

DETERMINATION OF BUD STRUCTURE AND FLORAL DEVELOPMENT PERIODS OF SOME RASPBERRY CULTIVARS IN ANKARA (AYAŞ) CONDITIONS

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ABSTRACT

In this study, it was aimed to determine the bud structure and floral development periods of Summit, Heritage, Aksu kırmızısı and Willamette raspberry cultivars produced in Ankara (Ayaş) conditions. Summit, Aksu kırmızısı and Willamette are cultivars to produce floricanne fruiting. Being a plant to produce two cultivars at harvest, Heritage is applied as Heritage I, to produce floricanne fruiting and Heritage II to produce only primocane fruiting. During the experimental period, buds collected once in every two weeks from raspberries were tested in the solution including formalin, acetic acid and alcohol (F.A.A.) for 24 hours. At the end of 24 hours, these buds were taken into 70% ethyl alcohol including solution. Buds in the solution including ethyl alcohol were observed using binocular microscope by opening technique and their periods were tried to be detected. In order to detect floral development periods, in addition to the “Opening Technique”, “Paraffin Technique”, described as a microtechnic method, was also used. It was determined that, raspberry plant has a mixed bud structure. The raspberries that produce summer fruit in Ankara (Ayaş) conditions with Opening and Paraffin methods had “Floral Development” between March-May and “Morphological Distribution” took place during March while raspberry that have autumn fruit completed its “Floral Development” between May-July and “Morphological Distribution” took place on May. Two months after bud distribution, blooming was detected to take place and approximately 1.5-2 months after blooming, fruits were observed to be ripe.

Keywords: Ankara (Ayaş), Bud, Floral development, Raspberry.

INTRODUCTION

The term “bramble fruits” describes plant species such as grape (*Vitis*), strawberry (*Fragaria*), raspberry and blackberry (*Rubus*), red currant and gooseberry (*Ribes*), huckleberry, cowberry, culture bilberry, marches blueberry, (*Vaccinium*), rose hip (*Rosa*), berberis vulgaris (*Berberis*), bullace grape (*Prunus*) (Ağaoğlu 1986). Pomologists describe *Rubus* cultivars as glasswort plants. According to some classifications, it is supposed that there are 740 *Rubus* cultivars and 12 subtypes (Ying *et al.* 1990). According to another classification, there are 15 *Rubus* subcultivars described (Jennings 1988). Raspberry and blackberry belong to *Rubus L.* species of *Rosoideae* subfamily in *Rosaceae* family of *Rosales* group. *Rubus L.* species is composed of two sub species. These are: 1) *Idaebatus* Focke and 2) *Eubatus* Focke sub species. Raspberry here is under the species of *Idaebatus* sub species. The cultivars in this sub species are separated from the black berries of *Eubatus* by fruit stem feature to be dispersed from the fruit with the torus and a hole to be formed inside the fruit (Ağaoğlu 1986). Bramble fruits are a new area of research in our country except for strawberries. However, bramble fruits that produced a momentum in the last three decades in our country are such fruits that

are largely consumed, used differently, and liked by consumers (Ağaoğlu 2007).

Compound bud and bud are the two terms that are mostly confused (Ağaoğlu 2002). A compound bud includes “1, 2, 3, n” number of buds. So, compound buds are the vital organs that include numerous numbers of buds. The main buds in a compound bud are the buds primarily important for the amount of the production (Ağaoğlu 2002). The physiological and morphological changes taking place in the buds are extremely important for fruit growing. By observing the internal structure of the buds, it is possible to detect the differentiations in organs and weather they are fruit buds or leaf buds. The period that starts when generative organs in a plant are differentiated and keeps on until blooming is “Floral Development Phase”. In floral development phase; physiological differentiation takes place first followed by the morphological differentiation. Later on, flower organs are developed. Morphological differentiation phase is the period in which first forms of flowers start differentiating in the bud. Physiological differentiation phase, on the other hand, is known as the period which takes place before morphological phase and starts the transition towards generative phase (Ağaoğlu 1999).

Many researchers states that, when primary buds are damaged; secondary buds replaces them and the process keeps on. But, it is within the issues stated above that these secondary buds do not function as productive

as the primary ones. In the studies carried out, most of the generative organs are stated to have their primal shape in spring inside the fruit buds (Ağaoğlu 1986). Differentiations of fruit buds and their development are crucial in practical garden plants production. These differentiations are also important in terms of choosing economically suitable cultivars and ripening times of the fruits. Most of the studies on raspberries both in America and Britain, were carried out on blooming and flower buds. According to MacDaniels (1922), raspberry cultivars grown in America have their fruit bud developments; between November and March although the date is not clear. Morphological development, on the other hand, is stated to take place through the end of September. In a study carried out in Oregon; Cuthbert, Marlboro and Lloyd George raspberry cultivars were studied and their bud differentiation was observed. At the end of the study, the differentiation in their buds was found to take place in November. In same cultivars, floral development is found to take place in late December and last until March. A second and a rapid development and a succeeding blooming were also observed (Waldo 1933). Taking the conditions of our country into consideration, these cultivars have high chances for marketing, therefore, performing adaptation and improvement studies for these raspberry and blackberry cultivars having glassworty plant features, have vital importance. When these two raspberry and blackberry cultivars are compared with others, they are observed to have a higher percentage of wider growing areas and bigger market potential. In order to improve the circumstances at present, territorial projects started to determine the most suitable cultivar that includes the maximum fruit specifications for each region, was an invaluable step in raspberry and blackberry cultivation as well as in the cultivation of other bramble fruits (Onur *et al.* 1999).

In order to have a good yield from raspberry plant, it should have adequate number of flower buds. In this respect, the detection of morphological differentiation phase in buds is very important. After this phase, the formations inside the bud can detected to be either normal or abnormal in structure. These formations show us the amount of yield in the production. Differentiation of fruit buds and their development is crucial in practical plant cultivation. These differentiations are also important in terms of selecting economically suitable cultivars and the ripening periods of fruits. A large number of flower bud formation means the formation of a large amount of product, which is really important for economical point of view. Besides, detection of differentiation phases in buds is also important. In this phase, it is easy to understand weather the bud is flower bud or leaf bud. After this phase, it is possible to understand weather the formation inside the bud is in normal or abnormal structure. Thus, the amount

of production from the cultivars and formation periods of the fruits can be defined.

The aim of this study was to detect the bud structure and floral development phases in four raspberry cultivars grown in Ankara (Ayaş) conditions. At the end of our study, for the four different cultivars of raspberries grown in Ankara (Ayaş) conditions, suitable cultural practices were determined. Ayaş district constitutes a microclimatic condition, within the boundaries of Ankara district, for lots of plant types as well as for bramble fruit cultivation. Not only ecology but also in terms of cultural practices such as trimming, irrigation, and fertilisation, enable the berry fruits grown here to display a better development in fruit buds. Thus, having the best use of unit area, which is the most important feature in cultivation, will be higher.

MATERIALS AND METHODS

Plant material: The present study was carried out between 2005–2006 in Ayaş Horticulture Research Station of Ankara University, Faculty of Agriculture located in Ayaş district of Ankara province. Raspberry plants used in the research were bought from Antalya Citrus Fruits Research Institute in 1998 and planted in Ayaş with the distances of 1.0 X 2.0 m within plants and within rows respectively. In this study; Summit, Heritage, Aksu kırmızısı and Willamette cultivars were studied. Summer fruit was obtained from Summit, Aksu kırmızısı and Willamette cultivars. From Heritage I only autumn fruit, and from Heritage II only floricanne fruiting was obtained. For this purpose, the suckers of Heritage I plants were trimmed in spring in the shoot and newborn suckers were studied. Suckers of Heritage II were left untouched.

In the study, vegetative materials provided by Ayaş Horticulture Research Station of Ankara University, Faculty of Agriculture located in Ayaş-Ankara were used. Temperature and precipitation values of the experimental field in 2005 and 2006 are given in Table 1. According to these values, the highest temperature was recorded in August at 2005 and 2006. While the month with maximum precipitation was March in 2005, it was February in 2006. Experiments were carried out in, the Cytology Laboratory at the Department of Horticulture, Faculty of Agriculture, Ankara University.

Features of raspberry cultivars: Some features of raspberry cultivars used in our study are summarised as follows.

Summit: It is an easily harvested productive cultivar which has thorns bigger than Heritage cultivar, white flowers, small and qualified fruits (Crandall and Daubeny 1989).

Heritage: Its stem is green; thorns are very small and purple, flowers pink-white, fruits big and qualified, it is easily harvestable, and a strongly developing type with both summer and autumn fruit (Crandall and Daubeny 1989).

Aksu kırmızısı: Its suckers are long, thorns are extremely small and fruits are big. It is a strongly developing type which is damaged by extreme heat. It is a cultivar chosen in Aksu Region of Bursa province in the territorial “Action of Bramble Fruits”, and its origin is unknown (Barut 1999).

Table 1. Temperature and precipitation values of the trial field in 2005 and 2006*

Months	Maximum Temperature ° C		Minimum Temperature° C		Average Temperature° C		Falling mm	
	2005	2006	2005	2006	2005	2006	2005	2006
January	15.2	12.0	-4.6	-19.2	3.6	-0.8	29.7	60.9
February	15.3	13.7	-10.0	-15.0	3.0	-0.4	48.2	84.7
March	21.4	25.4	-7.1	-5.1	6.8	8.1	68.4	43.0
April	28.9	22.4	-4.2	0.3	12.5	14.3	62.7	14.1
May	32.8	34.9	0.8	4.1	17.6	18.1	27.5	13.3
June	34.0	38.3	8.7	7.6	20.9	23.1	47.6	9.2
July	38.1	35.6	11.8	12.1	26.3	24.7	18.7	39.1
August	39.6	41.5	14.8	15.8	26.6	28.7	1.8	0.3
September	32.8	32.6	8.8	9.0	20.3	19.5	-	-
October	27.2	29.0	-0.1	4.7	12.2	14.9	-	-
November	19.2	18.7	-3.1	-5.2	7.1	6.3	-	-
December	16.2	13.0	-9.5	-10.0	3.6	1.3	-	-

* General Chairmanship of Meteorology, 2007 Ankara

Willamette: It has a claret red stem with small thorns, it is extremely productive and has big fruits and is a qualified productive cultivar that is easy to harvest (Crandall and Daubeny 1989).

Method: In the floral development phase of cultivars studied, buds were collected once in a week and in other phases once in two weeks. These buds were detected in F.A.A solution, and 24 hours after this, the samples were put into the bottles containing 70 % Ethyl Alcohol. Detection liquid comprised of; 90 ml 96 % of ethyl alcohol, 5 ml glacial acetic acid and 5 ml of 40 % formalin (Johansen 1940, Khalil 1961, Ağaoğlu 1969).

In the buds detected, beginning from the phase growing cone started getting straight, differentiation of flower organs and the period until blooming (Floral Development Phase) were studied. In order to determine the bud structures and floral development phases, opening and paraffin methods were used together.

Opening Method:“ Opening method” is a method easier than paraffin method, as stated by Ağaoğlu (1969), the majority of the material was opened with this method. Buds detected were observed in laboratory under binocular microscope. In the opening of the materials; forceps, blade and a very thin arrow headed needle were used. As stated by Kaşka (1961), in order for the leaves and flower organs in the buds to be observed clearly, the buds opened were maintained in potassium iodine (KI) including solution for 1–2 minutes for staining. Thus, growing cone is observed more clearly.

Paraffin Method: After being detected in F.A.A. detection solution, samples were taken into 70% ethyl alcohol including solution. As a microtechnic method, “Paraffin method”, which is explained by Johansen (1940) and Algan (1981) and modified by Marasali (1992) in order for the anatomic investigation of flower, kernel and flower samples of grape cultivars, is used. Paraffin method is composed of; detection, alcohol series, xylol series, paraffin saturation, xylol evaporation, inserting in pots to include porcelain templates, inserting in wooden blocks, cross-section taking, staining and sample preparing steps.

RESULTS

Bud Structure of Raspberry Cultivars: In the present study, the bud structures of raspberry cultivars were studied principally. At the end of the study, raspberry cultivars were determined to have mixed bud structure. Besides primary buds in raspberry plant, secondary and tertiary buds were present (Figure 1).

Phenological Observations: Phenological observations of raspberry cultivars in 2005 and 2006 are shown in Table 2 and 3. During phenological observations, the dates of; vegetative compound bud’s rising, sudden expansion of the compound buds, appearance of flower bunches, first blooming, last blooming, first fruit determination, first harvest, last harvest and defoliation were determined.

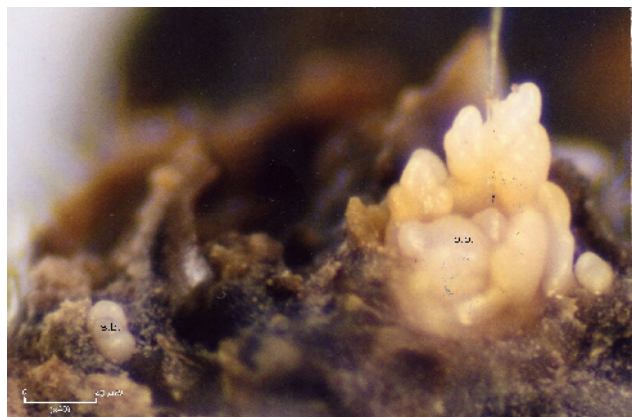


Figure 1. Image of Aksu Kirmızısı raspberry type in the condition of producing primer and secondar buds (p.b.: primer bud, s.b.: secondar bud).

As a result of phenological observations carried out in 2005 and 2006 in Ayaş (Ankara) conditions, it was found out that, in raspberry cultivars with summer fruit, floral development starts in March and keeps on even until blooming in May. 1.5-2 months after blooming, fruits were ready for harvest. Harvesting of raspberries with summer fruit in Ayaş (Ankara) conditions took place in June. Cultivars with autumn fruiting, floral development started in May and kept on until June. This cultivar was found to bloom in June and harvested in September (Table 2 and Table 3).

Floral Development Phases: Raspberry plant has the branch structure for two years. The branches formed in the first year are called generative (*floricane*) branches (Ağaoğlu 1986). The buds formed on vegetative branch, namely vegetative buds, turn into generative buds in the second year. These buds produce the most important product during cultivation, the fruit. Raspberry cultivars are not the cultivars that only give a yield from suckers of the second year; there are exceptional cases. Some raspberry cultivars can also produce fruit on vegetative

branch. That is to say, not just from the sucker of first year in summer, it is also possible to give a yield in autumn from the sucker of that year (sucker of summer). The Heritage cultivar we used in our trial is within the group of cultivars having these features.

Table 4. Floral development phased in raspberry primer buds

Phases	Development status
Phase 0	There is no division in growing cone. Primer bud is in vegetative bud phase, growing cone is surrounded by leaf formations (Figure 2).
Phase 1	Rising of sepal formations in perianth circle of growing cone. This phase is the start of "morphological division" (Figure 3).
Phase 2	Differentiation of perianth in primer buds and sepals to be more clear (Figure 4).
Phase 3	Start of development in anther formation (Figure 5).
Phase 4	Start of sucker activity in primer buds. Differentiation in petal and anther formations (Figure 6).
Phase 5	Differentiation of pistil (carpels) formations and anther formations to get visible (Figure 7).
Phase 6	Pistils to be totally clear; pistils and anthers to fill the half of the torus (Figure 8).
Phase 7	Flower buds to get the shape that is easy to discriminate at first glance; pistils to be more clear; pistils and anthers to surround the torus as three quarters (Figure 9 and Figure 10).
Phase 8	Completion of the formation of all the organs; flower buds to get ready to bloom; pistils and anthers to surround the torus (Figure 11 and Figure 12).
Phase 9	Filaments and pistils getting longer and formation of anther balls (Figure 13).
Phase 10	Blooming of first flowers

Table 2. Phenological observations of raspberry cultivars in 2005

Varieties	Dates of vegetative compound bud's rising	Dates of sudden expansion of the compound buds	Dates of flower bunches appearing	Dates of first blooming	Dates of last blooming	Dates of first fruit determination	Dates of first harvest	Dates of last harvest	Dates of defoliation
Summit	10.3.	21.3.	6.5.	20.5.	27.5.	10.6.	4.7.	15.8.	22.12.
Heritage I	16.5.	21.5.	29.6.	13.7.	27.7.	10.8.	4.9.	30.9.	22.12.
Heritage II	10.3.	21.3.	6.5.	20.5.	27.5.	3.6.	11.7.	22.8.	29.12.
Aksu kirmızısı	16.3.	21.3.	6.5.	27.5.	3.6.	17.6.	11.7.	22.8.	29.12.
Willamette	16.3.	28.3.	13.5.	27.5.	3.6.	17.6.	11.7.	22.8.	29.12.

Table 3. Phenological observations of raspberry cultivars in 2006

Cultivars	Dates of vegetative compound bud's rising	Dates of sudden expansion of the compound buds	Dates of flower bunches appearing	Dates of first blooming	Dates of last blooming	Dates of first fruit determination	Dates of first harvest	Dates of last harvest	Dates of defoliation
Summit	6.3.	31.3.	28.4.	10.5.	24.5.	21.6.	3.7.	14.8.	21.12.
Heritage I	15.5.	31.5.	10.7.	17.7.	3.8.	12.8.	3.9.	28.9.	30.12.
Heritage II	6.3.	31.3.	5.5.	10.5.	24.5.	10.6.	10.7.	14.8.	30.12.
Aksu kırmızısı	15.3.	31.3.	5.5.	10.5.	10.6.	21.6.	10.7.	21.8.	30.12.
Willamette	6.3.	31.3.	10.5.	24.5.	10.6.	21.6.	10.7.	21.8.	30.12.

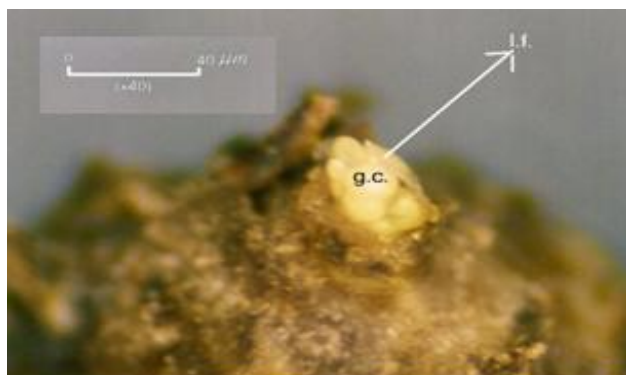


Figure 2. View of Willamette raspberry cultivar bud opened under the microscope (Phase 0) (Mids of February) g.c.: growing cone, l.f.: leaf formations

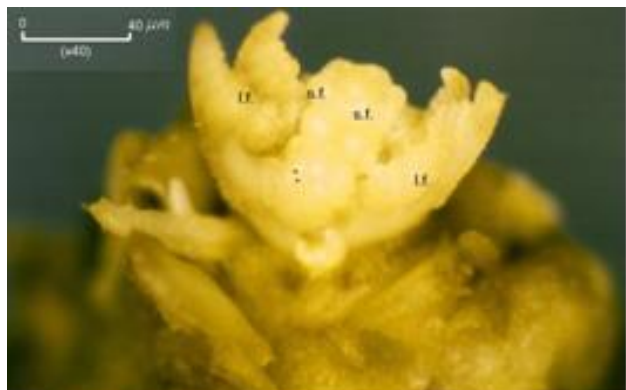


Figure 3. Appearance of sepal formations on the perianth circle of Aksu kırmızısı cultivar raspberry's primer bud (Phase 1) (Mids of March) l.f.: leaf formation, s.f.: sepal formation

Innumerable physiological events are detected to take place in the bud, irrespective of its being summer or winter period, by numerous studies (Ağaoğlu 1986, Ilieva 1996, Lopez *et al.* 1999). The period to be able to observe these happenings under microscope, that is to say the most suitable time for the determination of growing cone organs is known to be the period between risings of the buds until blooming. According to our study, this period in cultivars with summer fruit is between March and May

while it is between June and September in cultivars with primocane fruiting (Figure 2 and Figure 3).

The development phases in the buds of raspberry type (*Rubus idaeus* L.) either opened and/or cut with paraffin method is found as composed of 11 phases by us (Table 4).

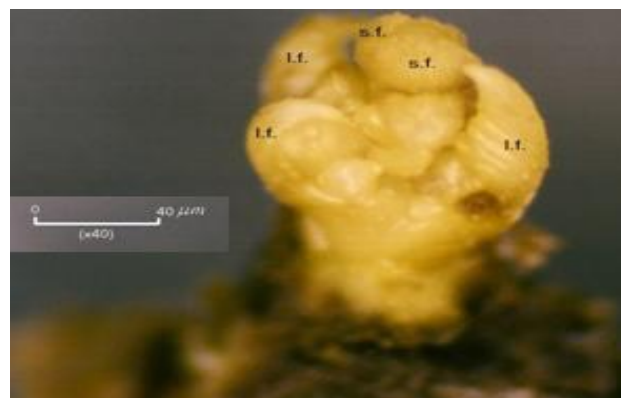


Figure 4. Differentiation of perianth and appearance of sepals in primer buds of raspberry (Phase 2) (Mids of March) l.f.: leaf formation, s.f.: sepal formation

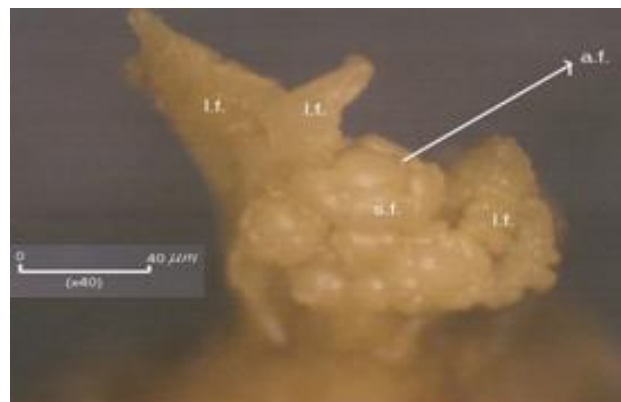


Figure 5. Start of anther formation development in Willamette raspberry cultivar primer bud. (Phase 3) (Mids of March) l.f.: leaf formation, s.f.: sepal formation, a.f.: anther formation

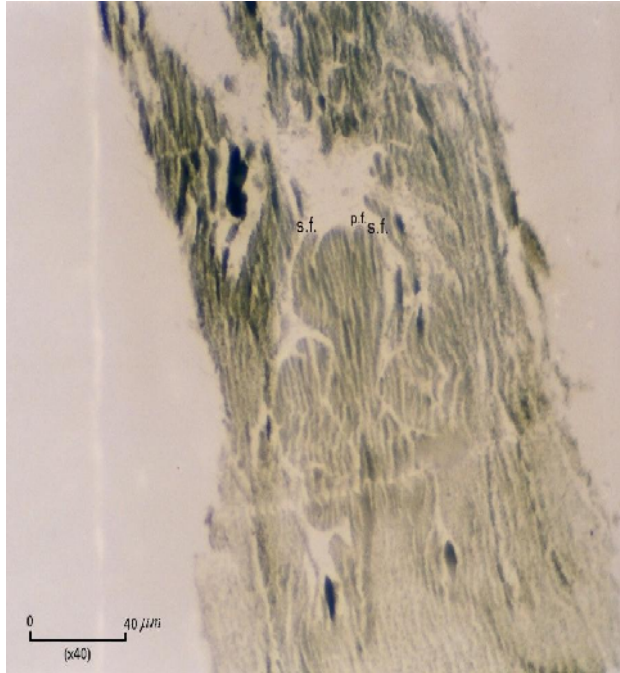


Figure 6. View of the period in which petal formations in Willamette raspberry type flower bud get clear in paraffin cross section. (Phase 4) (Late March) s.f.: sepal formation, p.f.: petal formation



Figure 7. Beginning of differentiations at the pistils (carpels) of the flower bud in Summit raspberry type (Phase 5) (Late April) s.f.: sepal formation, a.f.: anther formation, p.f.: pistil formation



Figure 8. Pistils and anthers in Heritage II type raspberry's flower buds to get visible and these organs to fill the half of torus (Phase 6) (Late April) s.f.: sepal formation, a.f.: anther formation, p.f.: pistil formation

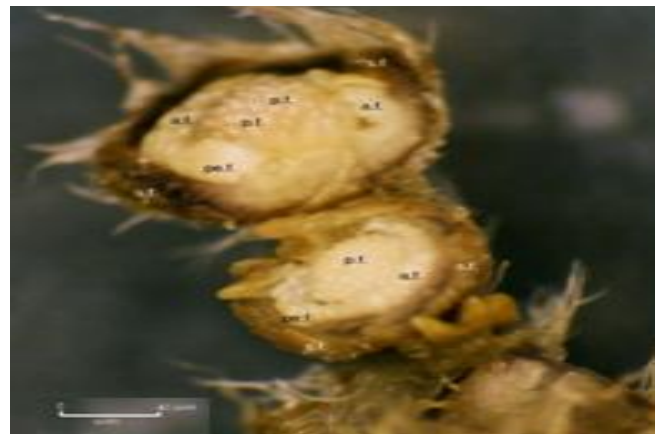


Figure 9. In the flower buds of Summit type raspberries, pistil and anther formations to surround the torus as three quarters (Phase 7) (Late April) s.f.: sepal formation, p.f.: pistil formation, a.f.: anther formation

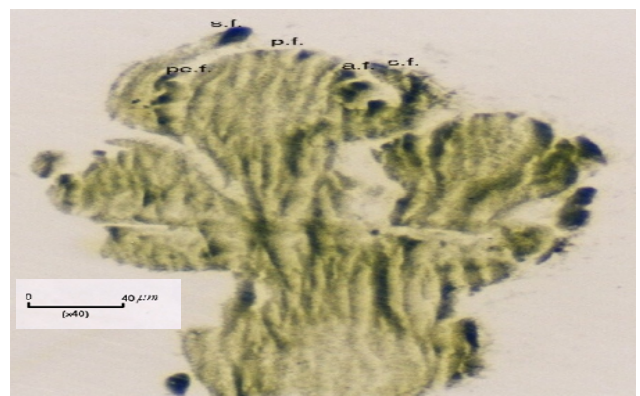


Figure 10. In the flower buds of Willamette type raspberry, view of the period in which pistils and anthers get clear in paraffin cross section (Phase 7) (Late April) s.f.: sepal formation, pe.f.: petal formation, a.f.: anther formation, p.f.: pistil formation



Figure 11. In the flower buds of Willamette type raspberry, pistils and anthers to surround the torus wholly (Phase 8) (Late April) s.f.: sepal formation, pe.f.: petal formation, a.f.: anther formation, p.f.: pistil formation

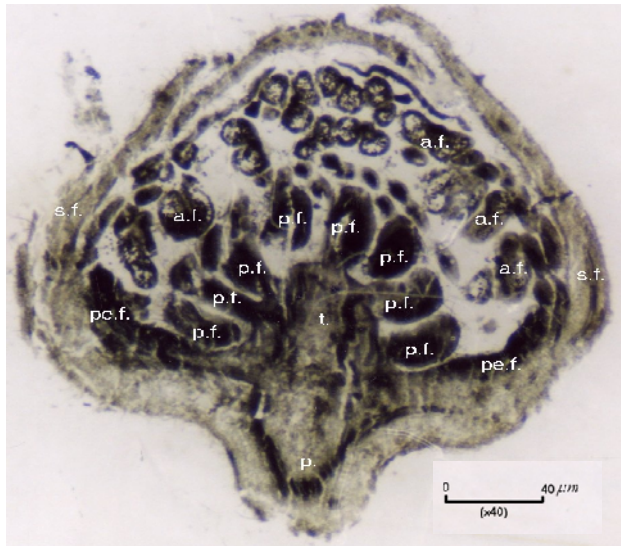


Figure 12. In the non bloomed buds of Heritage II type raspberry, view of the period in which pistils and anthers surround the torus in paraffin cross section (Phase 8) (Early May) s.: sepal formation, p.f.: petal formation, a.f.: anther formation, p.f.: pistil formation, p.: petiole, t.: torus

Floral development is completed by the time first flowers bloom. Blooming took extremely long. Approximately, 1.5-2 months after blooming, fruits are observed to get ripe. In raspberry plant, pistils have two carpels. Carpels start to get plump and dilute immediately after pollination (Figure 14 and Figure 15).

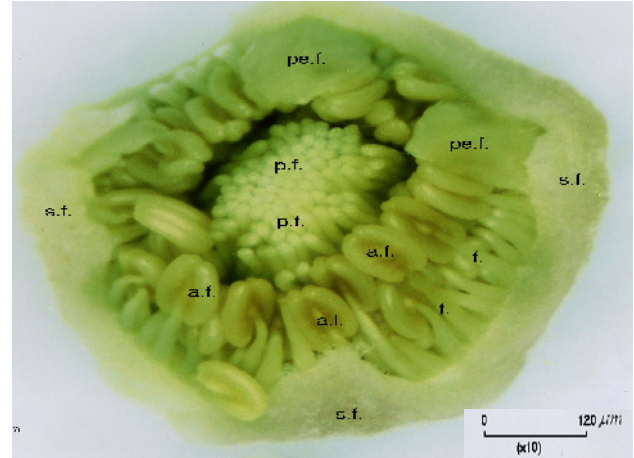


Figure 13. Elongation of filaments and pistils in a non bloomed flower bud and formation of anther lob (Phase 9) (Early May) s.: sepal formation, pe.f.: petal formation, a.f.: anther formation, p.f.: pistil formation, f.: filament, a.l.: anther lob



Figure 14. The view of Willamette raspberry type when its fruit has completed pollination (anthers are not totally fallen) (Late June) f.: filament, a.: anther, c.: carpel



Figure 15. The period in which fruits of Willamette type raspberry get plumb and dilute in the status of drupelets (Early July) a.f.: anther formation, s.: sepal formation, c.: carpels

In Ankara (Ayaş) conditions, spring yielding cultivars are harvested in July while autumn yielding cultivars are harvested in September (Figure 16).



16. Heritage II type raspberry that is rape (July)

DISCUSSION AND CONCLUSION

In this study, bud structures of Summit, Heritage, Aksu kırmızısı and Willamette raspberry types grown in Ankara (Ayaş) conditions were investigated; their floral development phases were determined by opening and paraffin methods. The first studies in the world on raspberry buds are primarily for detecting the floral phases of the plants. In the study Waldo (1933) carried out in Oregon on Cuthbert, Marlboro and Lloyd George cultivars; he found the differentiation period in the buds of these was in October. It was also detected that floral development, in these types, start in early December and lasts until early March. The same researcher has also detected that, a second and a rapid development took place and bud formation repeated in early spring.

In a study carried out by Quingwen and Jiajun (1998) in America; the differentiation and morphological characters of raspberry buds collected in every 5th and 7th days are investigated. It is found out that, raspberry buds start differentiating in late August and lasting for 60 to 90 days. Besides, it is found out that; the axis of flower and far end flowers start forming from early October until midst of April and also still buds start developing in this period. It is detected that; petal, stamen and pistils start to form in this period; anther and ovules have their shape in the midst of May, and blooming take place 2-3 days

after this event. The results concerning the formation of stamen and pistils in our study are analogous with the ones Quingwen and Jiajun (1998) have found. Also in our study, generative organs (stamen and pistil) had their final shape between late April and early May.

In a study carried out in Scotland, the flower formations of Malling Landmark and Lloyd George type raspberries are found to be in September (Wood and Robertson 1957, Robertson 1957). Blooming is detected to take place in March (Wood and Robertson 1957).

Mathers (1952), in his study on the environmental effects against bud formation in Scotland; have investigated the bud development of Lloyd George, Malling Promise and Malling Landmark raspberry types by collecting bud samples once in every two weeks. Cold weather is observed to have effects on the developments of fruit buds. It is detected that fruit buds develop after small leaf bud developed and the development of these buds have started in November and kept on until the midst of June. At the end of the current study, it was understood that vegetative development took place in July and floral development in September. The results found for Ayaş (Ankara) conditions were not analogous with the result found by the researcher. The reason for this difference is the places of collected bud samples that are explained in detail above.

Keep (1969), in a study at Newyork on Cuthbert, Marlboro and Herbert black raspberry types; found that bud differentiation took place in early autumn in October. Concerning the investigation of bud structure in raspberries, which is the second topic in our study, as it is understood from literature obtained and bud opening, cross sample taking activities carried out by us, the samples studied on were detected to have mixed bud structure. Just like many other researchers, Moore (1994) has studied secondary and tertiary buds. He has observed that when primer buds are damaged, they are replaced with secondary or tertiary buds. Primer buds are generally found to have been damaged because of cold and soon afterward, other buds are found to have been developed.

Some raspberry types give yield both in summer and autumn. In a study carried out in Arkansas Research Station, it is found out that, flower bud formation in raspberry types with spring yield is higher in short day conditions and low temperatures (Williams 1959, Williams 1960). The age, length, number of nodes in the sucker has effects on flower bud formation (Williams and Hudson 1956). On the other hand, the flower bud formation in the types with autumn yield is found to be affected by day length and solar radiation (Prive *et al.* 1993).

In the current study; Summit, Aksu kırmızısı and Willamette cultivars among the cultivars that give summer fruit are used. As for type to give autumn fruit, Heritage type is used. We get fruit from Heritage type not

only in July but also in September, namely twice a year. While yield is taken just for once from the types to give summer fruit in July; for autumn fruiting cultivar, bud differentiation took place and based on this differentiation, it was possible to get the second yield two months' after harvest.

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