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Annual Dinamics of Vegetative Development of Chinese Actinidia (Kiwi) and Perspective of Its Agricultural Production Under The Conditions of Ajarian Highlands

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ABSTRACT

The article overviews the growing perspectives of Chinese Actinidia (kiwi fruit) in the South-Western part of Georgia under the conditions of Ajara highlands, like in Ajara littoral, where the successful growing of kiwifruit becomes one of the leading crops. The article gives the dynamics of phenological observations of the growth and development rhythm of Chinese Actinidia under the conditions of Ajarian highlands collected by the authors and compared with the relative data of the control plot located in the coastal region. It also discusses the ecological and economical significance of growing industrial plantations of Chinese Actinidia on inclined slopes of mountainous regions. The article gives methodological recommendations on growing and caring agro techniques of Kiwi in mountainous regions: generative and vegetative propagation, grafting or oculation, seedling growing, plantation growing, selecting the territory and preparing for planting, fertilizing, the distance between the plants, distance between the plant rows, sizes of planting holes, caring of seedlings, terms, and rules of trimming and forming of kiwi seedlings, etc. Based on multi-year observations by the authors, practical experiences by kiwi producing regions of Georgia, Kiwifruit market demands, and consultations by the farmers, who export kiwifruit to European and Asian markets, the conclusion is drawn in terms of well-reasoned recommendations on growing industrial plantations of Kiwifruit in mountainous regions.

INTRODUCTION:

The Southwestern part of Georgia – Ajara belongs to the humid subtropical area and is located on a very Northern border of subtropics. Due to the peculiarities of orographic conditions of the Black Sea littoral, the seaside region Ajara is distinguished by a more humid subtropical climate unlike other subtropical regions of Georgia. The Black Sea itself as a thermoregulator and a warmth generator has an important effect on the climate formation in Ajara; During the cold periods of the year, it helps the air temperature to rise in the shoreline areas and lower in hot months of summer. The amount of moisture evaporated throughout a year from the sea surface moves toward the mountain slopes with the help of warm airflow, where it is condensed and falls back to earth as heavy precipitation.

Due to the warm and humid climate, subtropical agriculture is very well developed in the coastal regions of Ajara. Farm and industrial plantations of almost all citrus cultures, tea, oriental persimmon, feijoa, Chinese Actinidia (kiwi), and other subtropical fruit occupy an important place in local agriculture.

Active growing of subtropical cultures in the coastal regions is available, although impossible in highlands due to strict climate, rather cold winter, and a large volume of snowfall. Growing apples, pear, drupes, nuts, and annual crops is preferential. However, these cultures have disadvantages, making it difficult to grow industrial plantations. For instance, walnut bears fruit abundantly once in two or three years and flowers in early spring. While flowering it is very often damaged by the snow and then bears fruit once in five-six years. The apple species, which have high market prices are short in height and not prosperous for highlands because of a large amount of snow. The height of snow reaches 4 meters in the highlands of Ajara. The cases of soil erosion, landslides, and snowslides frequently occur there, conditioned by the tradition of growing annual hoeing crops. To increase incomes and implement ecological safety, it is necessary to develop perennial fruit-berry crops widely.

Based on our research, Chinese Actinidia (kiwi) is advantageous for Ajarian agriculture in highlands, as kiwi starts flowering at the end of May – the beginning of June and there is no threat of frost.

Kiwi is not a traditional culture in Georgia. Compared to the other cultures, it is characterized by the best taste and medicinal properties, abundant fruit-bearing, ability to be kept well, transportability, and less biennial bearing. Besides that, it has a surface root system preventing soil washing, erosion, and landslide processes. Compared to the other fruit crops available for the Georgian market, its price is a bit higher and frequently required [1-3]. If kiwi industrial plantations from the coastal regions are added to industries from the highlands, it will be possible to produce the amount of kiwi fruit enough not only for the internal market but also for export. However, before this, it is necessary to do thorough scientific studies and develop proper recommendations.

OBJECT AND METHODS:

The research object was Haivard, a breed of *Chinese Actinidia* (Actinidia chinensis) introduced to Georgia in 1980. The observations on the object were conducted during 2012-2018 based on vertical zonality, up to 1100 meters above sea level. The data were compared based on the control plants from the Kiwi collection planted on the collection plot of the Scientific-Research Institute of Phytopathology and Biodiversity of Batumi Shota Rustaveli State University.

In 2011, the seeds from the fruit of Chinese Actinidia were selected for research objects; they were sowed and then the seedlings were transplanted in pots. In 2012, the nursery was established at 1100 m above sea level; the kiwi seedling was replanted there and the peculiarities of its growth and development were observed by a phenological method (4;5).

RESULTS AND DISCUSSION

Bud soaking and plant vegetation periods differ from lowlands to highlands. The beginning of vegetation in the mountainous regions is conditioned by snow melting and warm weather. Compared to the control plants in the coastal areas, the vegetation process in the highlands starts 26-43 days later.

During the observation period in 2012-2018, the minimum temperature on the research object was -14,8 under the mountain conditions; however, it's not harmful to Actinidia. In 2012, the height of snow reached 3 m and 10 cm on the research plot, while on the control plot in the

coastal area it was only 15 cm. It is necessary to develop relevant agro technologies for the plant to get adopted with a big amount of snow and different climatic conditions in the highlands.

For sure, while starting working on kiwi, we applied already existing data about kiwi (6-8; 10-15) and developed our approaches during the working process: to grow kiwi plantations, it is possible to propagate by vegetative cuttings or seeds (obtaining roots for further grafting-oculation). Propagation by cuttings supports the preservation of breed properties, the other advantage is that better seedlings are available more rapidly. However, rooting requires much work and its rate does not exceed more than 35-50%.

The seedling becomes mature very late, but with a better ability to germinate. It develops a too strong root system and is distinguished by further heat resistance.

Wind protected area close to the watering channel with weak acidic and neutral reaction soil with light mechanical content was selected for growing the kiwi plantation. The soil was plowed 40 cm deep. Mineral and organic fertilizers were added before plowing. The soil was treated 4×4 m of the feeding area. We preferred kiwi planting in Autumn because the plants planted in Autumn can heal wounds on their roots in Winter and meet the vegetation period better-prepared. Holes were prepared two weeks before planting in 50 cm X 50 cm X40 cm, treated with up to 20 kg of organic fertilizer, 100 gr phosphorus, and 60 gr potassium. While planting, special attention was paid to the location of male plants on the plot: one male plant for 6-7 female ones.

The seedlings with soil balls on the roots were specially selected, they were well compacted and watered so that air left between the soil and roots had been removed to prevent the decaying of the damaged root. The seedling was firmly fixed on a small stake, which was placed not less than 50 cm in the soil and two meters above the soil not to be damaged by big snow while melting.

Due to a large volume of snow typical to the highlands, we preferred the wallpaper system with Ferro-cement poles. The diameter of the wire is 8 mm. The first row of the wire on the wallpaper must be not less than two meters above the surface of the soil.

The plant formation started in the very first year. When the plant reached the first row, we left only three sprouts. The top sprout is above-directed, while the other ones are fixed on the wire in opposite directions. The upper bud was cut on the last row. One sprout was fixed on each side

along the wire. Extra growings are removed from the plant during the vegetation period. However, sprouts along the wires must be untouched every 40-50 cm. The plant was trimmed before starting the fruit-bearing or winter period. Two or three buds were left on the side sprouts and then firmly fixed to the wire not to be damaged by snow and snowstorm. The best one from three developed sprouts was left untouched for the next spring.

After starting the fruit-bearing period, the formation was done three times a year. In December-January, after leaf fall, the fruit-bearing sprout (e.i. №1 sprout) was trimmed and only two buds after the stem of the last fruit were left. The best one remained untouched among further developed two sprouts. This sprout gives generative, fruit buds, which later develop shoots and start flowering. E.i №2 flower will flower in June. In January, only 2-3 buds are left on the sprout. It must be specially mentioned, that except №1 and №2 sprouts all the other sprouts are cut and removed from the plant. In July-August, pinching is carried out, which means removing the sprouts after 5-6 leaves of the last fruit on the sprout.

Under mountainous conditions, compared to the other fruit cultures, Chinese Actinidia is persistent against diseases and pests. The diseases, such spread in coastal regions may hardly ever appear in highlands. The only threat causing significant damage to kiwi seedlings is a brown hare (*Lepus europaeus*). The hare removes the plant bark and destroys the one-year seedlings left above the snow cover.

For the protection of kiwi seedlings against the brown hare, we elaborated the overwintering method without any damage. One-year-old seedlings were placed on plates made of bamboo. Therefore, the hare was unable to reach the plant by its teeth. After melting the snow, there is no threat of damage from hares. That's why in spring when the vegetation starts we remove the mentioned protective plates. Hares can not damage the bark of two or more years old seedlings.

From 2012-2018, during the growth and development observation process, vegetation in the highlands starts 43 days later than in the lowlands (tabl. №1;2 fig. №1,2). General climate datum about Ajara littoral and mountainous regions: average temperature, annual precipitation, and humidity, warm and cold months; the data is given in table №3.

Table №1

Seasonal development dynamics of vegetative organs of Chinese Actinidia

(1100 m above sea level)

years	bud				sprout growth		the sprout length (cm)		leaf fall	
	soaking		opening		beginning	the end	average	maxim.	massive	the end
2012 - 2021	beginning	massive	beginning	massive						
2012	14,04	2,05	2,05	16,05	16,05	22,9	256,5	513	2,12	17,12
2013	3,03	8,04	8,04	14,04	14,04	8,09	282	578	2,11	6,11
2014	5,03	8,05	8,05	14,05	14,05	11,09	280	517	2,10	6,10
2015	15,03	18.05	18,05	24,05	24,05	14,09	242	497	11,11	25,11
2016	3,03	8,04	8,04	14,04	14,04	8,09	282	578	2,11	6,11
2017	11,03	14,05	14,05	16,05	16,05	13,09	273	471	2,12	6,12
2018	16,03	19,05	19,05	21,05	21,05	18,09	283	491	12,12	27,12
2019	4,03	8,04	8,04	14,04	14,04	8,09	282	578	2,11	26,11
2020	13,03	15,05	15,05	21,05	21,05	14,09	242	494	11,11	25,11
2021	4,04	22,04	22,04	6,05	6,05	12,09	233	466	27,1	17,12

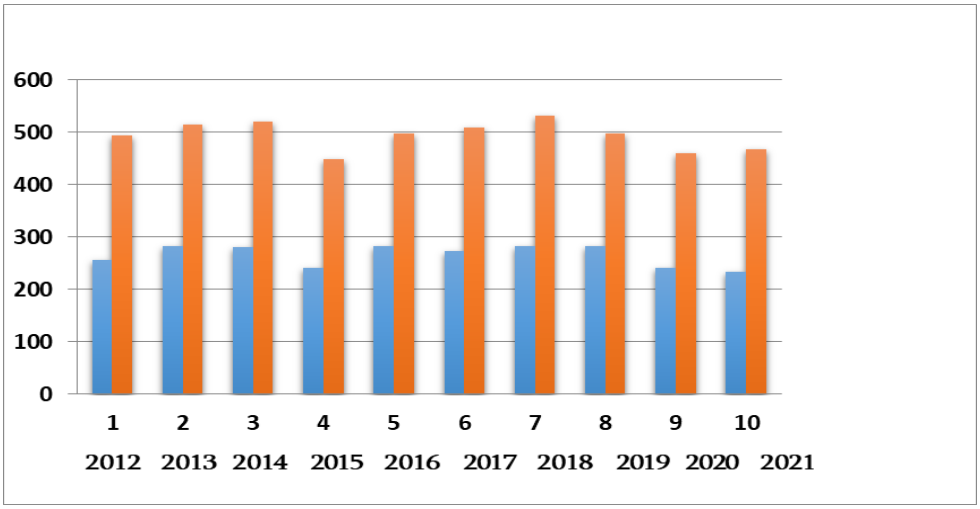

Figure №1.

Dynamics of growth of shoots (cm) of Chinese Actinidia (1100 m above sea level) years (average, maximum)

Table №2

Seasonal development dynamics of vegetative organs of Chinese Actinidia (100 m above sea level)

years	bud				sprout growth		the sprout length (cm)		leaf fall	
	soaking		opening		beginning	the end	average	maxim.	massive	the end
2012 - 2021	beginning	massive	beginning	massive						
2012	1,03	16,03	16,03	21,03	20,03	10,09	324,9	641,5	1,12	28,12
2013	2,02	23,02	23,02	2,03	7,03	18,08	326	646,5	15,11	8,12
2014	12,02	28,02	28,02	12,03	17,03	28,08	321	639	18,11	12,12
2015	20,02	6,03	6,03	18,03	24,03	29,08	317	612	18,11	12,12
2016	2,02	23,02	23,02	2,03	7,03	18,08	326	646,5	15,11	8,12
2017	21,02	3,03	3,03	12,03	17,03	18,08	316	586,5	15,11	8,12
2018	26,02	3,08	3,08	12,08	17,03	17,08	321	536, 4	11,12	25,12
2019	2,02	23,02	23,02	2,03	7,03	18,08	326	646,5	15,11	8,12
2020	17,02	3,03	3,03	15,03	21,03	26,08	317	608	18,11	12,12
2021	17,02	3,03	3,03	11,03	10,03	10,09	313	541,5	1,12	24,12

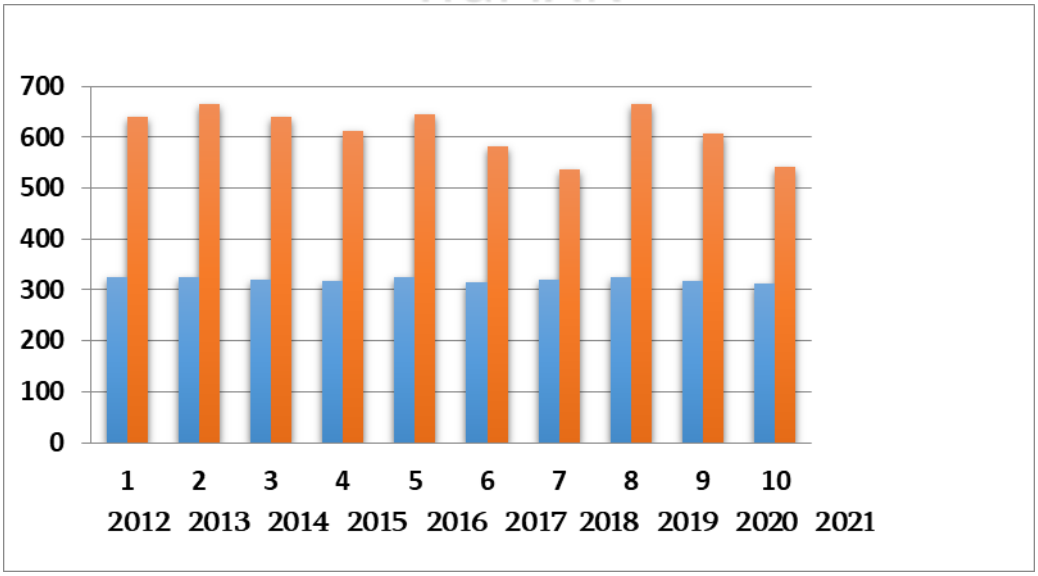

Figure №2. Dynamics of growth of shoots (cm) of Chinese Actinidia (100 m above sea level) years (average, maximum)

Table №3. General climatic index in Ajara

Regions in Ajara			Kobuleti	Khelvachauri	Keda	Shuakhevi	Khulo
Elevation above the sea level (m)			4-830	5-770	220-990	350-1500	530-1560
Air temperature ^{0} C	average	annual	13,4	14,4	12,7	12.3	10,4
		Warm month(aug.)	22,5	23	21	20	19
		Cold month(janv.)	5,1	6,7	3,5	3,4	1,0
	Absolute minimum		-9	-10	-15	-16	-18
	Absolut maximum		42	42	41	41	41
The number of days	>5^{0} C		320	322	303	288	253
	>10^{0} C		223	243	229	211	192
	Without frost		268	304	263	244	238
Precipittaion (mm)	Average	annual	2552	2531	1558	900	1177
		monthly	99	85	64	59	62
	Abs. monthly minimum		6	5	4	3	5
	Abs. monthly maximum		859	840	473	575	722
	Daily maximum		234	331	236	226	212
Relative humidity (%)	Warm month (aug.)		78	79	81	78	76
	Cold month (janv.)		81	80	77	72	69
	annual		79	79,5	79	75	74
Number of days with humidity	≥80		80	78	83	68	68
	≥30		15	14	24	46	46

CONCLUSION

The research has been going on since 2018 and based on our multi-year observations, in addition to practical experiences by kiwi producing regions of Georgia, Kiwifruit market demands, and recommendations by the farmers, who export kiwifruit to European and Asian markets, it is clear, that growing of plantations of the mentioned fruit for industrial purposes is timely and

topical. Therefore, it will become the reason for economic profit and strengthening for the farmers. Like coastal regions kiwi is the best crop for the highlands, also they perfectly protect declined slopes from erosion.

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