

On a Research of Raspberry and Blackberry's Bud Structure and Fruitful

S. Peral Atila and Y. Sabit Ağaoğlu

Department of Horticulture, Faculty of Agriculture, Ankara University, 06110 Ankara, Turkey.

Abstract: The buds structure of raspberry and blackberry and their fruitful are examined in this research. During this research, also the other existed researches are examined and benefited.

Key words: Raspberry, Blackberry, Bud, Fruitful.

INTRODUCTION

Raspberry plants do not have shoots that stay on the plant always for years these is growth continue from spring to autumn. In the second vegetation period, this shoot branches out, by creating side-shoots, which can hardly become wood^[1].

Despite the fact that raspberry and blackberry growth issue is something brand new in our country, it is possible to find researches about blackberry and raspberry growth, or about their bud structures. Researches about the bud structure of raspberry and blackberry go back to the history. Firstly in USA, in several countries, bud structure of raspberry and blackberry were examined by different scientists^[16].

Eye and bud are not only two terms that are completely different from each other but also are commonly confused. First of all these terms should be distinguished.

One eye include bud, at a number of 1, 2, 3,.....n. According to this, eyes are very important organs which are formed with several buds. In terms of the product amount, primer buds in the eyes are the most important buds^[2].

The first research about the physiological events, that take place in the flower bud, was carried out by Julius Sachs. Sachs said that, the cause of bud creation was some substances that exist on the branches, whose contents are unknown. And by saying that, he created the theory of "substances that form flower bud"^[15].

The middle parts of raspberry buds are preferred to be physiologic. In this part, the flowers grow with all of their organs and at in a most developed way. It is something preferable for side-branches to have lots of leaves and to be long. Flower drafts, unlike the branch, grow better on the top of the side-branches and they form big fruits^[1].

In the researches, carried out, it was observed that in some grapy fruits, such as raspberry and blackberry, the differing of the buds is nearly the same. It was found out that, the shoots on the point were formed in the previous year. The first different is seen at the shoots at the point

and this shows that, the flower bud is growing and flower clusters are growing^[22].

In raspberry, the growth of fruits starts with the first flowers appears on the shoots and ends with the last flowers on them^[1].

BUD STRUCTURE OF RASPBERRY SPECIES AND THEIR SITUATION

Changing of the fruit buds and theirs development is very important in practical garden plants growing. These changes are important in terms of the choice of the suitable kinds and fruits' growing times. In a research carried out in USA, it was found that, the changing of fruit buds take place at the end of the September^[8].

It is spotted that, the best development in 5-10 bud, from point to down. Besides these, the affect of environment conditions on flower bud was examined. It is found that, instead of primer buds, which was damaged because of the cold, secondary buds take place but cannot be as fruitful as the primer ones^[10]. In America, changing of flower bud differentiation happens in autumn, in red raspberry, black raspberry, purple hybrids, *R. coreanus*, *R. biflorus*, *R. lasiostylus* ve *R. Leucodermis*.^[23,24,5]

In Scotland, a research was carried out with, red raspberry, purple raspberry and hybrid kinds. As a result, it was observed that, the formation of flower bud in some kinds happens in early autumn. In black raspberry and in blackberries, it was spotted that the flower buds changes in spring^[18].

Some raspberry kinds can give fruits in both spring and autumn. In a research, carried out in Arkansas Research Station, it was found that, the raspberry cultivar's flower buds are being short day and less temperature^[27].

The affect of hormones on the formation of flower buds, in red raspberry kinds, which give spring and autumn produced, was investigated. It is found that the low temperature and Gibberellins have impacts on flower bud formation. Also, it was observed that cytokines stimulate the flower bud formation.

Table 1: Phase of *Rubus idaeus* L. kind bud^[31].

Phases	Development
1	Becoming smooth of the growing axle
2	Appearing of Perianth ring
3	Perianth changing
4	Starting of Anther development
5	Anther changing
6	Carpel shaping
7	Half of carpel's flower tray shaping
8	Quarter to three carpel's flower tray surrounding
9	Completely to carpel's flower tray surrounding
10	Carpel stretching and anther lobe being
11	The first blooming

In another research, in Loganberry raspberry, Himalayan Giant and Ashton Cross raspberry's fruitfulness of buds was measured by classifying their 1 year old shoots by dividing them into point, middle and bottom. It was observed that, these kinds' buds get into shape in a short time in June. In this study, took place between 28th August 1953 and 12th May 1954, 3-4 buds were taken from the each shoot and their fruitfulness was investigated.^[31] (Table 1).

Most of the generative organs get into shape in spring, in the fruit buds. If there is a problem in the development of primary buds, or if the bud damages, they change place with the secondary bud.

On the red raspberry kinds (*Rubus idaeus* L.) buds, which give spring and autumn product, gibberellin and cytokine impacts were investigated in both hot weather and cold weather.^[6,11,30]

It is found that, gibberellins are affective in floral growing. It is also found that, cytokines have simulative impacts on flowering^[9,12].

In America and Britain, studies were carried out about the flowering and flower bud formation on several raspberry kinds. MacDaniels^[8], in New York, studied on Cuthbert, Marlboro and Herbert raspberry kinds' buds. As a result, he found that changing of flower buds happens on October.

Waldo^[22], investigated bud changing on Oregon Cuthbert, Marlboro and Lloyd George raspberry kinds. As a result, he found that the changing happens on November. Same, Mathers^[10], investigated the floral development in Malling Promise, Malling Landmark and Lloyd George raspberry kinds' buds, in Scotland. As a result, he found that, vegetative development happens in July and the floral development happens in September. In another research in Scotland, it was found that, the flower draft formation of Malling Landmark and Lloyd George kinds happens on September^[31,18].

Macdaniels^[8] found that inflorescence differentiation in raspberry starts from the tip progressing towards the basal and that formation of inflorescence develops quickly from October or early November^[10,18]. It was reported that floral development continues till December of January^[10] or it starts from early December and goes on till early March^[22]. It was observed second fast development occurs in early spring and bud break takes place^[31].

Table 2: Flower organs of Raspberry kinds' changing phases^[10].

Phases	Development
1	Inflorescence formation in the mid-September
2	Formation of perianth at the end of September
3	Flattening of receptacle and development of sepal
4	Development of receptacle and first anther ring development in mid-October
5	Development of second anther ring at the end of October
6	Formation of sepal, 2-3 rings of anther and start of anther lobes in mid-November

In another research, secondary buds of the raspberry were investigated. It was spotted that, if the primary buds get damages, secondary ones take place of them^[22].

In 1991 and 1992, raspberry flower buds' changings and their morphologic characters were investigated, in every 5 and 7 days. It was found that, the changing starts on August and continues for 60-90 days. Floral Axis forms between October and mid-April, terminal flowers starts developing and dormant buds start activity. Petal, stamen and pistil start developing, anthers and ovules gain their shape in mid-May and 2-3 days after that anthesis takes place. A month later, buds develop a little on vegetative shoots^[17].

In another research, changings of buds on shoots with 35 nodes and more were investigated. It was observed that the changing starts on August. And then it was found that these buds get into resting^[3].

Moore^[13] investigated secondary and third buds on raspberries. He observed that when the primary buds gets damages, these buds take the control. It was spotted that, primary buds are damaged because of cold and than, the other bud develop. Primary buds of raspberry cultivars Comox, Chilliwack, Meeker and Willamette injured due to cold on February 2 in 1991 and February 25 in 1992 and they were replaced by the secondary buds.

In a research in New York, it was found that, bud changing of black raspberries happens in early spring and on early October^[4].

In 9 raspberry culture kinds (Distad, Lloyd George, Newburgh, Norna, Ottawa, Preussen, Sygna, Veten and Viking), bud development and flowering times were investigated for two years. It was found that Veten kind is grown well in Norway but despite this, the bud formation take more time than the others. It was spotted that, the bud development happens earlier in Newburgh and Ottawa, but not in Viking and Preussen. In Norna, Newburgh, Sygna and Distad kinds it was observed that, the flowering period is short^[19].

According to another research, raspberry kinds' bud formation happens on August and on early September. Floral development happens on the last week of September. The first flowers are seen at the top. In October term, development is fast. In this research the development divided into phases^[10] (Table 2.).

In Ranere and Lloyd George kinds, from red raspberry species, fruit bud formation happens in summer. In Oregon region, in Lloyd George kind, bud development

was seen in 15th July 1933. It was observed that bud development takes shape fast, from the bottom to the top. It is also found that, development at the bottom of the brunches is less than the top^[22].

Red raspberry kinds' flower buds, which give product in summer, grow in short-day conditions and in low temperature^[27,28]. Age, height and node number of shoot is also effective on flower bud formation^[29].

Fruit bud development of raspberry kinds such as Lloyd George, Malling Promise and Malling Landmark were investigated between June 1949 and March 1951. They are investigated by taking the buds in every two weeks. It was observed that cold is effective on them. It is spotted that, after the small leaf formation, fruit buds grow and their growth start on November and continue until the middle of June.

In a research, made in Scotland, it was found that, bud burst in raspberry kind, happens on late February and early March. It is spotted that flowering happens on April^[10].

BUD STRUCTURE OF BLACKBERRIES AND THEIR FRUITFULNESS SITUATION

Several studies were carried out about this issue. Information's about these studies were given at the bottom. In a research, in Maryland region, it was observed that, until January, there is no development in Himalayan blackberry fruit buds. In Oregon region, until 17th of February 1993, there is no development. Bud changing is observed on October in both Maryland and Oregon. Fruit bud changing in Loganberry raspberry was found to be on early September and October, in Oregon region^[22].

According to another research, bud development of blackberry kinds which give autumn product, is emphasized by phases^[7] (Table 3.).

Flower bud changing was searched in blackberries which grow perpendicularly, in Arkansas Agriculture Experiment Station.

- The ones which give product in autumn
- The ones which give product in both spring and autumn
- The ones which give product in spring
- The ones which give product few times in a year^[14].

While in some culture raspberries, flowering happens in autumn, in some other flowering happens in the middle winter or in spring^[22].

Another research was carried out on flower buds of raspberry kinds such as Cherokee, Boysen and Marion. At the end of the study, vertical growing Cherokee cultivar developed their buds in September in the Oregon and

Table 3: Blackberry kinds' bud development phases^[7].

Phases	Development
1	Vegetative buds with leaf primordial surrounding flat apical meristem
2	Receptacle starts developing with few leaves and bract primordium shows
3	Terminal flower differentiates. Receptacle widens and sepal primordial shows
4	Terminal flower develops. Sepal primordia widen and become 3 lobed. Petal primordia begin differentiating.
5	Sepals unite and close central receptacle.
6	Receptacle of terminal flower lengthens, petal primordia lengthen and widen. Calyx and corolla order on flower plane
7	Stamen primordia differentiate on receptacle.
8	Female structures become visible on the receptacle plane
9	Female structures cover receptacle center. Petals widen and stamen surrounds receptacle.
10	Anther and filaments develop, style and stigma become visible.

Arkansas regions. Floral bud formation in these regions was more advantageous in cultivars Boysen and Marion compared to cultivar Cherokee^[20].

Changing of fruit buds and their developments are very important in terms of practical garden plants. Choice of suitable kinds, designation of their maturing is important. About this issue, there are several researches in America. According to Mac Daniels'^[8] research results, for raspberry, fruit bud changing happens in late June.

Cell divisions and development of plant meristematic structure were studied in 1920's. In the growth cone, first tunica forms and later corpus develops. Divisions occur in tunica. Meristematic tissues develop. Tunica-corporis development is the first sign of vegetative growth. After this growth, floral growth starts in the terminal buds. Floral development causes many changes in major structures. Vegetative meristems consist of these parts;

- Central (axial) region: this region contains central cells of tunica and corpus. They have big cells such as RNA and protein because of the fact that these are big vacuoles.
- Peripheral region: it has a ring shaped structure in the central region and contains tunica and corpus cells. These cells are small and have thick starch. This is the region where usually divisions take place.
- Sponge-like meristem: it has sequential cell lines in the central region. Divisions occur regularly here. This region is mostly found on rosette plants.

According to the researches, all buds in grapy fruits are potentially fruit buds. Fruit bud formation at the point of shoots is more than the ones at the bottom. Fruit bud formation, generally, happens between December and March. Bud formation in Oregon region, in winter, is more than the one in Maryland. Fruit buds firstly arise at the top. When the primary buds are damaged, changing of secondary buds exists^[22].

Table 4: Developmental stages of anther and ovules in *Rubus* species^[10]

Phases	Development
1	Starting of floral development period in mid-October
2	In flowering phase, first flowers grow at the terminal buds and have their regular order
3	Development of torus, sepal ve stamen before winter and continuation of development until spring, formation of androeceum and gynoeceum and completion of their development in 4 weeks
4	Bud development continues slowly in November. Exact maturing in late summer.

Waldo^[22] found that, *Rubus* kinds' bud changing's happens in late September. Some researchers found that, the existance of fruit bud formation happens between November and March. Fruit bud changing of 3 *Rubus idaeus* kind was searched. As a result, they found that, floral development happens in late summer and spring and the bud development to happen between November and February.

According to Mac Daniels^[8], fruit bud development happens between November and march. According to Waldo^[22], fruit bud development happens in the middle of October and early December.

In raspberry and blackberry buds, resting can be seen. Compulsory dormancy happens by environmental and chemical factors. The real dormancy is related with growing and development and they happen by internal causes. In order to success in growing high temperature and enough water are needed. When these cannot be provided dormancy appears.^[28]

Waldo^[22] reported that buds taken from the middle part of the canes were more productive. In another study, development of top buds along the cane was observed. Top one third of the shoot was studied. 50 buds per cane were taken and divided in three: basal, middle and apical parts. The most productive buds were found in the middle part of the cane.

Another study showed that anther and ovule development in *Rubus* species were very fast. Following of meiosis, in approximately 4 weeks, anthers and ovules developed^[10] (Table 4.)

In the same study, cold tests were carried out on Dirksen and Shawne raspberries and on Nordic, Reveille red raspberries. In low temperatures primary buds were frozen. By this, their flower number and floral developments are lessened. In Dirksen blackberry and Reveille red raspberries, it was found that, in low temperatures, secondary buds take control^[25].

Researchers investigated the development of vegetative buds. Developments in the center were examined. What's more, buds at the points were searched. In this research, impact of nutriment substances and growth controlling substances on bud development were investigated.

Many problems were compared with the studies of fruit bud differentiation, its rate and its development. These studies were mostly done in strawberry. However, there are a few research also performed in other small

berries. Fruit bud formation is almost identical in all small berries. Terminal buds are fruit bearers. Buds on shoots actively growing in the season form a year before. These differentiations, first, are seen in vegetative buds. Differentiation, on the other hand, starts in basal buds progressing upwards^[22].

Studies performed on the buds of raspberry and blackberry showed little differences in their bud developments. Buds in raspberry develops in early fall, although it is in spring in blackberries. All buds are potentially a floral bud in raspberries; however, blackberries have leaf buds on the lower parts of their shoots.

REFERENCES

1. Aġaoġlu, Y.S., 1986. Bramble Fruits. Ankara University Agriculture Faculty Publications: 984 Lesson Book: 290, Ankara, pp: 377.
2. Aġaoġlu, Y.S., 2002. Scientific and Application Viniculture. Bind II. Vine Physiology. Kavaklıdere Education Broadcast. Number 5, pp: 455. Ankara.
3. Ilieva, I.N., 1996. "Studies on the morphogenesis of raspberry cultivar Shopska Alena. Rasteniev" dni-Nauki. 32: 110-114.
4. Keep, E., 1969. Accessory buds in the genus *Rubus* with particular reference to *R. idaeus* L. Ann. Bot. 33: 191-204.
5. Knight, R.L. and E. Keep, 1962. *Rubus* L. I. Systematics. Ed.: Kappert, H. Und Rudolf, W.: Haddbuch der Pflanzenzüchtung Paul Parey in Berlin und Hamburg, Band VI: 477-487.
6. Lang, A., 1957. The effect of gibberellin upon flower formation. Proc. Natl. Acad. Sci. U.S.A. 43: 709-717.
7. Lopez, M.J., J.N. Moore and K.S. Kim, 1999. Flower bud initiation in primocane-fruiting blackberry germplasm. Hortscience, 34: 132-136.
8. Macdaniels, L.H., 1922. Fruit bud formation in *Rubus* and *Ribes*. Proc. Amer. Soc. Hort. Sci., 19, 194.
9. Maheshwari, S.C. and I.I. Venkataraman, 1966. Induction of flowering in a duckweed (*Wolffia microscopica*) by a new kinin, zeatin. Planta, 70: 304-306.
10. Mathers, B.A., 1952. A study of fruit-bud development in *Rubus idaeus*. J. Hort. Sci., 27, 266.
11. Michniewicz, M. and A. Lang, 1962. Effect of nine different gibberellins on stem elongation and flower formation in cold requiring and photoperiodic plants grown under non-inductive conditions. Planta, 58: 549-563.
12. Michniewicz, M. and A. Kamienska, 1964. Flower formation induced by kinetin and vitamin E treatment in the cold requiring plant (*Cichorium intybus*) grown under non-inductive conditions. Naturwissenschaften 51: 295-296.

13. Moore, P.P., 1994. Yield compensation of red raspberry following primary bud removal. HortScience, 29: 701.
14. Moore, J.N., 1997. Blackberries and raspberries in the southern United States: Yesterday, today and tomorrow. Fruit Var. J. 51: 148-157.
15. Özbek, S., 1977. General Fruit. University of Cukurove. Agricultural Faculty's Publication, Number: 111.
16. Prive, J.P., J.A. Sullivan, J.T.A. Proctor and O.B. Allen, 1993. Climate influences vegetative and reproductive components of primocane-fruiting red raspberry cultivars. J. Amer. Soc. Hort. Sci., 118: 393-399.
17. Quingwen, H. and L. Jiajun, 1998. research on flower bud differentiation in raspberry. Journal of Fruit Science., 15: 69-73.
18. Robertson, M., 1957. Further investigations of flower bud development in the genus *Rubus*. J. hort. Sci., 32, 265.
19. Takeda, F., B.C. Strik and J.R. Clark, 1996. Flower bud organogenesis and development in blackberry cultivars. Hort Science 31: 682-683 (Abstr.).
20. Takeda, F., B.C. Strik, D. Peacock and J.R. Clark, 2003. Patterns of Floral Bud Development in Canes of Erect and Trailing Blackberries. J. Amer. Soc. Hort. SCI. 128: 3-7.
21. Vasilakakis, M.D., B.H. McCown and M.D. Dana, 1979. Hormonal changes associated with growth and development of red raspberries. Physiol. Plant 45:17-22.
22. Waldo, G.F., 1933. Fruit bud formation in brambles. Proc. Amer. Soc. Hort. Sci., 30, 263.
23. Waldo, G.F., 1934. Fruit bud formation in brambles. Proc. Amer. Soc. Hort. Sci. 30: 263-267.
24. Waldo, G.F., 1937. Fruit bud formation in small fruits and its relation to cultural practices. Prog. Annu. Mtg. Ore. St. Hort. Soc. For., 1935: 75-81.
25. Warmund, M.R. and M.F. George, 1990. Freezing survival and supercooling in primary and secondary buds of *Rubus* spp. Canadian Journal of Plant Science, 70: 893-904.
26. Westwood, M.N., 1978. Temperate Zone Pomology. W. H. Freeman and Company. San Francisco.
27. Williams, I.H., 1959. Effects of environment on *Rubus idaeus* L. III. Growth and dormancy of young shoots. J. hort. Sci., 34, 210.
28. Williams, I.H., 1960. Effects of environment on *Rubus idaeus* L. V. Dormancy and flowering of the mature shoot. J. Hort. Sci. 35: 214-220.
29. Williams, I.H. and J.P. Hudson, 1956. Effect of environment upon the growth and development of raspberry canes. Nature, 177: 798-799.
30. Wittwer, J.H. and M.J. Bukovac, 1963. Quantitative and qualitative differences in plant response to the gibberellins. Am. J. Bot., 49: 524-529.
31. Wood, C.A. and M. Robertson, 1957. Observations on the fruiting habit of the red raspberry *Rubus idaeus* L. J. hort. Sci., 32, 172.