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Effects of different hormone applications on phenological and pomological properties in some Raspberry (*Rubus idaeus* L.) species

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Abstract

The purpose of this study conducted in a raspberry garden in Karaagac central village of Usak province in 2017 and 2018 was to analyze the effects of phenological and pomological properties of different hormone applications on Heritage and Tulameen raspberry species in the ecology of Usak province. Our experiment was established as 3 replications with 10 plants in each replication. Hormones were applied as Giberallic acid (GA), Melatonin (Mel) and GA+Mel with 2 different doses (5 ppm and 10 ppm) and 2.5 ppm melatonin and 2.5 ppm GA mixture for GA+Mel 5 ppm and 5 ppm melatonin and 5 ppm GA mixture for GA+Mel 10 ppm twice before blooming and fruit set. When we analyze both species, we can see that blooming happens between 17th May and 18th June and the harvest is between 21st June and 12th September. In pomological measures, it was found that in both species fruit length was between 8.89 and 13.13 mm, fruit width was 9.76 and 13.68 mm and fruit weight was between 0.64 and 1.29 g. While pH is between 3.62 and 4.80 and SSC is between 9.27% and 13.82%, TEA is between 21.62% and 30.56%. While Total Phenolic content (ppm/GAE) is between 3.91 and 5.33, Total Flavonoid content (ppm/QE) is between 0.75 and 1.42 and Antioxidant activity (IC50) is between 43.66 and 175.66, vitamin C (ppm) is between 1009 and 2308.50 values. According to the results we obtained in our study, Mel 10 ppm application in Tulameen cultivar in terms of pomological measurements and Heritage varieties in terms of chemical results and hormone applications in 5 ppm dose can be suggested in general terms.

Keywords: Raspberry, Melatonin, Giberallic acid, Fruit quality

Introduction

Berry fruits include the genus and related species such as strawberries, raspberries, blackberries, gooseberries, ribes, blueberries, rosehips, blueberry-vaccinium, berberis vulgaris, blackthorns (Ağaoğlu, 2006) and they have very wide range in nature. Especially in Europe, Asia and North America in different climate areas they have sub-genus, species and inter-species hybrids (Onur, 2006). Although raspberry is a perennial plant in terms of its roots, its shoot is biennial and regeneration per year is its special characteristic that is not observed in many plants. In addition, another important characteristicis that it lays fruit in a short time. Raspberry is important for health. As its glucose structure is in the type of laevulose it is also suitable for the use of diabetic patients. Its juice has a positive effect in the flu and inflamatory diseases and also it is useful for rheumatic patients. In pharmacology the syrup obtained from its fruits is used for taste and odour for medicines. Its fruits are rich in vitamin C, organic acid and glucose. When consumed fresh, it is used as deuretic, appetiser, roborant and cathartic (Göktaş, 2011). It was revealed that ellagic acid, a phenolic acid with a strong anticancerogenic effect, had antiviral and antibacterial effects (Akiyama et al., 2001; Smerak et al., 2002). Ellagic acid is included most in red (Rubusideaus) and black (Rubusoccidentalis) raspberries among all fruits and vegetables and it has an anticancerogenic effect by inactivating cancer-causing chemicals in body (Stoner and Mukhtar, 1995). In addition, ellagic acid has an anti-aging effect. As a result of some studies, ellag-

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ic acid especially obtained from red raspberries was found to be blocking the development of some cancer cells (Glen and Halvorson, 2001; Kresty et al., 2001; McKenzie, 2000). Quercetin has anticancerogenic and antioxidant effects. The antioxidants such as quercetin and kaempferol may prevent the destructions by lipid peroxidation in cells of human body. Raspberry is an important source of quercetin and kaempferol flavonoids (Anonymous, 2002).

Giberallic acid has an important role in growth and development processes of a plant, germination, root elongation, leaf development and breeding. Giberallic acid is commonly considered as a compound which promotes the growth (Razem et al., 2006). Giberallic acid provides body elongation by stimulating cell proliferation and body elongation. It is effective in blooming and fruit coarsening. It grows the cells in elongation part and provides lateral elongation. It stimulates germination in seeds (Çelik, 1982; Hopkins, 1995). Giberallins are effective in the whole growth of a plant including leaves and roots as well as the body elongation. Direct application to the roots is not effective; however, the application that can reach to the tip of the shoots stimulates the development of young leaves and indirectly root development with the increase in photosynthesis (Salisbury and Ross, 1992).

In conducted studies so far it has been identified that melatonin functions as plant growth regulator and has been revealed that it has aging regulatory effects on rooting and shoot growth. It has an active role in the plant's response to the stress. It has been reported that melotonin directly acts like an antioxidant and provides an antioxidative response for the plant (Arnao and Hernandez-Ruiz, 2014; Tan et al., 2012; Zhang et al., 2013). An essential function of melatonin in plants is the defense against internal and environmental stress sources. Melatonin rate in plants is thought to be higher than the rate in animals. Melatonin has a role in the protection of chlorophyll, stimulation of photosynthesis and root development. Transgenic plants with improved melatonin content may lead to the attempts to increase plantive production in agriculture and improve overall health of people (Tan et al., 2012). Antioxidative effect of melatonin application has been presented in some plants (apples, rice and grapes) (Wang et al., 2012; Park et al., 2013; Vitalini et al., 2013). It has been reported that melatonin is a strong antioxidant and prevents the oxidative damage as a result of lipid peroxidation (Zhang et al.,1998; Longoni et al., 1988).

In the current study, by analyzing the effects of giberallic acid (GA) and melatonin (Mel) applicationson phenological and pomological structure in different species of raspberry plant with various use and consumption field and also serious benefits for human health in the ecology of Usak province, it is aimed to shed light for future studies that will investigate not only raspberry but also other berry fruits, make cotributions to the literature and provide new parameters to science.

Material and Method

Material

Plant Material

Our experiment was conducted in a 5-year-old Raspberry and blackberry garden with 5 decares of area in Mucevhir location of Karaağaç Village of Usak province with the coordinates of 38o38'51.54" north and 29o20'04.09" south. Heritage and Tulameen species which are 2 different latish raspberry (Rubus idaeus) species were used in our experiment. Our experiment was established as 3 replications with 10 plants in each replication. They are planted at 1.5 m. of interrow distance and 0.6 m. of intrarow distance.

Soil Properties of Experimental Area

Soil samples were taken from the experimental area and analyzed for physical and chemical properties in Uşak Provincial Directorate of Agriculture and Forestry Soil Laboratory (Table 1).

Table 1. Analysis Results of Experimental Area (Anonymous, 2018)

pH	Salt (micros\cm)	Lime (%)	Organic matter (%)	Saturation (ml)	Total N (%)	Useful P (ppm)	Useful K (ppm)
7.72	474	0.8	1.69	57	0.085	0.38	920

Although the raspberries do not have a special soil demand, they grow well in the organic matter-rich, light or medium-sized, deep, permeable, soil moisture-maintained drainage areas. pH of the soil should be between 6 and 7. Fertilization should be performed at the end of fall or at the end of winter in the form of N P K fertilization (Brand-Williams et al., 1995).

Method

There are seven application groups as Control, Giberallik acid (GA), Melatonin (Mel) and Giberallik acid + Melatonin (GA + Mel). Hormones were applied as GA 5 and 10 ppm, Mel 5 and 10 ppm and GA (2.5 ppm) + Mel (2.5 ppm) 5 ppm, GA3 (5 ppm) + Mel (5 ppm) 10 ppm mixtures before flowering and fruit attitudes before the two times.

Analyzed Properties in the Experiment

Phenological Properties

They are first blooming date, full blooming date, final blooming date, first harvest date, final harvest date, number of clusters, number of grapes in a cluster.

Pomological Properties

The yield per shoot and the fruit weight were calculated using the fruits taken randomly for each replication in harvest period in a scale with 0.1 g of sensitivity. Fruit length and width were calculated by a digital compass scaling the average length of 10 fruits taken accidently and average fruit length ofthe fruits belonging to the species was determined. pH was determined by Hanna brand of pH meter in the fruit juice obtained from randomly selected 10 fruits. Soluble solids content (SSC) was determined as % by a manual refractometer in the fruit juice obtained from randomly selected 10 fruits.

Titrable Acidity (TEA)

1 ml of fruit juice obtained from randomly selected 10 fruits was taken and completed to 50 ml with distilled water. For instance, it was titrated with sodium hydroxide (NaOH) until the pH value was 8.1. Calculations were determined as % in citric acid (Özdemir et al., 2001; Adak et al., 2003).

Determination of Vitamin C

The organic acid compositions of the samples were determined by Agilent brand 1260 model HPLC filtering the fruit juices with white tape filter paper first and then filtering by 25 micron of injector tip. For that purpose, ACE 5 C18 column (5µm, 250 mm x 4.6 mm) and UV detector were used. In the analysis carried out in the isocratic flow, 2% of KH2PO4solution was used as the mobile phase with orthophosphoric acid and the pH was adjusted to 2.3. In the analysis carried out at 30 °C in 0.9 mL/min flow rate and 10 µl of injection volume, organic acids were determined at 214 nm of wave length. Analysis period is 20 minutes. The amounts of organic acid components in the samples were calculated according to standard organic acid analysis results (Fadavi et al., 2005).

Identification of Total Phenolic Content (TPC)

By employing the Folin-Ciocalteu method, the TPC of blackberry juice extract was indicated. 4500 µL deionized water and 500 µL unsubtilised Folin-Ciocalteureagent were laced with 1000 µL extract. Following 60 seconds, 4000 µL of 7.5 % (w/v) aquatic Na2CO3 was mixed. And then, the solution was taken to 30 minutes of maturing period at 30 ºC, which was then followed by measuring the absorbance at 765 nm through employing an UV-Vis spectrophotometer. And the result was aligned with a gallic acid calibration curve. The all phenols were identified as gallic acid equivalents (mg gallicacid/g extract), the valves of which have been suggested as medium of triple assessment (Kähkönen et al.1999).

Identification of Total Flavonoid Content (TFC)The TFC of the plant extraction was identified by employing aluminum chloride colorimetricassay (Chang et al. 2002). To begin with, 0.5 ml aliquots of the extract and 0.01-1.0 mg/ml of quercetin were mixed with 2 ml of distilled water and then with 0.15 ml of sodium nitrite (5% NaNO2 w/v).Upon waiting for 6 minutes, 0.15 ml of it (10% AlCl3, w/v) was accompanied. The solutions were made to rest for 6 minutes more. The last volume was adjusted to 5 ml level by adding instantly the water under distillation, then it was mixed utterly and left to rest up to quarter of an hour. The absorbtion of each composition was identified at the level of 510 nm together with an empty tube as a controller. TFC was determined as mg quercetin equivalent to per gram of sample with the help of calibration curve of quercetin. Every test that indicates the level of extract was conducted for three times (n=3).

Idenetification of Antioxidant Activity (DPPH)

The DPPH (2.2-diphenyl-1-picrylhydrazyl) was conducted by employing Thaipong et al. technique (Thaipong et al. 2006). The existing solution was made up through solving 24 mg of DPPH into 100 ml of methanol which was then stocked at –20°C till necessity accurs(Brand-Williams et al. 1995). The working solution was derived by way of stirring 10 ml of existing solution with 45 ml of methanol so as to make the absorbtion of 1.1 ± 0.02 units at 515 nm emplaying the spectrophotometer Shimadzu UV Mini 1240. 150 µl plant extracts were put under reaction with 2,850 µl of the DPPH sol for an hour under the darkness. Afterwards, the absorbtion level was applied at 515 nm. The antioxidant level showed a demise in absorbtion value under the equation. The outcomes of the absorbtion were transformed into the table content via a standardized calibration curve. These outcomes were then noted in ascorbic acid equivalents (AAE). The extract which supplies 50% of radicalscavenging activity (IC50, the concentration of the sampletoscavenge 50% of the DPPH radicals) was counted up by the the graphic of scavengingpercentage against extract concentration. In order to achieve this goal, subtilization series (five different concentrations) were made up for every plant sample extract. The resulting valves were counted up and given in µg/ml.

Statistical Analysis

Analyses were made in SPSS 24.0 statistics software. Kruskal Wallis H test was used in the comparison of application groups. In case of significant differences among groups, Maan Witneey U test was used for dual comparisons instead of multiple comparison test. Maan Witneey U test was again used for the comparison of the plant in application.

Result and Discussion

Phenological Observations

We can see the phenological observation results of Heritage and Tulameen species in Table 2. While the first blooming date is 17th May in Heritage species, it is 22nd May in Tulameen species. Full blooming date in Heritage species is 31st May; however, it is 8th June in Tulameen species. When we look at the final blooming date, we can see that it is on 10thJune in Heritage species; however, it is on 18th June in Tulameen species. The first harvest in Heritage species in GA+Mel 5 ppm application is 21st June and it is 29th June in Control and GA+Mel 10 ppm applications, however, it is 23rd June in all the other applications. The first harvest started on 21st June in Tulameen species in Mel 5 ppm and 10 ppm applications and on 23rd June in all the other applications. We can see that final harvest date in Heritage and Tulameen species is 12th September.

Yıldız (2011) reported that in Heritage species first blooming was on 16th May, full blooming was on 19th May, final blooming was on 24th May, first harvest was on 20th June and final harvest was on 20th July; however, in Tulameen species first blooming was on 15th May, full blooming was on 24th May, final blooming was on 27th May, first harvest was on 20th June and final harvest was on 30th July. Aydemir; in a study in 2008, stated that in open-air cultivated Heritage I species first blooming was on 7th May, full blooming was on 11th May, final blooming was on 21st May, first harvest was on 11th June and final harvest was on 20th October; however, in Tulameen species first blooming was on 13th May, full blooming was on 17th May, final blooming was on 30th May, first harvest was on 19th June and final harvest was on 29th July. Ada (2014); in his/her study, stated that first blooming date was between 21st and 24th May, 2013, final blooming was between 3rd June and 23rd August, 2013, first harvest

was between 27th and 31st May, 2013 and final harvest was between 17th June and 1st October, 2013. Öz (2006) found the first blooming date between 7th and 13th May, full blooming date between 13th and 18th May, final blooming date between 20th and 24th May, first harvest between 8th and 17th June and final harvest between 9th and 23rd July. Pehluvan (2000) observed blooming in Heritage between 8th June,1999 and 15th June,2000, in Tulameen between 22nd June,1999 and 28th June, 2000. Cangi and İslam (2003) found that harvest period started in the first week of June and lasted until the end of September and as a conclusion Heritage species was found to be the most suitable species for the region. When these studies are analyzed, it can be seen that our study is more similar to Yıldız's study; however, the potential differences between the years among studies and the ecologies of the study zones should be considered.

Table 2. Phenological Observation Results of Heritage and Tulameen Species

Species	Applications	First Blooming	Full Blooming	Final Blooming	First Harvest	Final Harvest
Heritage	Control	17.05	31.05	10.06	29.06	12.09
	GA 5 ppm	17.05	31.05	10.06	23.06	12.09
	GA 10 ppm	17.05	31.05	10.06	23.06	12.09
	Mel 5 ppm	17.05	31.05	10.06	23.06	12.09
	Mel 10 ppm	17.05	31.05	10.06	23.06	12.09
	GA+Mel 5 ppm	17.05	31.05	10.06	21.06	12.09
	GA+Mel 10 ppm	17.05	31.05	10.06	29.06	12.09
Tulameen	Control	22.05	08.06	18.06	23.06	12.09
	GA 5ppm	22.05	08.06	18.06	29.06	12.09
	GA 10 ppm	22.05	08.06	18.06	23.06	12.09
	Mel 5 ppm	22.05	08.06	18.06	21.06	12.09
	Mel 10 ppm	22.05	08.06	18.06	21.06	12.09
	GA+Mel 5 ppm	22.05	08.06	18.06	23.06	12.09
	GA+Mel 10 ppm	22.05	08.06	18.06	23.06	12.09

When we look at Table 3 indicating the number of grapes in a cluster and the number of clusters in a plant in Heritage and Tulameen species, we can see that maximum number of clusters is in Mel 5 ppm with 5.67; however, minimum number of clusters is in GA+Mel 5 ppm group with 2.67 in Heritage species. In Tulameen species maximum number of clusters is observed in Mel 10 ppm with 17.33 and GA+Mel 10 ppm applications with 17.00. When we looked at the difference in the number of clusters in plants among the applications of two species, a statistically significant difference was observed in all applications except for GA 5 and 10 ppm doses (P<0,05). When we analyze the number of grapes in a cluster, approximately the same values (between 3.53 and 4.30) were statistically obtained in Heritage species and the highest values were obtained in Control, GA 5 ppm and Mel 5 and 10 ppm applications in Tulameen species. When we look at the difference in the number of clusters in plants among the applications of two species, we can see that there is a statistical difference in GA 10 ppm and GA+Mel 5 and 10 ppm applications (P<0,05).

Table3. The Number of Clusters in a Plant and Number of Grapes in a Cluster in Heritage and Tulameen Species

Application	Number of Clusters (number/shoot)			Number of Grapes in Cluster (number)		
	Heritage	Tulameen	P	Heritage	Tulameen	P
Control	4.67ab*	8.00b	0.010	3.90	4.03a	0.589
GA 5 ppm	4.33ab	12.67ab	0.162	3.77	3.60ab	0.422
GA 10 ppm	4.33ab	8.67b	0.249	3.73	2.97b	0.051
Mel 5 ppm	5.67a	13ab	0.018	3.53	3.27ab	0.502
Mel 10 ppm	5.00ab	17.33a	0.000	3.60	3.70ab	0.798
GA+Mel 5 ppm	2.67b	10.67b	0.026	4.07	2.93b	0.058
GA+Mel 10ppm	4.33ab	17.00a	0.000	4.30	2.87b	0.028
Overall Average	3.81	12.48	<0.0001	3.84	3.31	<0.0001

*There is a significant difference between applications at p<0,05 level

Aydın (2008); in his study,stated that the annual average number of clusters was 11.83in Heritage I and 10.77 in Heritage II species and 10.20 in Tulameen species; however, the number of grapes in a cluster was 6.32 in Heritage I, 6.05 in Heritage II and 5.54 in Tulameen species as the average of two years. While Yıldız (2011) found the average number of

clusters as 6.67 in Heritage and 5.35 in Tulameen species, he found the average fruit number in a cluster as 5.15 in Heritage species and 3.42 in Tulameen species. Öz (2006) found that the average cluster number per fruit was between 3.33 and 4.43 according to the data he obtained in 2004; however, the number of fruit clusters on annual shoots varied between 16 and 49.5. When we look at other research, we can see that in the current study the number of clusters is a bit more in Tulameen species in general; however, the number of grapes in clusters is less, but not much different.

Pomological Measurements

The fruit size, fruit width, fruit weight and yield per shoot are presented in Table 4 for the applications on the species used in the experiment. The maximum fruit length in Heritage species was obtained in Control and Mel 10 ppm applications. The highest value in the fruit length in Tulameen species was observed in Mel 10 ppm application. When the differences in fruit size of the plants among the applications of two species were analyzed, it was observed that there was a statistically significant difference in all applications except for Control (P<0,05). In the fruit width values of these two species, the highest values in Heritage species were in Control, GA 10 ppm and Mel 10 ppm applications. In Tulameen species approximately the same values were obtained in all the applications. When the differences in fruit width of the plants among the applications of two species were analyzed, it was observed that there was a statistically significant difference in all the applications except for Control and Mel 10 ppm applications (P<0,05). The highest values in fruit weight in Heritage species were in Control and Mal 10 ppm applications and they were in Mel 10 ppm and GA+Mel 10 ppm in Tulameen species. When the differences in fruit weight of the plants among the applications of two species were analyzed, it was observed that there was a statistically significant difference in all the applications except for Control application (P<0.05). While the highest values in yield amount per shoot in Heritage species were obtained fromControl, Mel 5 and 10 ppm applications, the highest values in Tulameen species were obtained from Mel 10 ppm application. When the differences in yield per shoot of the plants among the applications of two species were analyzed, it was observed that there was a statistically significant difference in all the applications except for GA 5 and 10 ppm applications (P<0,05).

Table 4. Length, Width, Weight and Yield per Shoot Measurement Results of Heritage and Tulameen Species

Application	Length (mm)			Width (mm)			Weight (g)			Yield per Shoot (g)		
	Heritage	Tulameen	P	Heritage	Tulameen	P	Heritage	Tulameen	P	Heritage	Tulameen	P
Control	10.5a*	10.74c	0.380	12.15a	13.2	0.238	0.91a	093c	0.724	84.17a	239.56d	0.000
GA 5 ppm	8.59b	11.56bc	0.005	9.76b	13.07	0.007	0.64b	1.10abc	0.006	45.87ab	775.60bc	0.166
GA 10 ppm	9.96ab	11.41bc	0.004	11.79a	13.21	0.038	0.79ab	1.0bc	0.011	58.72ab	254.67d	0.312
Mel 5 ppm	9.84ab	11.99abc	0.004	10.97ab	13.30	0.007	0.77ab	1.16ab	0.001	92.65a	648.44bcd	0.031
Mel 10 ppm	10.94a	13.13a	0.017	12.17a	13.68	0.121	0.94a	1.29a	0.005	87.42a	1427.60a	0.002
GA+Mel5 ppm	9.61ab	11.87abc	0.001	11.21ab	13.46	0.004	0.78ab	1.17ab	0.003	22.52b	381.42cd	0.028
GA+Mel 10ppm	9.81ab	12.45ab	0.001	11.24ab	13.54	0.004	0.75ab	1.27a	0.002	66.75ab	1051.98ab	0.002
Overall Average	9,93	12.03	<0.0001	11.38	13.37	<0.0001	0.80	1.15	<0.0001	65.46	489.33	<0.0001

*There are significant differences between applications at p<0,05 level

From Heritage species,Yıldız(2011) found the average fruit length as 15.63 mm, the average fruit width as 15.89 mm and the average fruit weight as 2.07 g. For Tulameen species, he/she found the average fruit length as 17.84 mm, the average fruit width as 18.69 and the average fruit weight as 2.88 g. According to Aydemir (2008), in Heritage I fruit length is 15.29 mm, fruit width is 15.47 mm and fruit weight is 2.14 g. In Tulameen species fruit length is 18.03 mm, fruit width is 15.55 mm and fruit weight is 2.05 g. In Heritage II species fruit length is 14.41 mm, fruit width is 16.38 and fruit weight is 2.03 g. Yılmaz (2007) found the fruit weight as 2.62 g, the fruit diameter as 16.14 and the fruit length as 16.75 mm. Ada (2014) in his study found the fruit length between 11.83 and 13.46 mm, the fruit width between 11.53 and 14.23 mm and the fruit weight between 1.31 and 1.70 g. Öz (2006) in his study in Tokat on Rubin raspberry found the average fruit length as 1.99 mm, fruit diameter as 13.49 mm and fruit weight as 1.28 g. While Pehluvan (2000) found the fruit weight in Heritage species as 2.23 g, he/she found it in Tulemeen species as 2.31 g. Cangi and İslam (2003) determined the fruit weight between 1.08 and 2.26 g and as a result found out that Heritage species was the most suitable species for the region. Küçükhüseyin (2017) determined the fruit weights of the species between 2.11 (Heritage) and 2.23 (Canby) g according to the average of two years. According to the study result, Heritage species stood out in terms of the analyzed properties. According to the data obtained by Eke (2017), it was determined that the fruit width in wild raspberries was 14.8 mm, in wild blackberries it was 12.8 mm, in wild blueberries it was 8.7 mm; the fruit length in wild raspberries was 13.0 mm, in wild blackberries it was 14.6 mm and in wild blueberries it was 9.4 mm; the fruit weight in wild raspberries was 12.7 g, in wild blackberries it was 11.8 g and in

wild blueberries it was 4.0 g. While Yıldız (2011); in his/her study, found the amount of yield per shoot in Heritage species in 2009 as 82.03 g, he/she found it as 60.17 g in 2010 and in Tulameen species he/she found it as 53.54 g in both 2009 and 2010. While Aydın (2008) obtained the yield per shoot as a result of his study in Heritage I in 2007 as 87.79 g, in 2008 as 96.86 g and in Heritage II in 2007 as 121.46 g and in 2008 as 127.54 g, he/she obtained it in Tulameen species in 2007 as 94.43 g and in 2008 as 104.72 g. Atila (2002); in his/her adaptation study, obtained 18.20 g of yield per shoot in Heritage I species, 22.40 g of yield per shoot in Heritage II and 50.30 g of yield per shoot in Tulameen species. Aydemir (2014); in his/her study,obtained the yield per shoot in outdoor cultivation in Heritage species in 2006 as 74.32 g, in 2007 as 24.90 g, in Tulameen species in 2006 as 51.01 g and in 2007 as 44.35 g and in Heritage II species in 2006 as 82.04 g and in 2007 as 46.47 g. When the current study carried out in Usak and the previous studies are compared, we can see that lower values in the fruit length, width and weight of Heritage and Tulameen species are obtianed in the current study; however, in the amount of yield per shoot, higher values are obtained in Tulameen species.

According to Table 5 which indicates some chemical properties of Heritage and Tulameen species, there is no significant difference in all the groups when we analyze TEA analysis results of Heritage species and near results are obtained in all applications in Tulameen species and there is no significant difference. When we look at the difference of TEA in plants among applications of two species, no significant difference is observed among the applications (P<0.05). No significant difference is obtained in pH analysis results of the applications in Heritage species and also there is no significant difference when pH analysis results are analyzed in Tulameen species. When we look at the pH difference in plants among applications of two species, we can see that there is a statistical difference in GA 5 ppm and GA+Mel 10 ppm applications (P<0,05). While the highest value is obtained in GA 5 ppm application in Heritage species in SSC values, the lowest value is obtained in Mel 5 ppm application. When the difference in SSC of the plants among the applications of two species is analyzed, we can seethat there is a statistical difference in GA 10 ppm, GA+Mel 5 ppm and GA+Mel 10 ppm applications (P<0,05).

Table 5.TEA, pH, SSC Measurement Results of Heritage and Tulameen Species

Application	TEA (%)			pH			SSC (%)		
	Heritage	Tulameen	P	Heritage	Tulameen	P	Heritage	Tulameen	P
Control	26.61	29.78a	0.5	4.15a	3.72a	0.552	11.93abc	10.92a	0.164
GA 5 ppm	27. 35	22.46a	0.060	4.80a	3.85a	0.008	13.82a	9.86bc	0.105
GA 10 ppm	26.75	21.61a	0.219	4.27a	4.03a	0.440	11.13abc	9.85bc	0.017
Mel 5 ppm	25.72	21.76a	0.219	4.37a	4.00a	0.258	10.04c	10.32ab	0.476
Mel 10 ppm	25.26	26.85a	0.5	4.28a	3.62a	0.133	10.58bc	11.18a	0.258
GA+Mel 5 ppm	30.56	26.73a	0.219	4.27a	3.68a	0.124	13.27ab	9.27c	0
GA+Mel 10 ppm	28.63	26.93a	0.5	4.54a	3.84a	0	12.11abc	10.53ab	0.023
Overall Average	27.27	25.16	<0.0001	4.39	3.83	<0.0001	11.66	10.23	<0.0001

*There are significant differences among the applications at p<0,05 level

Ada (2014) found SSC value between 14.4% and 16.3%, pH value between 2.2 and 2.6 and TEA value between 3.3% and 5.6%. While Yılmaz (2007) found 2.23 for TEA, 3.67 for pH and 13.87 for SSC, Aydemir (2008) in his/her study found pH value in Heritage I as 3.53, SSC value as 11.41 and TEA value as 2.97; however, he/she found pH value in Tulameen species as 3.72, SSC value as 12.57 and TEA value as 2.31. While Aydın (2008) in his/her study found pH value in Heritage as 2.81, SSC value as 9.45 and TEA value as 1.33, he/she found pH value in Tulameen as 3.26, SSC value as 7.16 and TEA value as 1.02. Öz (2006) found pH value as 3.60, SSC value as 11.26 and TEA value as 2.77 g/l. Küçükhüseyin (2017) determined soluble solid contentof the species between 9.70% (Aksu red) and 10.10% (Tulameen) and titrable acid rate between 2.43% (Tulameen) and 2.54% (Hollanda Boduru) according to the average of two years. According to the study results, Heritage species stood out in terms of the analyzed properties. Pehluvan (2000) found SSCin Heritage species as 10.23%, in Tulameen species as 9.48% and he/she found TEA in Heritage species as 4.09% and in Tulameen species as 2.97%. Cangi and İslam (2003) determined that soluble solid contentvaries between 10.30% and 13.80% and as a result it was decided that Heritage was the most suitable species for the region. Eke (2017) found SSC in wild raspberry as 13%, in wild blackberry as 11.1% and in wild blueberry as 10.2%; he/she found TEA in wild raspberry as 1.93%, in wild blackberry as 1.53% and in wild blueberry as 1.68 %. When the existing research is reviewed, it is seen that there are some similarities and differences with the current study. TEA values in the current study are close to the ones found in the studies of Yıldız, Aydemir andKüçükhüseyin. When pH values are analyzed, values close to the ones found the studies of Yılmaz, Aydemir and Öz are obtained in the current study; however, we can see that there are not too many differences with other studies. SSC values in the current study are lower than those reported by Ada, but we can see that they are close to the ones reported by

Aydemir and Yılmaz's studies and higher than those reported by Aydın and Küçükhüseyin.

According to the analysis results in Table 6, while the highest value in Heritage species in total phenolic content was found in GA 5 ppm application, the lowest value was found in GA+Mel 5 ppm application; the highest value in Tulameen species was found in GA+Mel 10 ppm and nearly the same values were found in all the other applications. When we look at the difference of total phenolic content in plants among applications of two species, a statistically significant difference was observed in all the applications except for GA+Mel 5 ppm (P<0,05). According to the results of the analysis of total flavonoid content in Heritage species, the highest value was obtained in all the applications except for Mel 10 ppm species and the highest value in Tulameen was obtained in GA and Mel 5 ppm applications and the lowest value was obtained in GA+Mel 5 ppm application. In the difference of total flavonoid content in plants among applications of two species, a statistically significant difference was observed in all the applications except for Control, GA 10 ppm, Mel 5 ppm and GA+Mel 10 ppm applications(P<0.05). According to antioxidant activity analysis results, the highest value in Heritage species was in Mel 5 ppm application; however, the lowest value was in Control group. While the highest value in Tulameen species was in Control group, the lowest value was in GA 10 ppm application. When the difference of antioxidant activity in plants among applications of two species was evaluated, a statistically significant difference was observed in all the applications except for Mel 10 ppm, GA+Mel 5 ppm and GA+Mel 10 ppm applications (P<0,05). In vitamin C values of Heritage and Tulameen species, while the highest value in Heritage species was observed in GA+Mel 10 ppm, the lowest value was observed in GA+Mel 5 ppm applications. While the highest value in Tulameen species was observed in GA 5 ppm and GA+Mel 5 ppm applications, the lowest value was observed in GA+Mel 10 ppm application. When the difference of vitamin C in plants among applications of two species was evaluated, no difference was observed among applications (P<0.05).

Table 6.Total Phenolic, Total Flavonoid, Antioxidant Activity and Vitamin C Measurement Results of Heritage and Tulameen Species

Application	Total Phenolic (ppm/GAE)			Total Flavonoid (ppm/QE)			Antioxidant Activity (IC50)			Vitamin C (ppm)		
	Heritage	Tulameen	P	Heritage	Tulameen	P	Heritage	Tulameen	P	Heritage	Tulameen	P
Control	4.46bc*	3.96b	0.02	1.42a	1.16ab	0.06	95c	153.66a	0.02	1365ab	1731.50ab	0.06
GA 5 ppm	5.33a	4.37b	0.04	1.15a	1.28a	0.04	137.50b	103.66b	0.04	1503ab	2221.50a	0.06
GA 10 ppm	4.54bc	4.09b	0.02	1. 29a	1.11ab	0.25	105bc	43.66c	0.02	1516.50ab	1560.50bc	0.5
Mel 5 ppm	4.65b	4.26b	0.02	1.13a	1.31a	0.08	175.66a	111.33b	0.02	1488.50ab	1200bc	0.06
Mel 10 ppm	4.25cd	4.49b	0.02	0.75b	1.186ab	0.02	128.33bc	115.66b	0.41	1455ab	1250.50bc	0.21
GA+Mel 5 ppm	3.91d	4.15b	0.13	1.34a	0.98b	0.02	109bc	107.66b	0.41	1314.50b	2308.50a	0.06
GA+Mel 10 ppm	4.19cd	5.25a	0.04	1.17a	1.12ab	0.5	130bc	119.33b	0.18	1866.50a	1009c	0.06

*There are significant differences among applications at p<0.05 level

Phenolic compounds (mg/100g in fresh fruit) were found as 113.73-177.6 mg (De Ancos et al., 2000), 192-359 mg (Anttonen and Karjalainen, 2005), 517 mg (Wada and Ou, 2002) and 330 mg (Proteggente et al., 2002) in another studies. The amount of anthocyanin (mg/100 in fresh fruit) was found as 65 mg (Wada andOu, 2002), 19-51 mg (Anttonen and Karjalainen, 2005) and 35.1-49.1 mg (Pantelidis et al., 2007). Antioxidant capacity was found by (µmol Trolox/g) Proteggente et al. (2002) as 18.49.When we look at the vitamin C values in Pahluvan'sstudy (200), it was determined that Heritage species had 28.92mg/100 g of vitamin C content, Tulameen species had 24.27mg/100 g of vitamin C content. In the current study, it was determined that Heritage and Summit species with two yields per year, Newburg species with only one yield per year could adapt to the region better than other species. Aydın (2008) found the vitamin C (mg/100g) amount as 21 mg in Heritage species; however, it did not find any values in Tulameen species. According to the chemical measurements, Eke (2017) obtained the phenolic matter (µg GAE/g ta) in wild raspberry as 1108, in wild blackberry as 1580 and in wild blueberry as 1308; he obtained the antioxidant(µmol TE/g ta) in wild raspberry as 14.95, in wild blackberry as 24.05 and in wild blueberry as 21.35; he obtained the anthocyanin (µg siy-3-glk/g ta) in wild raspberry as 203.36, in wild blackberry as 303.39 and in wild blueberry as 256.19. According to the results of Sezgin and Çelik (2015), tirable acidity value (TEA) was 0.71 g/100ml and antioxidant level was 2,100-2,240 µ mol TEAC. When some pomological properties of the current study conducted in Usak are compared with other studies, total phenolic contents found in the current study are higher. When vitamin C values are analyzed, it is seen that the values in Pehluvan's study are higher; however, there are not so many differences. In adaptation study by Aydın, the value found in Heritage species is very close to the value found in the current study.

Conclusion

According to the results in the current study, Mel 10 ppm application in Tulameen in terms of pomological measurements and Heritage species in general in terms of chemical results and the 5 ppm doses of hormone application in terms of hormone application can be recommended. While Tulameen species can be recommended for fresh consumption due to fruit size, Heritage species can be recommended for industry due to important chemical contents. In our study, while evaluating the

results obtained from the same or different results from other studies, the characteristics of the places where the studies are carried out, such as climate, soil, and time difference between these studies should be taken into consideration. While this kind of studies are carried out in different fruit species in the world, the studies on berry fruits have just become a current issue in our country and it is thought that our study will contribute to this topic. Both in our city Usak and in our country, the fact that raspberry and hormone studies go on gradually may include more new parameters to science.

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References

Ada, M. (2014). Adaptation of Some Raspberry (Rubus idaeus L.) Varieties to Kahramanmaraş Conditions, Master Thesis, Kahramanmaraş, 44.

Adak, N., Gübbük, H., Pekmezci, M. (2003). Research on the Possibilities of Some Strawberry Cultivars Under Cover in Antalya Conditions. Turkey IV. National Horticulture Congress, Antalya, Turkey.313- 315. [URL]

Ağaoğlu, S.Y. (2006). Today and Future of Small Fruits in Türkey, II. National Grape Fruits Symposium, Tokat, Proceedings, 1-7.

Akiyama, H., Fujii, K., Yamasaki, O., Oonoand, T., Iwatsuki, K. 2001. Antibacterial Action of Several Tannins Against Staphylococcus Aureus, Journal of Antimicrobial Chemotherapy, (48): 487-491. [CrossRef] [Google Scholar]

Anonim, (2002). Caneberries are Healthy Fruits. ORBC Nutraceutical Information, Nutraceutical Bulletin Vol. (3): 1 [URL]

Anonim, (2018). Uşak Provincial Directorate of Agriculture and Forestry Soil Laboratory. [URL]

Anttonen, M.J.,Karjalainen, R.O. (2005). Environmental and Genetic Variation of phenolic compounds in Red Raspberry. Journal of Food Composition and Analysis, 18(8), 759-769. [CrossRef]

Arnao, M.B., Hernandez-Ruiz, J. (2014). Melatonin: Plant Growth Regulator and/or Biostimulator during Stres Trends in Plant Science. 19 (12) 789-797. [CrossRef]

Atila, S.P. (2002). Preliminary Evaluation of Adaptation in Ayaş (Ankara) Conditions in Some Raspberry and Blackberry Varieties ", M.Sc. Thesis, Ankara University, Ankara, 90.

Aydemir, M. (2008). Investigation of Plant and Fruit Properties of Some Raspberry and Blackberry Varieties Grown in Open and Unheated Glass Greenhouse Conditions, Master Thesis, Gaziosmanpaşa University, Tokat, 71.

Aydın, E. (2008). Adaptation of Some Raspberry and Blackberry Varieties to Hayrat (Trabzon) Ecological Conditions, Master Thesis, Ordu, 75.

Brand-Williams, W., Cuvelier, M.E., Berset, C. (1995). Use of a Free Radical Method to Evaluate Antioxidant Activity, LWT-Food Sci. Technol, 28, 25-30. [CrossRef]

Cangi, R., İslam, A. (2003). Adaptation of Some Raspberry Varieties to Ordu Region (2000-2002 Observation Results), National Kiwi and Grape Fruit Symposium, Proceedings, Ordu, Turkey, 344-347.

Chang, C., Yang, M., Wen, H., Chern, J. (2002). Estimation of Total Flavonoid Content in Propolis by Two Complementary Colorimetric Methods, J. Food Drug Anal., 178-182.

Çelik, S. (1982). Use of Plant Hormones in Viticulture Ministry of Agriculture, Forestry and Rural Affairs General Directorate of Agricultural Affairs, Viticulture Seminar, Yalova.

De Ancos, B., González, E.M., Cano, M.P. (2000). Ellagic Acid, Vitamin C, and Total Phenolic Contents and Radical Scavenging Capacity Affected by Freezing and Frozen Storage İn Raspberry Fruit. Journal of Agricultural and Food Chemistry, 48(10), 4565-4570. [CrossRef]

Eke, İ.. (2017). Determination of Antioxidant, Phytochemical and Pomological Properties of Some Wild Vaccinium and Rubus Species, Niğde Ömer Halisdemir University, M.Sc. Thesis, Niğde, 54.

Fadavi, A., Barzegar, M., Azizi M.H, Bayat M. (2005). Note. Physico chemical Composition of ten Pomegranate Cultivars (Punica granatum L.) Grown in Iran",Int J Food Sci Tech, 11(2): 113-119. [CrossRef]

GlenA., Halvorson, M. D. (2001). Chemo preventive Properties of Phytochemical Ellagic Insurance Formula,Weltek, Inc. 7925-A North Oracle Road, Tuscon, AZ85404.

Göktaş, A. (2011). Raspberry and Blackberry Cultivation, Fruit Research Station Directorate, Publication no: 38, 1-5.

Hopkins, W.G. (1995). Introduction to Plant Physiology. John Wiley and Sons, Inc, USA.

Kähkönen, M.P., Hopia, A.I., Vuorela,H.J., Rauha, J-P., Pihlaja, K., Kujala T.S., Heinonen, M. (1999). Antioxidant Activity Of Plant Extracts Containing Phenolic Compounds. J. Agric. Food Chem. 47:3954–3962. [CrossRef]

Kresty, L.A., Morse, M.A., Morgan, C., Carlton, P.S., Lu, J., Gupta, A., Black wood, M., Stone,G.D. (2001). Chemoprevention of Esophageal Tumori genesis by Diatary Administration of Lyophilized Black Raspberries, Cancer Research (61): 6112-6119. [Google Scholar]

Küçükhüseyin, E. (2017). Adaptation of Some Raspberry (Rubus İdeaus L.) Varieties to Çorum Conditions, Gaziosmanpaşa University, M.Sc. Thesis, Tokat, 53 .

Longoni, B.,Salgo, M.G., Pryor, W.A., Marchiafava, P.L. (1988). Effects of Melatonin on Lipid Peroxidation Induced by Oxygen Radicals, Life Sci 62, 853-859. [CrossRef]

McKenzie, C. (2000). Berry Works News. Oregon Raspberry&BlackberryCommission, Oregon Strawberry Commission, Berryworks, Inc. 712 NW4th st.Corvallis, 10.

Onur, C. (2006). From Grape Fruits Breeding Project to Symposiums, II. National Grape Fruits Symposium, Tokat, Proceedings Book, 7-10.

Öz, Ö. (2006). The Effect of Planting Frequency and Pruning Levels on Plant and Fruit Properties of Rubin Raspberry (Rubus idaeus L.), Master Thesis, Gaziosmanpasa University, Tokat, 51.

Özdemir, E., Gündüz, K., Bayazit, S. (2001). Determination of Yield, Quality and Earliness of Some Strawberry Cultivars Grown in High Tunnel with Fresh Scalled Seedlings in Amik Plain Conditions, Bahçe, 30 (1-2), 65-70.

Pantelidis, G.E., Vasilakakis, M., Manganaris, G. A., Diamantidis, G. R. (2007). Antioxidant Capacity, Phenol, Anthocyanin and Ascorbic Acid Contents in Raspberries, Blackberries, Red Currants, Gooseberries and Cornelian Cherries", Food Chemistry, 102(3), 777-783. [CrossRef]

Park, S., Lee, D.E., Jang, H., Byeon, Y., Kim, Y.S., Back, K. (2013). Melatonin Richtransgenic Rice Plants Exhibit Resistance to Herbicide-İnduced Oxidative Stress. Journal of Pineal Research 54, 258–263. [CrossRef]

Pehluvan, M. (2000). A Research on Adaptation of Some Raspberry Varieties to Oltu District, M.Sc. Thesis, Ataturk University, Erzurum, 75.

Proteggente, A.R., Pannala, A.S., Paganga, G., Buren, L.V., Wagner, E., Wiseman, S., Rice-Evans, C.A. (2002). "The Antioxidant Activity of Regularly Consumed Fruit

and Vegetables Reflects Their Phenolic and Vitamin C Composition. Free Radical Research, 36(2), 217-233. [CrossRef]

Razem, F.A., Baron, K., Hill, R.D. (2006). Turning on Gibberellin and Abscisic Acid Signaling. Curr. Opin. Plant Biol. 9, 454–459. [CrossRef]

Salisbury, F.B., Ross, C.W. (1992). Plant Physiology. Wads worth Inc. Fourth Edition, California, USA.

Sezgin, O., Çelik, S. (2015). Found in Wild Flora of Turkey Red Currant (Ribesrub L.) phenological Culture Consideration Determination of Morphological Characteristics and Pomological, VII. National Horticulture Congress, Volume I, Çanakkale, 1095-1100.

Smerak, P., Sestakova, H., Polivkova, Z., Barta, Z., Turkek, B., Bartova, J., Longova, M., Andel, M. (2002). Antimutagenic Effects of Ellagic Acid and its Effect on the Immune Response in Mice. Czech J. FoodSci. (20): 181-191. [Google Scholar]

Stoner, G. D., Mukhtar, H. (1995). Polyphenols as Cancer Chemopreventive Agent. Journal of Biochemistry Supplement. (22): 169-180. [Google Scholar] [CrossRef]

Tan, DX., Hardeland, R., Manchester, L.C., Korkmaz, A., Ma, S., Rosales-Corral, S., Reiter, R.J., (2012). Functional Roles of Melatonin in Plants, and Perspectives in Nutritiona land Agricultural Science. Journal of Experimental Botany 63 (2): 577-597. [CrossRef]

Thaipong, K., Boonprakob, U., Crosby, K., Cisneros-Zevallos, L., Byrne, D.H. (2006). Comparison of ABTS, DPPH, FRAP, and ORAC Assays for Estimating Antioxidant Activity Fromguava Fruit Extracts, J. Food Compos. Anal, 19, 669-675. [Google Scholar] [CrossRef]

Vitalini, S., Gardana, C., Simonetti, P., Fico, G., Iriti, M. (2013). Melatonin, Melatonin İsomers and Stilbenes in Italian Traditional Grape Products and Their Antiradical Capacity. April, Volume 53, Issue 3, 322-333. [CrossRef]

Wada, L.,Ou, B. (2002). Antioxidant Activity and Phenolic Content of Oregon Caneberries, Journal of Agricultural and Food Chemistry, 50(12), 3495-3500. [CrossRef]

Wang, P.,Yin, L., Liang, D., Li, C., Ma, F., Yue, Z., (2012). "Delayed Senescence of Apple Leaves by Exogenous Melatonin Treatment: Toward Regulating The Ascorbate–Glutathione Cycle. Journal of Pineal Research. Agust Volume 53, Issue 1, 11-20. [CrossRef] [Google Scholar]

Yıldız, A. (2011). Adaptation of Some Raspberry and Blackberry Varieties Grown in Hayrat (Trabzon) Conditions, Master Thesis, Ordu, 72.

Yılmaz, A. (2007). Effects of Different Fertilizer Applications on Plant and Fruit Properties of Tulameen Raspberry (Rubus idaeus L.), M.Sc., Gaziosmanpaşa University Tokat, 59.

Zhang, H., Squadrito, G.L., Pryor, W.A. (1998). The Reaction of Melatonin with Peroxy nitrite: Formation of Melatonin Radical Cation and Absence of Stable Nitrated Products. Biochemical and Biophysical Research Communications. Volume 251, Issue 1, 83-87. [CrossRef] [Google Scholar]

Zhang, N., Zhao, B., Zhang, H.J., Weeda, S., Yang, C., Yang, Z.C., Ren, S., Guo, Y.D. (2013). Melatonin Promotes Water-Stress Tolerance, Lateral Root Formation, and Seed Germination in Cucumber (Cucumis sativus L.). Journal of Pineal Research, 54(1), 15-23. [Google Scholar] [CrossRef]