AGROTECHNOLOGY

АГРОТЕХНИКА

SUMMER CROPS

Buyankin N.I.,
PhD in Agriculture

Krasnoperov A.G.
PhD in Agriculture, associate professor,
Kaliningrad research institute of agriculture –
Federal State Budget Scientific Institution «Federal Williams Research Center
of Forage Production and Agroecology»

Abstract. In various climatic conditions (Northern Kazakhstan and the Kaliningrad region) accumulation of green material of one-year cultures of the lengthiest day was studied (oats, a colza, a lupine, etc.) at spring and summer sowing time. On the basis of the conducted long-term researches new approach to a solution of the problem of degradation of soils and increase of efficiency of fields is offered.

Keywords: summer crops, one-year cultures, soil sideration.

Буянкин Н.И.
Доктор сельскохозяйственных наук
Калининградский научно-исследовательский институт сельского хозяйства –
филиал Федерального государственного бюджетного научного учреждения «Федеральный научный центр кормопроизводства и агроэкологии имени В.Р. Вильямса»

Краснопёров А.Г.
Доктор сельскохозяйственных наук, доцент
Калининградский научно-исследовательский институт сельского хозяйства –
филиал Федерального государственного бюджетного научного учреждения
«Федеральный научный центр кормопроизводства и агроэкологии имени В.Р. Вильямса»

ЛЕТНИЕ ПОСЕВЫ

Аннотация. В различных климатических условиях (Северного Казахстана и Калининградской области) изучалось накопление зеленой массы однолетних культур длинного дня (овес, рапс, люпин и др.) при весеннем и летнем сроках посева. На основании проведенных многолетних исследований предложен новый подход к решению проблемы деградации почв и повышения продуктивности полей.

Ключевые слова: летний посев, однолетние культуры, сидерация почвы.

The rapid development of the society on the basis of new achievements of science and technology and unusual rate of growth of population were characteristic features for the past twentieth century. the Earth population increased from 1 billion 620 million to 7 billion (in 4.3 times).

It was necessary to increase the supply of provisions' production on the Earth, in order that to feed all increasing population. World agrarian science as a whole has succeeded to cope with this task in the 20^{th} century. The growth of products feeding of production was achieved owing to

spreading of chemico-technogen intensification of agriculture, based on the exploitation of nature resources at the second half of the last century. However, such approach to the increasing of products feeding created real threat of ecological disaster for all mankind to the beginning of the 21st century.

At present human society achieved such threshold development when its subsequent existence by the nature exploitation and exhausted resources is impossible. So the problem of products feeding provision all increasing planet's population at the expense of usual agrotechnology, methods, agriculture systems, etc. is impossible to decide. It needs to catch up with the plan – a new approach in the solving this problem.

A main question of agriculture future is a green plant, a key biological biosphere component. It is the only ecological pure nature generator of organic matter, one part of which goes to the mankind's feeding, but the other goes to the reproduction of soil fertility. Efficiency work of this "living generator" is connected with soil and solar energy. Society prosperity will depend on that fact how "wise man", individual assimilate photosynthesis process and will effectively use it in his vital functions.

Sun and plant are the beginning of all vital principles at our planet. Creation of organic matter by a plant with the participation of carbonic acid, water, solar beam and secretion of oxygen attached to it – the most exciting of all natural phenomenon as intercommunication of living and inorganic nature begins from there and its involving into biological rotation. However, this most important nature biological phenomenon depending on different environment conditions is not enough studied. So it is necessary to concentrate all modern arsenal of agronomical knowledge on the photosynthesis with the purpose of subsequent increasing of plants productivity. Natural highly effective influence on a green plant and new technologies on deep green mass processing must be taken as a principle with the purpose of receiving of protein and other feeding matters directly from green mass.

Vegetable organism is fraught with itself very many biological properties for increasing of our fields productivity, that are not brought to light by science owing to insufficient study those favorable environmental combinations, that will positively affect on the productivity of cultivated crops.

All plants life proceeds in full intercommunication with the environment, that constantly changes during vegetation period influencing on vital plants processes attached to it. The plant in its turn, springing up in that or other constantly changing environment, tried to attain to adjust to it, to master all necessary for its development and all useful succeeds with the only purpose that is may useful in future. As a result original clockwork synchronizing ontogenesis rhythm with a seasonal rhythm is produced by plants in the evolution process. These clocks assume the name "photoperiodical reaction of plants" (American scientists W. Garner and G. Allard are the authors of this phenomenon, 1920).

All investigations on the study of intercommunication of ontogenesis rhythm of annual crops with seasonal rhythm are carried out still by the scientists attached to spring sowing term and cultivating them in the main for the grain.

The plants find themselves in unusual conditions for them with continuously variable environment during sowing of this annual crops in summer. Intercommunication of vegetable organism with unusual variable environment factors for plants are not enough studied in this case and so sometimes it has to observe the display before unknown qualities of plants that give practical, economical and ecological expediency for production.

Seeds of annual crops are sowed with all specific features of this summer period (quality and quantity of solar light, temperature, moisture, mineral feeding, etc.) at the growth and development process do not copy in variable aspect known already biological and physiological features of these crops in the time of sowing them in spring, as spring-summer period on ecological conditions essentially differ from summer-autumn period. The reason of ecological differences of these two periods is that if an angle of being of sun in upper culmination with respect to horizon daily decreases in summer-autumn period in temperate zone of both hemispheres, it increases on the contrary in

spring-summer period. As a result of it the environment constantly change from spring to autumn (quality and quantity of sun light, temperature, humidity, etc.). So spring sowing date of annual plants – unnatural environment. If the growth and development of a plant passes normally in the time of spring sowing date and finishes by seeds maturing, a plant obliged to strive for adjust to unnatural for itself outer environment in the term of summer sowing date. In these conditions seeds maturing does not occur, the aging of vegetable organism has been slowing down and vegetation has been lasting before cold attack. Vegetable organism converts into "factory" on organic matters by it as in this case not the growth and the development of a plant stands first and foremost for the sake of staying descendants but endless synthesis of organic matter by force of unusual, but favorable for growth and development environment endless synthesis of organic matter that in full are confirmed by our investigations of many years.

The authors took investigations on influence of spring and summer sowing dates annual crops on their vegetative productivity in several regions of former Soviet Union (from 1974 to 1992 years in the Northern Kazakhstan, from 2000 to 2015 years at the west of Russia) for a period more 30 years. On the grounds of received results it was determined that summer annual sowing crops form the most considerable green mass harvest than spring sowings of these crops. Like this at an average for investigations years if spring annual sowing crops have given from 5 to 15 t/hectare, then summer sowings – from 11 to 50 t/hectare of green mass (by the average precipitation sum of many years falling out for a year in the regions where investigations are passed over from 280 to 700 mm). Analogous crop capacity green mass data in favor of summer sowing annual crops were received in another scientists investigations in conditions of European part of Russia and Siberia [3,4,5,6].

In spite of positive results received in numerous investigations, summer annual crops are not taken an adequate place in production till now.

Frequently summer sowing annual crops are used in production as "insurance" in doing of mass swarms of spring sowings or in doing of their unsatisfactory development because of precipitation absence or other reasons. In the best case they are set aside secondary meaning and recommend to use both hay-harvest, stubble, soil-integumentary and other sowings.

The principal cause of insufficient attention to the summer annual crops sowings now the difference is that agrotechnical factor has expected or the absence of sufficient sediment quality in spring -summer period with hope that they will fall out in summer-autumn period. It is not quite rightly just as role and meaning of summer sowing annual crops for farming and plant-growing are humbled, and hence underestimation of this method by production occurs. Summer sowing of annual crops must be based on ecological principle. In this case increasing of field's productivity and preservation of soils fertility will be achieved not at the expense of application of fertilizers, pesticides and other methods, occasioned by the negative influence on soil and environment but at the expense of ecologically safe natural outside factors of environment and complex of its interaction that it is confirmed by our investigations.

In the process of spending our numerous investigations it was noticed that seeds of one and the same annual crop, one and the same sort, they are taken from one and the same group, but they are sowed in different dates (in spring and in summer), at one and the same soil, one and the same field, in one and the same climatic conditions they give as much as differing between themselves plants by morphological indications, biological features and green forage quality that involuntary a doubt steals in its relationship. For example, a habitus of a plant is expected compact, stems and leaves are disposed not far from each other. Fruiting begins in normal terms for all by that and proceeds before ripening without deflection. The plant is getting with stretched both central and side stems that are directed to different sides by summer lupine sowing. Sprouts are strongly foliaceous for all that but attempts occur a few to begin these plants fruiting, but not a single attempt ends by seeds ripening. Vegetable organs of summer sowing annual plants as a rule are more developed and essentially differ from spring sowing. Stem stickness by plants of summer oats sowing are more far 1.5-2.0 times, leaves are longer and wider for 2.0-2.5 times than by spring sowing plants. If total bushiness of spring sowing oats plants composes 1.2-1.5 (seldom 2.0 times), then summer sowing

plants composes 10-15 and more than. Number of leaves on summer sowing plant sharply increases as a result high-powered assimilating surface forms. Thus if leaf surface area of spring rape in spring sowing at the harvesting moment composed 49.4, then 77.2-81.2 thousand sq.m./hectare. High-powered developed root plants system is typical for summer sowing annual crops which it exceeds root plants system of spring sowing at a soil stratum 0-20 cm for 3-4 times. Besides that heightened frost-resistance is developed at summer annual sowing crops (oats stands the test momentary night-time frosts till minus 12 degrees but lupine till minus 5 degrees) and unusual biological property to make up aerial roots from lower stem internodes are discovered at summer sowing oats plant in the redundant moistened years (Application, figure 1, 2, 3, 4, 5).

Green fodder from summer sowing on nutritiousness is considerably richer than from spring sowing. (table 1)

Table 1 – Qualitative exponents of green oats mass at different sowing terms (Kockchetav RIAI – Research Institution of Agricultural Industry, 1986-1990 years; Kaliningrad RIAI - Kaliningrad Research Institution of Agricultural Industry, 2009-2015 years)

Indexes (in transfer on absolute dry substance)	Spring sowing (1-10 June)	Summer sowing (1-10 July)
Untreated protein, g/kg	109,7±23,1	138,1±25,7
Digestible protein g/kg	61,5±10,4	96,8±18,5
Carotene, mg/kg	47,7±8,3	65,2±12,7
Calcium, g/kg	11,6±3,9	14,0±4,0
Phosphorus, mg/kg	0,91±0,08	1,30±0,7
Untreated cellulose, percent	40,2±6,7	25,8±6,6
Sugar (lactose), gr/kg	4,2±1,1	61,0±10,8

Our own investigations and investigations results for the latest 15-20 years of physiologists have aroused to make a supposition that such unusual annual crops development by its summer sowing is a result of adjustable character of photo periodical plant reaction on unnatural change of external environment factors for them.

We observe the Sun interchange on dome of the sky on the Earth every day. The Sun rises so morning comes, the Sun sets to the horizon – evening approaches. The middle of the day is the upper Sun culmination moment. If upper Sun culmination point on the equator with respect to horizon is constant not only every day but and during the year and correspond to approximately 90 degrees, but it changes not only the whole year round but every day to the North Pole direction.

The Sun rises quickly above horizon on the equator in the morning (morning daybreak practically is absent), but in the evening it quickly "sets" beyond the horizon and the night falls at once (twilight is absent there). The Sun doesn't rise and set at the North Pole in summer, it behaves itself as unsetting star. The Sun rises early and sets late in middle latitudes and moves on the dome of the sky nearby horizon by the trajectory directed at an angle that is the less the farther to the North a place of observation is found.

Such peculiar Sun transference on dome of the sky makes itself out to the condition of lighting of different geographical Poles of the Earth. So, if the Sun is in zenith on the equator, then falling rays spectrum distorts insignificantly. The angle location of the Sun with respect to horizon as moving off equator to upper and lower latitudes is reduced. In this connection atmosphere begins to work as prism as a result visible solar spectrum is refracted and it differs from equatorial.

Different angles Sun location in upper culmination with respect to horizon on the equator and Poles have formed on the Earth different on duration vegetation periods with different durations for a day and a night (Application, fig. 7). If vegetation period lasts a circular year at the equator and day and night duration doesn't change and equals approximately 12 hours during a year that vegetation period as moving off equator has been reducing in upper and lower latitudes. In this case

day period has been increasing but night period has been lowering. Day period reaches 24 hours in summer period in the most upper latitudes.

Different plants groups have formed in these different vegetation periods due to adaptive character of photo-periodical reaction. The physiologists distinguish seven groups of plants (neutral, long daily, short daily, long short daily, short long daily, middle daily and amphiphotoperiodal). All plants groups are fixed to its vegetation periods where they have formed at the genetic level and differ among themselves on biological and physiological peculiarities.

If solar condition existing at the globe has led to formation some plants groups differing among themselves on biological and physiological features then it means that this factor is defining and can influence on vegetation productivity of annual plants sowed in different terms and in different Earth points. The whole question is that how does it influence on vegetated plant? To answer this question we imposed vegetation plants productivity on solar activity of intensity lighting on the Earth in the conditions of Kaliningrad location. As a result it is obtained that yield capacity of green mass is inversely proportional to solar activity of intensive lighting (Application, Fig. 8).

This conclusion is suggested by the well-known position that the highest harvests of vegetative plants mass are received not at the South of Russia where vegetation period is longer and in summer period height of Sun being with respect to horizon is higher, but in Siberia, Ural and North West regions where vegetation period is shorter and height of Sun being is lower in summer period. The fact that the vegetable kingdom is awaked in spring in the conditions of North latitudes of temperate zone it doesn't indicate that existing solar condition is favorable for photosynthesis in this period. Simply monocarpic plants, springing up in these conditions in evolution process, adopted by themselves to this solar condition to keep its origin continuation.

Annual crops sowing in any sowing term comes to an end by grain harvest in tropic zone conditions (they are received in 2-3 seed harvest in a year in this zone). July sowing of annual crops comes to an end by unusual development (in secret or evident form) of vegetative organs of these crops and by the high green mass quality of these sowings in temperate zone. It indicates at this fact that in summer-autumn period in temperate zone conditions the length of day and night and solar light spectrum are essentially change and it is caused by Sun transference behind horizon to the side of southern hemisphere temperate zone and therefore environment dwelling.

Solar light spectrum and the length of day and night as defining main ecological factor in the complex with other factors in the time of summer sowing annual crops are in the lack of correspondence with growth and development phases of plants that leads to breach produced peculiar clockwork in evolution process with the help of which seasonal rhythm with ontogenesis plant rhythm is synchronized. However, annual crops owing to adaptive character of photoperiodical reaction of plants sowed in summer not only are adapted to the solar light spectrum and to the length of day and night in summer-autumn period but successfully develop other external factors of this period which are having enough and to spare and beneficially influence on its productivity. The plant's answer at breakdown of evolution clockwork synchronizing ontogenesis rhythm with seasonal rhythm is variation in morphological features and biological structure of vegetative organs of annual crops sowed in summer. That is a plant unavoidably answers adequately at environment variation from natural by its unusual ontogenesis rhythm that in this case presents an interest for production.

What is a practical value of these investigations? In the first place, it may suggest that owing to the fact that favorable conditions for vegetative plants productivity form at the second part of summer, autumn at least in the highest latitudes. Biomass maximum is formed at the expense of it in natural conditions to the end of vegetation, biomass goes to soil after dying off plants thus promoting for increasing of organic matter in it. When a man ploughs up a land and sows annual crops at large areas (winter crops, spring crops), that finish its development up to the beginning of maximum vegetative plants productivity, then entering of organic matter is sharply reduced into the soil and it becomes degraded that is recurrence law gets broken. In this connection degradation degree increases as a result of manifestation of wind and water erosion which in turn is a result of intensive man influence on soil. The more a man will aim for raise grain productivity from hectare, the more

he will influence on soil reducing organic matter contents in it and worsening agrophysical properties and biological activity that creates favorable conditions for erosion. In order that it wouldn't happen it is necessary to link with growth grain productivity from hectare with growth of organic matter entering into soil both in theory and in practice. At present the divergence in strategic of man and nature clearly glances over in the meantime. If nature aspires to increase gross output then man aspires to increase pure production.

Summer sowing of annual crops is an effective agromethod in the struggle with soil degradation, and so it is necessary to practice it both in crop rotations and outside them. Besides increasing of organic matter in soil carries strategic character as in this case long-term carbon burial is achieved, that at present having in atmosphere in abundant quality. It may essentially obtain increasing of organic in soil at the expense of autumn sedation. Summer sowing of annual lupine without fertilizing application in favorable conditions on moistening allows to receive green mass in amount of 50 tone/hectare and together with root remainders till 60 tone/hectare in autumn. A part of green mass can be directed at biofuel receiving without prejudice. Stubble-field and root remainders and biological activity of tubercle bacterium staying on the field will raise fertile soil. Using green mass for receiving biofuel in the capacity of raw materials won't favor the increasing of lack of grain and rise in prices of it.

Why do just annual crops go very well for these purposes? The point is that annual plants are a highly productive organism in the plan of synthesis of organic matters since they are evolutionally better adopted for immediate using of favorable, frequently momentary situations. In addition, spring annual crops plants have no seasonal migration of assimilation products out of overground part into roots and backwards and so all making photosynthesis products for vegetation period concentrate on overground part of plants. So using such crops as oats and spring rape in the capacity of summer sowing in North latitudes of temperate zone will permit to receive high quality green forage for animals in late autumn period.

Summer crops of annual cereals will permit to create winter pastures for sheep and horses by means of temporary closing-down of green plants by natural coldness in regions similar with Siberia on climatic conditions.

Summer sowing of annual drought-resisting crops will allow to defend soil from erosion and to increase soil stores of moisture in drought-afflicted regions of temperate zone. Summer sowing of annual lupine will permit to prevent redundant soils oversetting in regions with autumn period with over wetting.

They ought to assign not a minor role but an independent part of agronomical science with scientific basing and agrotechnology by its cultivation depending on resolved by production tasks and aims taking into account perspective wide application spectrum of summer sowing annual crops in farming, plant-growing and forage production. The great future will wait for summer sowing of annual crops expecting its recognition.

Following the results of work of authors in the Kaliningrad region the patent for the invention No. 2478301 was taken out, registered in the State register of inventions of the Russian Federation 10.04.2013 [7].

Библиографический список

1. Буянкин Н.И., Краснопёров А.Г. Внешняя среда и урожай // Земледелие. – 2008. – №8. – С. 31–33.

2. Буянкин Н.И., Краснопёров А.Г. Летний посев // Достижения науки и техники АПК. – 2009. – № 1. – С. 15–20.

3. Мейснер А.Ф. Летние посевы однолетних культур // Труды Тульской ГСХС. – Тула, 1971. – Т. 1.

4. Милащенко Н.З. Рапс в Омской области. – Омск: Омское кн. изд-во, 1983. – 116 с.

5. Неклюдов А.Ф. Научные основы полевых севооборотов на черноземах Западной Сибири. Автореф. дис. … д-ра с.-х. наук. – Омск, 1990. – 24 с.

6. Сдобников С.С. Вопросы земледелия в целинном крае. – М.: Колос. – 218 с.

7. Зотиков В.И., Нечаев Л.А., Буянкин Н.И., Краснопёров А.Г. Способ получения зеленого корма и сохранения плодородия почвы. Патент РФ на изобретение №2478301, 2013.

References

1. Bujankin N.I., Krasnopjorov A.G. (2008). Vneshnjaja sreda i urozhaj. [Environment and crop]. In: Zhurnal «Zemledelie» [Agriculture journal]. 2008. № 8. P. 31–33. [in Russian]

2. Bujankin N.I., Krasnopjorov A.G. (2009). Letnij posev. [Summer crops]. In: Zhurnal «Dostizhenija nauki i tehniki APK» [Journal Achievements of Science and Technology of the Agro-Industrial Complex]. № 1. P. 15–20. [in Russian]

3. . Mejsner A.F. (1971). Letnie posevy odnoletnih kul'tur [Summer sowing of annual crops]. In: Trudy Tul'skoj GSHS [Proceedings of the Tula State Agricultural Experimental Station], Tula, 1971.-T.1 [in Russian].

4. Milashchenko N.Z. (1983). Raps v Omskoj oblasti, [Raps in Omsk region] / Omsk: Omskoe kn. izd-vo. 116 p. [in Russian]

5. Nekljudov A.F. (1990). Nauchnye osnovy polevyh sevooborotov na chernozemah Zapadnoj Sibiri [Scientific bases of field crop rotation on chernozems of western Siberia]. Avtoreferat dissertacii na soiskanie uchenoj stepeni doktora s.-h. nauk, Omsk. 34 p. [in Russian]

6. Sdobnikov S.S. Voprosy zemledelija v celinnom krae. [Farming questions in virgin land]. Moscow, Kolos. 218 p. [in Russian]

7. Zotikov V. I., Nechayev L.A., Buyankin N. I., Krasnopyorov A.G. Sposob polucheniya zelenogo korma i sohraneniya plodorodiya pochvy. Patent RF na izobretenie №2478301, 2013. [The method of obtaining green food and preservation of soil fertility]. Russian Federation patent for the invention No. 2478301, 2013. [in Russian]

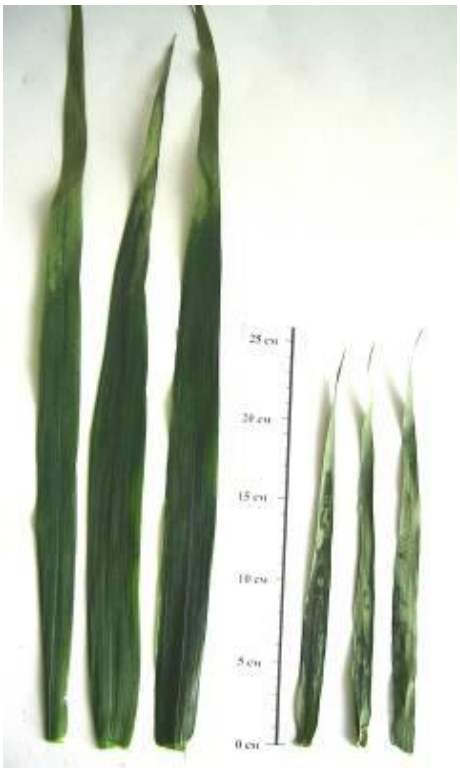

Fig. 1. Influence of summer date of oats sowing at value of flag leaf (on the left is summer sowing, on the right is spring sowing)

Fig. 2. Influence of summer date of oats sowing at stulk height and thickness (on the left is summer sowing, on the right is spring sowing)

Fig. 3. Influence of summer date of oats sowing at total oats bushiness (37 stulks on the same plant)

Fig. 4. Development of aerial roots from lower interknots of summer oats sowing

Fig. 5. Unusual cold-resistance of narrow-leaved lupine of summer sowing

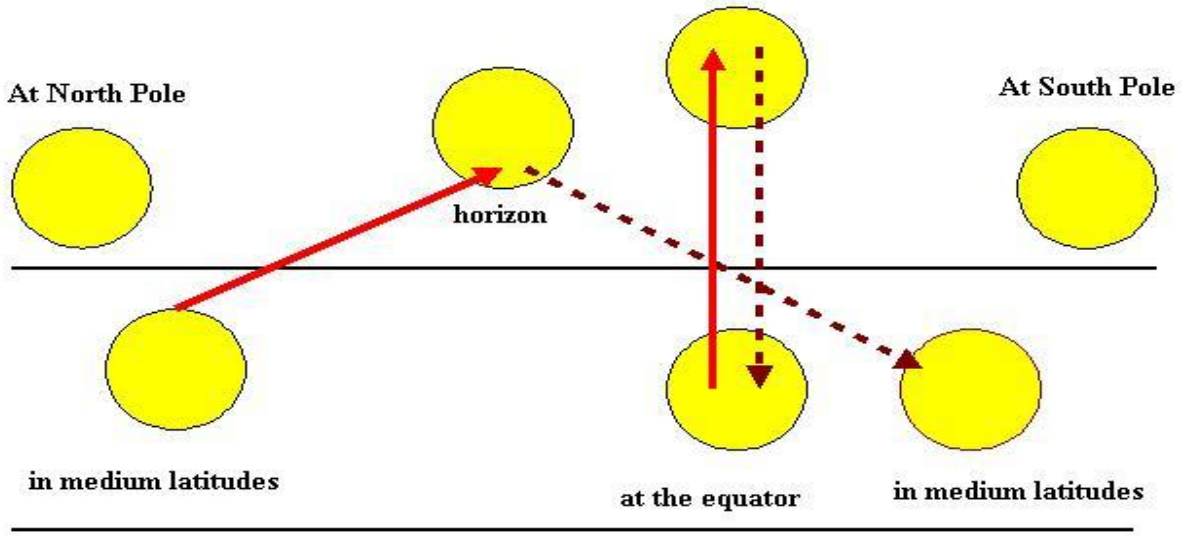

Fig. 6. Summer Sun transference at the sky in respect of horizon at different latitudes

Sunrise

Sunset

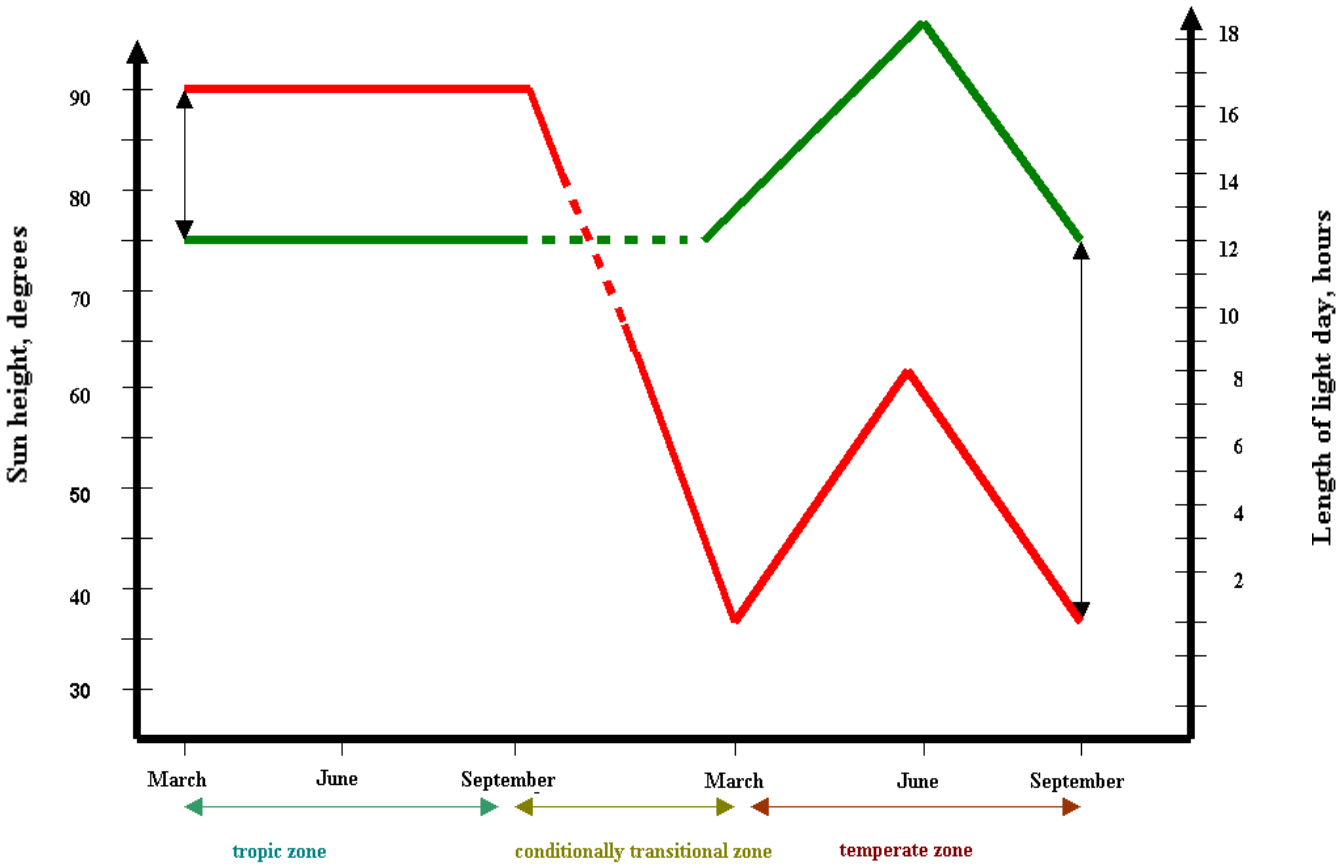

Fig. 7. Influence of Sun height at length of light day and character of vegetative period of plants

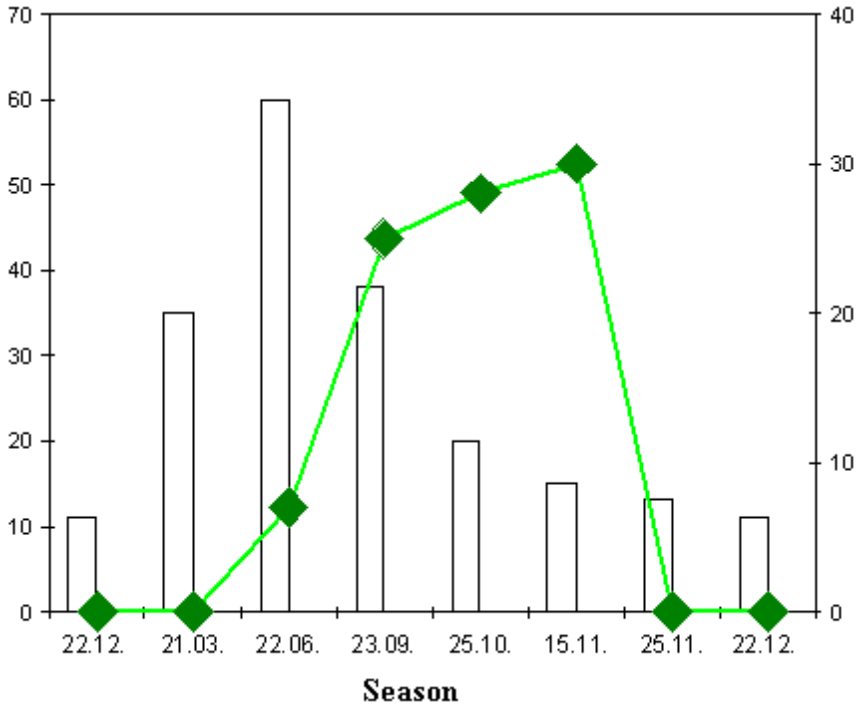

Fig. 8. Influence of Sun height at vegetative plants productivity