Assessmentofpollenqualityandquantityinwhiteandblack Turkish *Myrtus communis* L. accessions, through *in vitro* pollen germination under varied boric acid concentrations

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ABSTRACT

This study aimed to evaluate the pollen properties, pollen viability and germination with suitable germination medium and amount of pollen production in 6 Turkish myrtle genotypes. The genotypes were evaluated as their origin and fruit colours in terms of 3 different origins (Erdemli, Karaisali and Tarsus) and 2 fruit colours (black andwhite).Resultsshowedthat,pollenpropertieswereaffectedfromfruitcoloursandblackgenotypesgenerally showedhigherpollenproperties.Theamountofpollenproductionofoneflowerwasveryhighrangingfrom2.5to 4.5 million. Pollen viability and germination rates showed sufficient results for successful pollination in Turkish myrtle genotypes.Among pollen germination media, the best pollen germination rate was obtained from 50 ppm boricacid.Consequently,thisstudyidentifiedthepollenperformanceofwhiteandblackTurkishmyrtlegenotypes andsuggestedanoptimalpollengerminationmediumforMyrtuscommuniswhichcanbeusedinthefuturebreeding programmes.

***Keywords*:**Anther,flower,Myrtaceae,pollenbiology,pollination

INTRODUCTION

Myrtle (*Myrtus communis* L.) belongs to the familyMyrtaceaeandisoneofthemostsignificant specieswidelyspreadintheMediterraneanregion, the Middle East and warmer regions of North America and Australia. In Turkey, it has been intensively grown naturally in the Mediterranean region especiallynear naturalpine forests, particularlyintheTaurusMountainsandriversides. The species are growing wild in warm and temperate regions of the Mediterranean basin, where it is well known for its medicinal and aromatic properties (Mulas *et al*., 1999; Yildirim *et al*., 2013). Essential oil from the leaves is used in the perfume and food industries (Lawrence, 1994; Boelens and Jimenez, 1992), while both leaves and berries are used to produce typical liqueurs(Mulas*etal*.,1999).Duetothesuccessof myrtle liqueur and the number of processing industries, the demand for raw material has increased (Mulas and Fadda, 2004)

Myrtle has several genotypes with yellowish-white or bluish-black coloured fruits (San *et al.*, 2015;Simsek*etal*.,2020).Recentstudiesofmyrtle have focused on the health functions of aromatic and medicinal plants, which have antioxidant, antimicrobial and mutagen properties due to the dietary intake of antioxidant compounds (Duh *et al.*, 1999; Yildirim *et al.*, 2013). Myrtle oil has a very extensive consumption as food, cosmetics, medicine, perfumery etc. (Jamoussi *et al.*, 2005, Mechchate *et al.*, 2022). In recent years as it has been understood as an important fruit, it gained importanceandstartedtotakeplaceinmarketsand in herbalists (Montoro *et al.*, 2006;Alim, 2020). Due to high food value and wide usage of myrtle fruitsandleaves,itsproductionhasbeenincreased. Whether there is not a closed myrtle orchard in Türkiye,plantswerestartedtoplantashedgeplant in order to provide the demand of customers.

Myrtleflowersneedpollinationtosetfruitsand a successful pollination depends on quality of flowersespeciallyintermsofpollenquality.Myrtle fruits has lots of seeds (Mulas and Fadda, 2004). Whetherthisseedexistencedisturbscustomers,the studiesfor decreasingseed numbercaused excessivefruitdrops(Gonzalez-Varo*etal*.,2009, Alim,2020).Thisshowsthat,seedformationafter

successfulpollinationandfertilizationisessential for adequate fruit set in myrtle.

Myrtle buds develop from the leaf axillae on youngshootsassingleflowers(MulasandFadda, 2004). It has a 1-2,5 cm green or red peduncle generallylinkedwithfruitcolour.Myrtleflowers arehermaphroditicwithbothstamensandpistilare atthesameflower(Fig.1a).Flowerscompriseof 5greensepals,5whiteorpinkypetals,about100-150stamenswithlongfilamentsandalittleanther. Pollensaretriangularinshapeandhastricolporate apertureswithadiameterabout8-15mm(Fig.1b). The flower has a single pistil at the middle of the flower.Itisembeddedintothereceptacleshowing an inferior ovary type with 3 syncarpous carpels with axile plasentation of about 25-50 ovules (Mulas and Fadda, 2004). Flowers secrete lots of nectar at the bottom of the anthers and originally nearfromtheapexoftheantherinordertoattract pollinatorinsectsforabetterpollination(Ciccarelli *et al*., 2008).

Recent studies have been showed that, myrtle pollen viability is very high immediately after anthesis.Alongwiththeendofthefirstday,pollen viabilitydeclinesand36hoursafteranthesisalmost allgrainsbecomeunviable.Atthesametime,while pollen viability remains high for several hours at high temperature and dry conditions, it rapidly decreases at high humidity (Aronne, 1999). So, myrtle pollen should be transferred to the stigma as soon as possible by pollinator insects which indicates the importance of pollen limitation and pollenviabilityonemoretime.Althoughmyrtleis aself-compatiblespeciesandneedspollinatorsto increase fruit set, fruit size and quality increases with cross pollination showing that the pollen quality has a great importance for myrtle fruit formation(AizenandHarder,2007;Gonzalez-Varo *et al.*, 2009).

Consideringtheeffectsofpollenimportancein myrtle flowers, this study aims to evaluate the pollenqualityintermsofpollenviabilityandpollen germinationrates,suitable*in vitro* pollen germination medium and *in vitro* pollen tube growth in 3 black and 3 white Turkish myrtle genotypes.Atthesametime,theamountofpollen production was also determined for relevant genotypes.

MATERIALSANDMETHODS

This study was conducted in 2023 flowering seasonof 6 Turkish myrtle genotypes.The genotypeswereselectedfortheirsuperiorqualities fromMediterraneanregionofTürkiye(Simsek*et al.*, 2020). The selected genotypes were from 3 differentregionsofTürkiye(Erdemli,Karaisaliand Tarsus)duetotheirfruitcolours(whiteandblack) (Table1).Theselectedgenotypeswereplantedin research field of Cukurova University in 2020 at 3x2 m spacing. Plants were 3 years old, drip irrigatedandallnecessaryculturalpracticeswere followed uniformly in the research field.

In this study the amount of pollen production and pollen homogeneity, *in vitro* pollen viability and germination rates, suitable *in vitro* pollen germination medium and *in vitro* pollen tube growth rate parameters were evaluated. For this purpose, at least 100 unopened flowers were collected one day before anthesis from 5 trees of each genotype and immediately taken to the Cytology Laboratory in Cukurova University.

Amountof pollen productionand pollen homogeneity

For determining amount of pollen production andhomogeneitytests,30flowerswereseparated to3groupsandanthersofeachgroup(10flowers foreach)weretakentoplasticcontainers.Prepared sampleswerelefttodryforatleast15days.Pollen production tests were made by hemacytometric methodand countingslideswereprepared according to Eti (1990) with 4 ml of sterile water (Fig. 2a).Then, the samples were analysed with OlympusBX51lightmicroscopeandmicrographs weretakenwithDP72camerawithaspecifiedarea onthemicrograph(Fig.2b).Followingpreparation, thequantityofpollenwithinthespecifiedareawas tallied,and subsequent calculationswere performed,incorporatingamodificationbasedon Eti (1990). While calculation, the counting place volumewasfoundwithmultiplicationofthecreated area and depth of hemacytometric slide. The amount of pollen at calculated volume was then rated to whole container volume to find "amount ofpollenfor10flowers".Thenthe"pollennumber perflower"wasfoundbydividingeachdatato10. Atleast12areaswerecountedforeachreplication and the average data were used for calculation.

The“normallydevelopedpollenratio”wasalso determined in each micrograph by counting and ratingnormallydevelopedpollentototalpollenin created volumes according to Anvari (1977).

_Invitro_pollenviabilityrate

In order to obtain pollen for viability tests, anthersfrom6genotypesofmyrtuswerecollected randomlybeforeanthesis.Anthersofthecollected flowers were separated and placed in room temperature until dehiscence for about one night (MulasandFadda,2004).Afterpollendehiscence, pollen viability rates were determined using 1% TTCtest(2,3,5Triphenyltetrazoliumchlorid).TTC was prepared and evaluated according to Norton (1966).Foreachgenotype3sliderеplicationwere prepared and at least 100 pollen grains were counted fromeachreplication.Pollencountingweremade by Olympus BX51 microscope. While counting, red pollens were considered as “viable”, light pinkiesas“semiviable”anduncolouredpollensas “non-viable” (Fig. 3a). Then the pollen viability ratewascalculatedaccordingtoNorton(1966)as the ratio of “sum of total viable and half of semi viable pollens” to “total pollen number”.

Suitable_invitro_pollengerminationmediumand _invitro_pollengerminationrate

Inordertodeterminepollengerminationdata, samepollenswereusedthatwaspreparedforpollen viability tests.The suitable*in vitro* pollen germination tests were all performed in a basic media,whichconsistedof1%agar,100mldistilled water and 15% sucrose (Mulas and Fadda, 2004) with single factor experiment of boric acid (H_3BO_3) in concentration of 0, 50 and 100 ppm.

Media and germination petri dishes were prepared according to Karabiyik and Eti (2016). Pollen germination ratio for each medium was determinedafter24hours.Thepollengrainswere consideredtobegerminatedwhenthepollentube lengthwasgreaterthanthediameterofthepollen grain (Fig. 3b). At least 100 pollen grains were counted for each replication.

The *in vitro* pollen tube growth rate was also determined after 2, 4 and 10 hours of preparation inordertosetoutthedifferenceatemergenceand elongation of pollen tubes for each media and genotype.Inordertomeasurepollentubelength inspecifiedhours,littlesegmentsweretakenfrom preparedmediabetweenslideandcoverglassand immediatelytakento-20^{0}Ctostopgrowthandfix themediasamplesfilledwithpollen.Experiments were prepared as 3 replications for pollen tube measuring tests. The *in vitro* pollen tube growth was determined by measuring pollen tube length withOlympusBX51microscopeequippedwitha DP72digitalcamera(Fig.3c).Atleast30pollen tubesweremeasuredforeachmedia,eachhourand each replication. By this way, the fastest pollen germinatingmediacouldbedeterminedformyrtle genotypes.

Statisticalanalysis

AlldataanalysiswasperformedusingJMP13 statistical software. The effects of the treatments were analysed using one way anova analysis of variance.APvalueof<0,05wasconsideredtobe significant.Thestatisticalanalysiswasconducted intermsoftheoriginsandfruitcolourofgenotypes. Bythisway,2factorialrandomiseddesignhasbeen used for analysing pollen production, normally developed pollen and pollen viability data. In the otherpartofourexperiment,thepollengermination ratewasanalysedby3factorialrandomiseddesign as genotype origin,colourand boron concentrations. Percentages were analysed after arc-sintransformation.

RESULTSANDDISCUSSION

Amount of pollen production and normally developed pollen rate

Amount of pollen production for 6 Turkish myrtlegenotypesweregiveninTable2intermsof originsandfruitcoloursofthegenotypes.Thetable shows that amount of pollen production in one flowersignificantlyinfluencedbyfruitcolourand origin x colour interaction while differences between genotypes did not find to be important. Thepollenproductionineachflowerwasveryhigh rangingbetween2657493(Karaisali-White_KB) and 4 885 013 (Karaisali-Black_KS) pollens per flower and the average pollen production was definitelyhigherinblackgenotypes(3843840) than white genotypes (3 056 213). In terms of genotype origin averages, the highest pollen productionwasdetectedinKaraisaligenotypes(3

Table1:Originsandfruitcoloursofusedgenotypes

Genotypename	Genotypecode	Origin	FruitColour
Erdemlibeyazi	EB	Erdemli/Mersin	Whitefruited
Erdemlisiyahi	ES	Erdemli/Mersin	Blackfruited
Karaisalibeyazi	KB	Karaisali/Adana	Whitefruited
Karaisalisiyahi	KS	Karaisali/Adana	Blackfruited
Tarsusbeyazi	TB	Tarsus/Mersin	Whitefruited
Tarsussiyahi	TS	Tarsus/Mersin	Blackfruited

Table2:Amountofpollenproductionperflowerin6Turkishmyrtlegenotypesintermsoftheir origins and fruit colours (pollen/anther)

Origins	Fruit Colours		OriginsAverage
	White	Black	
Erdemli	3295146b[1]	3 412 266b	3 353 706
Karaisali	2657493 b	4885013 a	3771253
Tarsus	3216000 b	3234240 b	3225120
ColoursAverage	3056213 B	3843840 A	

LSD_{origin}***:N.S.[2] LSD_{colour}**: 586 814,2 $LSD_{orixcol}$***:1 016 392,0

[1]Differencesbetweenaveragesshowedbydifferentlettersarestatisticallysignificant
N.S.meansnot-significant;**meansp<0,01;***meansp<0,001.

Table3:Normallydevelopedpollenratiosin6Turkishmyrtlegenotypesintermsoftheirorigins and fruit colours (%)[1]

Origins	FruitColours		OriginsAverage
	White	Black	
Erdemli	93.17	93.97	93.57A[2]
Karaisali	89.35	88.02	88.68B
Tarsus	93.95	93.75	93.85A
ColoursAverage	92.16	91.91	

LSD_{origin}***:1,985 LSD_{colour}:N.S. $LSD_{orixcol}$:N.S.

[1]Statisticalanalysisweremadeafterarc-sintransformation.
[2]Differencesbetweenaveragesshowedbydifferentlettersarestatisticallysignificant
N.S.meansnot-significant;***meansp<0,001.

Table4:Pollen viability levels in 6 Turkish myrtle genotypes in terms of their origins and fruit colours (%)[1]

Origins	FruitColours		OriginsAverage
	White	Black	
Erdemli	42.84 cd[2]	85.46a	64.15A
Karaisali	51.99 b	35.11d	43.55B
Tarsus	50.30 bc	44.63bc	47.47C
ColoursAverage	48.38 B	55.07A	

LSD_{origin}***:3,605 LSD_{colour}**:2,943 $LSD_{orixcol}$***:5,098

[1]Statisticalanalysisweremadeafterarc-sintransformation.
[2]Differencesbetweenaveragesshowedbydifferentlettersarestatisticallysignificant
N.S.meansnot-significant;**meansp<0,01;***meansp<0,001.

Table5:Pollen germination levels in 6 Turkish myrtle genotypes in terms of their origins, fruit colours and Boron concentrations (%)[1]

Origins	Boron Concent.	FruitColours White	FruitColours Black	Originx Boron	Origins Average
Erdemli	0ppm	26,20	46,34	36,27	41,58
	50ppm	27,99	63,49	41,58	
	100 ppm	19,68	65,79	46,89	
Originx Colour		24,62b[2]	58,54a		
Karaisali	0ppm	31,00	68,07	49,53	42,53
	50ppm	37,45	37,27	37,36	
	100 ppm	26,04	55,37	40,71	
Originx Colour		31,50b	53,57a		
Tarsus	0ppm	47,17	43,57	45,37	51,34
	50ppm	51,15	67,14	59,15	
	100 ppm	50,54	48,49	49,52	
Originx Colour		49,62a	53,07a		
ColoursAverage		35,25B	55,06A		

LSD_{origin}:N.S. LSD_{colour}***:4,919 LSD_{boron}: N.S. $LSD_{ori\ x\ bor}$: N.S. $LSD_{orixcol}$***:8,521 $LSD_{orixcolxbor}$: N.S.

[1]Statisticalanalysisweremadeafterarc-sintransformation.

[2]Differencesbetweenaveragesshowedbydifferentlettersarestatisticallysignificant

N.S.meansnot-significant;***meansp<0,001.

771253),followedbyErdemli(3535706)and Tarsus(3225120)genotypes.

Pollenproductionisanimportantdataforseededcultivarsasitguaranteesthepollenmeetingprobabilitywiththestigma.Inthisstudy,amountofpollenproductioninonemyrtleflowerwasveryhighatabout2.5millionsand4.5millions.However,myrtleflowershavealotofanthers between120-150(MulasandFadda,2004)andthis means each anther has at about 15 000 – 30 000 pollens.Tothebestofourknowledge,thereisnotanydataforamountofpollenproductioninmyrtleflowersandthisreportisthefirstforpollenproductionfor*Myrtuscommunis*.However,thedatawascoherentwithotherspecieslikecitrus(KarabiyikandEti,2019),carob(Eti,1990),strawberry(Karabiyik*etal*.,2016),pecan(KarabýyýkandEti,2018),watermelon(Adiguzel*etal*.,2022),loquat(KarabiyikandEti,2015)etc. intermsofamountofpollenproducedinoneanther.

Nevertheless, pollen production for myrtle genotypes should be higher than most of the species.Because,Beardsell*etal*.(1989)havebeen stated that members of Myrtaceae has secretes underanthersofthestamenscalledantherglands thathelpsflowerstoattractpollinatorinsects, especiallythebees.Theauthorshavebeenreported thatthissecretemixeswithpollenwhichactsasa foodsourceforinsects(Ciccarelli*etal*.,2008).This structureofflowerscauseslotsofpollenloses,so thehighpollenproductionrolesoutthesehandicap.

Normally developed pollen ratios were given in Table 3. The data showedthat normally developedpollenwhichshowspollenhomogeneity level is generally high and only origin of the genotypeaffectsnormallydevelopedpollenratio. The highest ratio was obtained from Erdemli (93.57%) and Tarsus (93.85%) genotypes while Karaisali genotypes (88.68%) had the lowest homogeneity level. Fruit colour did not differ significantly and white genotypes had an average of 92.16% while black genotypes has an average of 91.91% pollen homogeneity level.

Besidesthe high pollen productionof a genotype, it is important to have a genotype high normally developed pollen ratio. Anvari (1977) havebeenstatedthattheundevelopedorabnormal pollens,whichshowsdiversionsfromnormalshape andsize,areunlikelytogerminate.So,ifthenormal rateofpollenratioapproachto100%,the

Fig. 1: Flower (a) and pollen (b) of myrtle

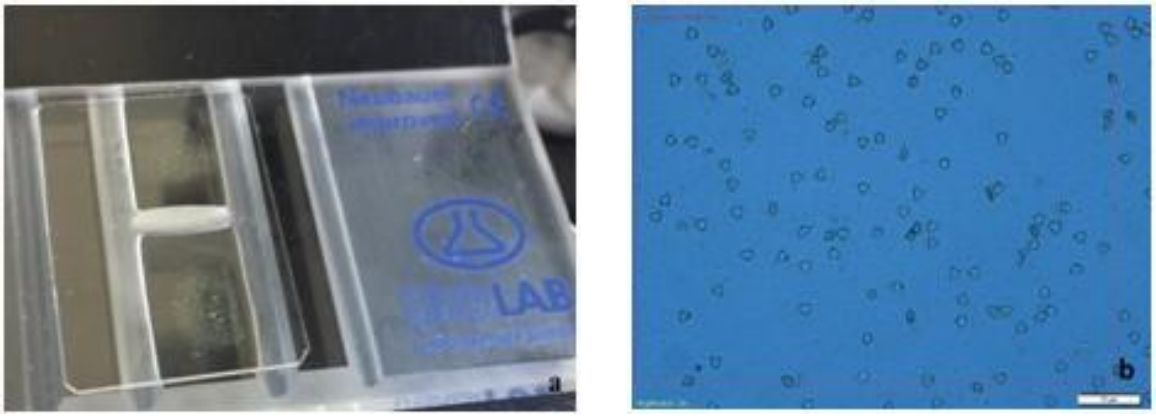

Fig. 2:The hemacytometricslide (a)and thepollen countingarea(b)

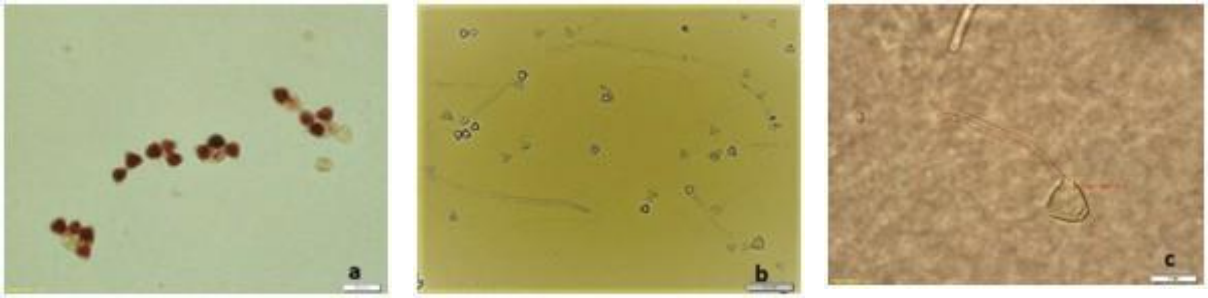

Fig.3:a.pollenviabilitytest,b.germinatedpollens,c.Pollentubeelongation

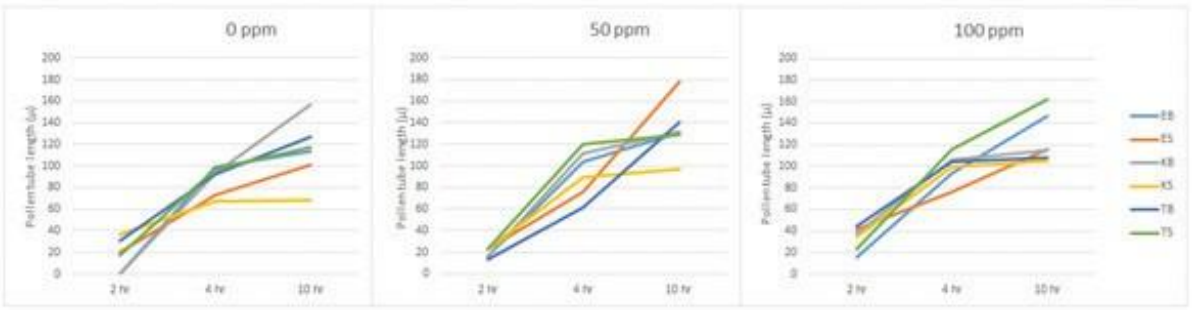

Fig.4:PollentubegrowthrateofTurkishmyrtleaccessionsindifferent*invitro*pollengerminationmedia.

pollination potential of genotype will increase in the same rate. The results showed that myrtle pollens have adequate pollen homogeneity and pollenproductionlevelforsuccessfulpollination.

***Invitro*pollenviabilityrate**

Invitro pollenviabilityhavebeendetectedby TTCmethodandtheresultswereshowninTable 4.Thestatisticalanalysisshowedthatorigin,colour andoriginxcolourinteractionsignificantlyaffected pollen viability rate of used myrtle genotypes. Pollen viability rate was highest in Erdemli originated genotypes with 64.15% while it was 47.47%inTarsusand43.55%inKaraisali.Interms offruitcolours,averageofblackcultivarsshowed better results (55.07%) than white genotypes (48.38%).Theoriginxcolourinteractiondatahad a wide range as much as 35.11% (Karaisali-Black_KS) and 85.46% (Erdemli-Black_ES).

AsMulasandFadda(2004)havebeenreported, pollen viability rate was not differed between freshly opened flowers and dried flowers and the pollenviabilityratesof10myrtusgenotypeswere higherthanourresultsthatdifferedbetween85% and 95%. It is thought that this difference is originated from differences in genotype and ecological conditions (Eti, 1991).

***In vitro* pollen germination rates and suitable pollen germination media**

Table4shows *invitro*pollengerminationlevels of 6 Turkish myrtle genotypes in terms of their origin and fruit colours as well as different germinationmedia.Inthestudy,different concentrationsofboricacid(HBO_3)weretested for optimization of *in vitro* pollen germination medium. The results showed that boric acid concentrationhas no importanceon pollen germination ratio while fruit colour and origin x colour interaction (genotype effect) showed statistically important values.

In terms of fruit colours, pollen germination levels were higher in black genotypes (55.06%) than white genotypes (35.25%), like pollen production and pollen viability levels. Origin x colourinteractionthatshowsthegerminationlevels of each genotype were highest in Erdemli-Black (ES)whichwasfollowedbyKaraisali-black(KS) and Tarsus-black (TS) and the lowest from Erdemli-white (EB).

In general, pollen germination level gives the best results for the pollen quality of a genotype. Although genotypes should have a good pollen productionandpollenviabilitypercentage;pollen germination,pollentubeemergenceandpollentube growthhassuchadegreeimportanceforpollination and especially for fertilization level. In a recent study, Mulas and Fadda (2004) tested 10 myrtle genotypes in terms of pollen germination levels with 10, 15 and 20% sucrose concentrations and foundtheratesof6genotypesas70to85%;other 3 genotypes differing from 25 to 40% and one genotype with 0.7%. Authors reported the best media as 10 and 15% sucrose concentrations for mostof the genotypes.The 15% sucrose concentration that was used in this study was suitableformyrtlepollengermination.Despitethe statisticalanalysishasnosignificantimportance,a 50 ppm Boric acid addition to germination media couldincreasepollengerminationrateformostof the genotypes.

Pollen germination assays frequently require optimisationaswellasbeingtimeconsumingand difficult to reproduce (Rathod *et al*., 2018). The germination media should imitate stigma surface forthetruestdata.Ithasbeenreportedthat,boric acidcontentinthepollenisinsufficient(O'Kelley, 1957)andBoroninthestigmaandstyleisrequired to compensate for this; thus a certain amount of boric acid needs to be added to *in vitro* cultures (JohriandVasil,1961;Luo*etal*.,2020).Therewas notanytestforadditionalsubstancesfor*Myrtus communis*.Ingeneral,10ppm(0.001%)orhigher concentrationsofBoricacidistoxictoplantgrowth whilepollengrainscantolerateconcentrationsup to 1 200 ppm (0.12%) and optimum results were obtainedbetween10and150ppmconcentrations forpollengerminationformostofthespecies(Johri and Vassil, 1961).

In this study, the results of viability and germination rates were in parallel except from Karaisali-black (KS).The chemicalTTC (Tetrazolium) forms a red coloured compound formazanbyHtransferreactionscatalysedbythe enzyme dehydrogenases (Norton, 1966). This results shows that, only TTC test might not give the real performance for some myrtle genotypes due to its possible insufficient reaction capacity withH^+ions.So,differentviabilitytests

accomplished with *in vitro* pollen germination could be used for better results in future studies.

Pollen tube growth rate was also evaluated in this study and results were given in Fig. 4. The pollentubegrowthratewasfasterin50ppmboric acidconcentrationswhichmeanspollentubeswill emerge and grow faster in a boron fertilized genotype.In0ppmBoron(Control)especiallyKB and EB did not emerge any pollen tubes in first 2 hours while KS and ES could not show their real performance of pollen tube acceleration. At the sametime,100ppmBoricacidalsoincreasesthe first emergence and formed faster pollen tubes.

It is known that boron accelerates pollen tube by its promoting absorption of sugars and their metabolism by forming sugar-borate complexes, increased oxygen uptake and is involved in the synthesisofpecticmaterialsrequiredforthewall of the actively elongating pollen tube (Johri and Vasil,1961).As pollendid not have sufficient boron contentandstigmaandstylewillcompensateboron requirement, additionof boricacidto the germination medium simulates this situation and shows the real potential of performance of pollen tubeelongation(JohriandVasil,1961;Jayaprakash *et al*., 2018; Luo *et al*., 2020).WhenTable 5 and Figure 4 were evaluated together boric acid was thought to be accelerated the first pollen tube emergenceandpollentubeelongationratiobutnot have any effect on pollen germination ratio.

CONCLUSION

Pollenqualityand quantityis vitalfor understandingfertilityandincompatibility,pollen-pistilinteraction,breeding,cropimprovementand seedindustry.Forsuccessfulpollination,theinsight knowledge of pollen biology including pollen viability, germination and amount of pollen production is required for reasonable approaches to increase productivity. This study evaluates amountofpollenproduction,normallydeveloped pollenratio,pollenviabilityandgerminationlevels with suitable pollen germination medium as well as pollen germination rates of 6 Turkish myrtle genotypesintermsoftheiroriginsandfruitcolours. In*Myrtuscommunis*,amountofpollenproduction per flower was found to be very high as much as 2.5-4.5 million. The high pollen production is thoughttoberelatedwithanthersecretesthatwill cause pollen losses. Normally developed pollen ratiowasalsosohighandsufficientforsuccessful pollination. The pollen viability and germination rateswereSufficientformostofthegenotypesand pollen tube elongation was faster in the media containing 50 ppm boric acid with 15% sucrose and 1% agar solution which is thought to be the bestmediafor *Myrtuscommunis*pollen germinationtests.Ingeneral,allpollenproperties were higher in black genotypes than the white genotypes.

Infuturestudies,pollinationcapacityofwhite cultivars should be experienced for it's possible stimulatory effect because of their lower pollen characteristics. So, a pollination study should be plannedforpotentialseednumberdecreasingeffect of white genotypes.

REFERENCES:

Adiguzel,P.,Solmaz,I.,Karabiyik,S.andSari,N. 2022.Comparisononflower,fruitandseed characteristics of tetraploid and diploid watermelons (*Citrullus lanatus* Thunb. Matsum. and Nakai).*International Journal of Agriculture Environmentand Food Sciences*, **6**(4):704-710.

Aizen, M.A. and Harder, L.D. 2007. Expanding the limits of the pollen-limitation concept: effects of pollen quantityand quality. *Ecology*, **88**: 271–281.

Alim, E. 2020. Effects of GibberellicAcid TreatmentsontheSeedlessnessandQualýty ofBlackFruityMyrtle(*Myrtuscommunis*L.). PhD thesis. Akdeniz University, Türkiye.

Anvari, S.E. 1977. Untersuchungen über das pollenschlauchwachstumund die entwicklungdersamenanlageninbeziehung zumfruchtansatzbeisauerkirschen(*Prunus cerasus* L.) *Diss. Univ. Hohenheim*, 105.

Aronne,G.1999.Effectsofrelativehumidityand temperature stress on pollen viability of *Cistusincanus*and*Myrtuscommunis*. *Grana*, **38**(6): 364-367.

Beardsell, D.V., Williams, E.G. and Knox, R.B. 1989.Thestructureandhistochemistryofthe nectary and anther secretory tissue of the flowers of *Thryptomene calycina* (Lindl.) Stapf (Myrtaceae). *Aust. J. Bot.*, **37**: 65-80.

BoelensM.H.andJimenezR.1992.Thechemical composition of Spanish myrtle oils. Part II. *Journal of Essential Oil Research,* **4**: 349-353.

Ciccarelli, D., Garbari, F. and Pagni,A.M. 2008. Theflowerof*Myrtuscommunis*(Myrtaceae): Secretorystructures,unicellularpapillae,and their ecological role. *Flora-Morphology, Distribution,Functional Ecologyof Plants,* **203**(1): 85-93.

DuhP.D.,TuY.Y.andYenG.C.1999.Antioxidant activity of aqueous extract of harng jyur (*Chrysantheum morifolium* Ramat). *Food Sci. Tech*., **32**: 269-77.

Eti, S. 1990. Çiçek tozu miktarini belirlemede kullanilan pratik bir yöntem.*Çukurova Üniversitesi Ziraat Fakültesi Dergisi*, **5**(4): 49-58.

Eti,S.1991.Bazimeyvetürveçesitlerindedegisik *invitro*testleryardimiylaçiçektozucanlilik ve çimlenme yeteneklerinin belirlenmesi, *Çukurova Üniversitesi Ziraat Fakültesi Dergisi*, **6**(1): 69-80.

González-Varo, J.P., Arroyo, J. and Aparicio,A. 2009.Effectsoffragmentationonpollinator assemblage, pollen limitation and seed productionofMediterraneanmyrtle(*Myrtus communis*). *BiologicalConservation,* **142**(5): 1058-1065.

JamoussiB.,RandhaneM.,AbderrabaA.,Hassine, B.B.andGadri,A.E.2005.Effectofharvest timeontheyieldandcompositionofTunisian myrtleoils.*FlavourandFragr.Journal*,**20**: 274-277.

Jayaprakash, P. 2018. Pollen germination *invitro.In*:*PollinationinPlants*,Ed.Phatlane WilliamMokwala,PhetoleMangena.**81**:81-96.IntechOpenPress, England.

Johri,B.M.F.andVasil,I.K.1961.Physiologyof pollen.*TheBotanicalReview*,**27**(3):325-381.

Karabiyik, ‘. and Eti, S. 2018. Determination of floweringdatesandpollenpropertiesofsome pecan nut cultivars in Adana ecological conditions.*Turkish Journal of Agriculture-FoodScienceandTechnology*,**6**(12):1795-1801.

Karabiyik, S. and Eti, S. 2015. Farkli yenidünya çesitlerinin degisik çiçeklenme dönemlerinde çiçektozucanlilikveçimlenmedüzeyleriile üretim miktarlarinin belirlenmesi. *Meyve Bilimi,* **2**(1): 42-48.

Karabiyik, S. and Eti, S. 2016. Bazi ticari limon çesitlerininfarkliçiçektipioranlariveçiçek tozu özelliklerinin belirlenmesi. *Bahçe,* **45**(1): 279-284.

Karabiyik,S.AndEti,S.2019.EffectsofFlowering Types and Flower Structures on Pollen ProductionandFruitSetRatioinInterdonato Lemon Cultivar.*3. International Mediterranean Symposium Proceedings Book* 1. Pp.22-32.

Karabiyik, S., Eti, S., Saridas, M.A. and Paydas Kargi,S.2016Bor ve kalsiyum uygulamalarinin Sweet ann çilek çesidinde çiçektozuözelliklerivebozuksekillimeyve olusumuna etkisi. *Bahçe,* **45** (1): 70-78.

Lawrence,B.M.1994.Progressinessentialoils. *PerfumerandFlavorist*,**19**(6),57-62.

Luo,S.,Zhang,K.,Zhong,WP.,Chen,P.,Fan,X. M.andYuan,D.Y.2020.Optimizationof*in vitro*pollengerminationandpollenviability testsfor*Castaneamollissima*and*Castanea henryi*.*ScientiaHorticulturae*,**271**:109481.

Mechchate, H.,Castro Alves, C.E., Es-Safi, I., Amaghnouje, A., Jawhari, F. Z., Costa de Oliveira,R. and Grafov,A. 2022. Antileukemic,Antioxidant,Anti-Inflammatoryand HealingActivities Induced byaPolyphenol-EnrichedFractionExtracted fromLeavesof*Myrtuscommunis* L.*Nutrients*,**14**(23):50-55.

Montoro, P.,Tuberoso, C.I.G., Piacente, S., Perrone, A.,DeFeo,V.,Cabras,P.andPizza,C.2006. Stabilityand antioxidant activityof polyphenolsinextractsof*Myrtuscommunis* L.berriesusedforthepreparationofmyrtle liqueur.*J.PharmBiomedAnal.,* **41**(5):1614-1619.

Mulas,M.andFadda,A.2004.Firstobservations onbiologyandorganmorphologyofmyrtle (*Myrtus communis*L.) flower[Sardinia].*Agricoltura Mediterranea,* **134**: 223-235.

Mulas, M., Cani, M.R. and Brigaglia, N. 1998. Charactersusefulto cultivationin spontaneouspopulationsof*Myrtuscommunis* L.*In:SymposiumonPlantBiotechnologyas atoolfortheExploitationofMountainLands, Acta Hort.* **457**: 271-278.

Mulas,M.,Cani,M.R.,Brigaglia,N.andDeidda, P.1999.Studyofmyrtle(*Myrtuscommunis* L.) genetic resources to promote extensive cropasintegrationofspontaneousharvests. *In II. WOCMAP Congress Medicinal and AromaticPlants,Part 3: Agricultural Production,Post Harvest Techniques, Biotechnology, Acta Hort.* **502**: 85-88.

Norton,J.D.1966.Testingofplumpollenviability with tetrazolium salts. Proc. *Amer. Soc. Hort. Sci.,* **89**: 132-134

O'Keley, J.C. 1957. Boron effects on growth, oxygen uptake and sugar absorbtion by germinating pollen. *American Journal of Botany*, **44**: 239-244.

Rathod,V.,Behera,T.K.,Munshi,A.D.,Durgesh, K.,Jat,G.S.,Krishnan,B.G.andSharma,N. 2018. Pollen viability and *in vitro* pollen germination studies in Momordica species andtheirintraandinterspecifichybrids.*Inter. J.Chem.Studies*,**6**(6):32-40.

San,B.,Yildirim,A.N.,Polat,M.andYildirim,F. 2015. Chemical compositions of myrtle (*Myrtus communis* L.) genotypes having bluish-black and yellowish-white fruits. *Erwerbsobstbau*, **57**(4): 203-210.

Simsek, O., Donmez, D., Saridas, M.A., Paydas-Kargi, S. andAka-Kacar, Y. 2020. Genetic Relationship and Polymorphism of Turkish Myrtles (*Myrtus communis* L.) as Revealed by Inter SimpleSequenceRepeat (ISSR).*ApplEcolEnvironRes*,**18**(1):1141-1149.

Yildirim, H.,Paydas Kargi, S. and Karabiyik, S. 2013.AdanaveMersinekolojikkosullarinda dogal olarakyetisenMersin(*Myrtus communis*L.) bitkileri üzerindebir arastirma. *Alatarim*, **12**(1): 1-9.