the characteristics of biomass accumulation of varieties and the impact of irrigation on the plants. For example, if the height of plants under irrigation of the variety Fedora 17, with row spacing of 15 cm is 187.6 cm, at 30 cm - 186 cm, the cultivar Felina 34 - 135.5 and 148.0 cm, grade Futura 75 - 174 and 169 respectively. When the watering the plant height of cultivar Lovrin is 160 cm. That is, row spacing significantly affects plant height only in the variety Felina 34. In the absence of watering the plant height was less than the varieties Fedora 17, Lovrin 110. At the grades Felina 34 and Futura 75 plants were higher than in the version without irrigation. Row spacing effected to heights of plant in the varieties without irrigation. At the varieties Fedora 17 and Felina 34 the row widths of plants were 30 cm higher and of the variety Futura 75 lower than between rows with 15 cm.

The diameter of the stem at the test plants depends on the grade and width of the aisle. The stem is thicker when the distance between rows is 30 cm than 15 cm. Varieties Fedora 17 and Lovrin 110 have most a thick stem. This pattern is typical for the lower, so the top of two tiers. In the absence of irrigation stem diameter is greater, especially in the variety Futura 75.

An important indicator of the structure is a number of crop seeds from the 1st plant. Varieties differ considerably on this indicator. Number of grains ranges from 32 to 172

in watering embodiment and in the embodiment without watering 28 to 143. In the embodiment watering, the minimum quantity of seed in varieties Felina 34 and a maximum - 172 in varieties Fedora 17. Usually, the plants growing in row widths of 30 cm more seeds. The exception is the sort of Felina 34 version watering, where the number of beans in the variant irrigation for row widths of 30 cm less than 15 cm.

Index weight of the 1-st stem is also very sensitive to the biological characteristics of varieties and irrigation. Usually in the form of 30 cm between rows aboveground part is heavier than in the version of 15 cm. In the variety Fedora 17 and Futura 75 in aboveground irrigation of weight is less than without irrigation. At grades Lovrin 110 u Felina 34 inverse relationship: in the version aboveground part of the plant watering harder.

Index weights of leaves from the 1st plants are more sensitive to watering. Weight of leaves is more in plants by watering than without it 1.5 -2.5 times. Of course, the amount of weight of the leaves in the 0,9-4,0 g does not reflect the total weight of the leaf, which has been on the branches during the growing season. However, by the time of harvest they are falling. Preserved only in apical leaves.

Seed weight from the 1st of the investigated varieties of plants depends on the conditions of irrigation, row spacing values. Thus, the greater the weight of the seeds of plants growing in 30 cm distance from each other by watering (Tables 1-3).

Good results was obtained with the variety Fedora 17. Weight of seed of this variety in the 1st plant is higher than that of other varieties (Table 4). The appearance of the descendants of the European wild hemp different (Figure 1): in the valley of Chui smaller seeds.

Greatest interest to producers represents gross results. Thus, we determined the yield of seeds, stems from the 1st ha. So, without watering from the 1st ha we collected from 22.6 to 93.9 kg of seeds. Under the conditions the crop irrigation is above. It varies from 109 to 398 kg. Fedora 17 and Felina-34 showed the highest seed yield. The distance between rows does not play a role in seed production. It is also due to the fact that the number of plants per 1 square meter in the varieties of 15 cm row spacing is slightly different from that at 30 cm row spacing. In the initial phase of development of varieties 15 cm was preferred over 30 cm. Usually under the plants of this option in the first 4 phenophase were not weeds. In the varieties of 30 cm row spacing at first time was weeds, especially in the phase of 4 leaves.

Interesting results were obtained in yield stems. It is higher in grade Felina-34 about 6 tons. It's an option when watering. At varieties Futura-75 and Lovrin-110 crops of stems lower than the other 2 types. Particularly the variety Lovrin 110 is sensitive to watering. Without watering it for 1 ha is formed only 650 kg of stems. All of varieties is a significant difference between the options without watering and irrigation. On the varieties 15 cm row spacing in all subjects varieties weight of stems is higher. This is understandable, since for fiber plants should be planted as close as possible to each other. When making complex of fertilizers were would be yield even higher. However, in this case it would not reach the average yield characteristic for Europe. Similar patterns are observed in the analysis of indicators of productivity of leaves and overall productivity. In fact, these results are not as important as indicators of productivity of seeds and stems, as yellowing leaves are not used for industrial processing. Although on the earlier timing of the harvest of leaves can be used for the preparation of herbal teas. Based on table 3 and 4 most of promising for the production valley of Chui of the examined species are Fedora 17 and Felina 34.

Weight of 1000 seed of yield in 2002 and 2003 of the studied varieties is different. Thus, the weight of the seed of yield in 2002 ranged from 17 to 19 grams. It is maximal at Lovrin 110 varieties and with minima in varieties Felina 34. In 2003 in seeds of 1000 grain of weight is 35-40% less and they varies from 6 to 12 grams. With the minimum of weight 6.8 mg of seed was the varieties Felina 34 and is maximal in the variety Lovrin 110. Overall the seeds of Lovrin 110 are larger than other varieties. This is apparently genetic feature of class. Unlike than other 3 cultivars he is not germofradit. He has a same-sex male and female. In origin it is from Romania and the remaining varieties have been bred in France.

If will take 1000 grains harvests in 2003, we can note their heterogeneity. We beat them by appearance to the fractions were counted and weighted. It was found that the brown seed from the class formed Fedora 17 – 39.1%, they weight made up 6.2 g (representing 57% of the total weight of the seed), on the cultivar Futura 75 – 35.0%, 3.6 g (52%) and Felina 34 – 33.0%, 4.4g (64%), on the cultivar Lovrin 110 – 45.0%, 96g (78%) respectively. The green seeds same as the brown. So, the variety Fedora 17 is 36.6%, they weight 3.6g, which is make 33% and in the cultivar Futura 75 – 46.0%, the weight is 2.3g, total is 33%, in cultivar Felina 34 – 30.0%, weight is 1.63g, 24%. In Lovrin 110 – 25.5% - 2.2g, total is 18%. The white with filled seeds are much smaller. In the cultivar Fedora 17 in

Table 1: Elements of a crop in varieties of hemp under irrigation in the valley of Chui

Varieties	Height of stems, cm	The diameter of the stem at the level of tier cm			The number of seeds per plant	The number of nodes of per plant	The number of plants on 1 m <sup>2</sup>
		1 tier	2 tier	3 tier			
Fedora 17 (b.n. 15 cm)	187.6± 9.46	0.74±0.03	0.54±0.02	0.26±0.01	138.8± 5.85	14.1±0.69	74
Fedora 17 (b.n. 30 cm)	186.5±5.89	0.85±0.04	0.71±0.03	0.30±0.01	172.9± 7.17	14.5±0.67	38
Felina 34 (b.n. 15 cm)	135,52±6,13	0,56±0,03	0,4±0,02	0,2±0,1	40±2,0	13,04±0,6	81
Felina 34 (b.n. 30 cm)	148±6,4	0,61±0,03	0,5±0,02	0,2±0,01	32,43±1,6	13,57±0,51	58
Futura 75 (b.n. 15 cm)	174±7,71	0,69±0,02	0,5±0,01	0,25±0,01	75,8±3,7	15,4±0,48	84
Futura 75 (b.n. 30 cm)	169±4,83	0,72± 0,03	0,61± 0,03	0,26± 0,01	101,5± 4,5	16,9± 0,77	41
Lovrin 110	160,7±5,12	0,87±0,04	0,68±0,03	0,27±0,01	122,1±3,6	16,1±0,75	25

Table 2: Elements of a crop in varieties of cannabis in Valley of Chui without irrigation

Varieties	Height of stems, cm	The diameter of the stem at the level of tier cm			Number of seeds per plant	Number of nodes of per plant	Number of plants on 1 m <sup>2</sup>
		1 tier	2 tier	3 tier			
Fedora 17 (b.n. 15 cm)	160.87± 7.88	0.81±0.03	0.7±0.02	0.27±0.0	92.3± 4.04	15.8±0.45	15
Fedora 17 (b.n. 30 cm)	177.3±6.1	0.83±0.04	0.68±0.03	0.28±0.01	136.5±7.0	20.28±0.76	16
Felina 34 (m.p. 15 cm)	161.1± 7.34	0.81± 0.04	0.66± 0.03	0.27± 0.01	136.0± 5.79	17.17± 0.83	39
Felina 34 (b.n. 30 cm)	166.37± 5.32	0.86± 0.04	0.75± 0.03	0.23± 0.01	119.0± 4.96	18.8± 0.92	19
Futura 75 (b.n. 15 cm)	200.6±9.85	0.98±0.03	0.78±0.03	0.3±0.01	28.13±1.36	12.07±0.6	41
Futura 75 (b.n. 30 cm)	184,33±8,31	0,88±0,04	0,64±0,03	0,27±0,01	143,8±7,0	20,14±1,0	28
Lovrin 110	151,33±2,31	0,79±0,04	0,62±0,03	0,24±0,01	63±1,73	10,5±0,53	15

Table 3: Production of terrestrial mass varieties of cannabis in the Chui Valley

Varieties	Weight of 1 stem, g		Weight of leaves of per plant, g		Weight of seeds, per plant, g	
	No watering	Watering	No watering	Watering	No watering	Watering
Fedora 17 (b.n. 15 cm)	18.17±0.49	14.2±0.58	1.08±0	1.72±0.08	0.489± 0.02	0.99± 0.04
Fedora 17 (b.n. 30 cm)	21.87±0.63	16.96±0.51	1.14±0.05	2.98±0.11	1.08±0.05	1.6± 0.08
Felina 34 (b.n. 15 cm)	8.08±0.5	14.32± 0.51	1.05±0.05	2.56± 0.12	0.232±0.01	0.83± 0.04
Felina 34 (m.p. 30 cm)	10.55±0.5	17.0± 0.67	1.06±0.5	2.0± 0.1	0.219±0.01	1.03± 0.05
Futura 75 (b.n. 15 cm)	16.09±0.72	12.58±0.61	0.99±0.02	1.8±0.08	0.127±0.004	0.536±0.01
Futura 75 (b.n. 30 cm)	22.36±0.94	13.34±0.61	1.23±0.05	1.55± 0.05	0.447±0.02	0.49± 0.02
Lovrin 110	7.97±0.15	17.46±0.4	1.95±0.09	4.09±0.19	0.717±0.03	1.0±0.05

Table 4: Aboveground productivity of hemp varieties in the Chui valley on 1 ha

Varieties	Seed production, kg/ha		Productivity stems, kg/ha		Productivity leaves, kg/ha		Overall productivity, with 1m <sup>2</sup> /ha	
	No Watering	Watering	No Watering	Watering	No Watering	Watering	No Watering	Watering
Fedora 17 (b.n. 15 cm)	39.6	398.1	1481.2	5710.9	88.0	691.7	1609.1	6800.7
Fedora 17 (b.n. 30 cm)	93.91	330.4	1901.7	3502.6	99.1	615.4	2097.7	4448.4
Felina 34 (b.n. 15 cm)	49.2	365.4	1712.6	6303.9	222.5	1126.9	1984.3	7796.2
Felina 34 (b.n. 30 cm)	22.6	324.7	1089.4	5358.7	109.4	630.4	1221.4	6313.8
Futura 75 (b.n. 15 cm)	28.3	244.7	4030.9	5743.0	220.6	151.2	4279.8	6138.9
Futura 75 (b.n. 30 cm)	68	109.2	3402.6	2972.5	187.2	345.4	3657.8	3427.1
Lovrin 110 (b.n. 30 cm)	58.4	135.9	649.7	2372.3	159.0	555.7	867.1	3063.9

of 1000 seeds – 9.3%, they weight is 0.6g, which in has 6.2% of the total weight of seeds and in the Futura 75 is 7.0% - 0.72g, total is 10%. In cultivar Felina 34 is 2.0% - 0.03g – 0.4% and Lovrin 110 is 9.0% and the weight of seeds is 0.89g – 7.2% in total.

The small immature seeds are more than white filled seeds. Their weight is usually in the range 3- 4.5%. However, the weight of cultivar Felina 34 is 11% of the

total weight, which indicates a significant effect of climate on the formation of seeds in that class. Weight of empty seeds does not exceed 0.07 - 0.6%. The total number of per 1000 seeds is 17 to 60. The cultivar Felina 34 had the largest number of them. The weight of 1000 seeds of cultivars of hemp in 2003 is not the same. The differences relate to both of varieties and fractions of seeds. The latest is the “know-how” of Kazakhstan in

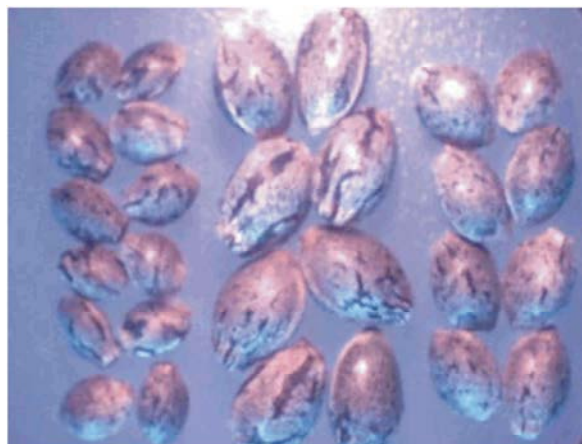


Fig. 1: Appearance of hemp seeds of various origins. In the middle the seeds of the cultivar, on the left is Chui, on the right of the highlands

quotes, because usually the hemp seeds of cultivated varieties ripen at the same time, the size and weight almost the same. We have identified fractions of the same seeds, 1- the brown in color filled seeds with small white spots, 2- green in color, filled but ordinary size seeds, 3- the white filled seeds, 4- unformed small seeds in different colors, 5- is empty, brown color and in size is normal, but without the internal contents. We suspect that the middle of the seeds of by spider-crab (spider-crab – *Xysticus cristatus*, ctv. *Thomisidae*). That is a spider in a lot on the inflorescences of cannabis in valley of Chui.

The maximum weight of filled seeds in the cultivar Lovrin 110, the minimum weight is on the cultivar Futura 75. The weight of 4 fractions with developmental disabilities had the cultivar Fedora 17. All fractions filled green and white close to each other. Weight of 1000 seeds in the fractions of immature and empty is very small - less than 4 grams and sometimes 0.9 g.

The ability to germinate saved only filled with brown, green and white fractions. The latest of the two is not high: the green does not exceed 7.5%, white is - 5%. In the cultivar Futura 75 white and green seeds are fertile, in Lovrin 110 germination of white and green seeds is 1%. In brown seed germination is 90%, although the cultivar Futura 75 is lower - 80%. If we analyze the germination of seeds without separating them into fractions, it may be noted that during the year the germination of seeds in 2002 has dropped to 59-72%. In 2003 seed of yield, which includes all the studied fractions germination ranges from 26 to 46%. Moreover, it is the in the cultivar Futura 75 is maximal and at the cultivar Felina 34 is minimum.

## CONCLUSION

According to our research the vegetative mass and seed production of European varieties of cannabis in Chui valley decreases. Moreover, the initial stages of seed development did not differ from European standards. You could see up to 800 seeds per 1 up a plant is 10 on phenological stages. With a high proportion of immature seeds they are quickly matured. Bloom repeatedly was observed. New seeds ripen quickly and also fell back. There was uneven ripening in the inflorescence. 11 and 12 phenophase delayed by 1.5 - 2 months. As a result of uneven ripening we got on dry land from 20 to 70 kg of seeds per 1 ha (in Europe the yield reaches 800 - 1200 kg / ha). Thus, the cultivation of hemp seed in the valley of Chui is not promising. Weight of stems, leaves, also decreases. Only when watering is possible to grow European cultivar of hemp for fibre.

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