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Assessment of the main causes of sorting gaps in the Citrus packinghouses of Berkane, Morocco

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Sorting gaps are one of the main challenges that the Citrus industry is facing worldwide. In Morocco, the rates of sorting gaps reach levels exceeding 40% on average. In Berkane area, the rate of Clementine sorting gaps in packinghouses is an important concern to exporters and their characterization is not well studied. The present study covered five clementine packinghouses of Berkane area out of the 20 packinghouses inventoried in the zone during the 2019/2020 export campaign between October 20th, 2019, and January 20th, 2020. In each packinghouse, the sorting gaps were examined and characterized to separate the different categories of sorting gaps types and determine the sorting gaps rate. The objective of this study is to characterize the frequent causes of Clementine sorting gaps and analyze the effect of the packing period on the importance of the rate of different types of causes of sorting gaps. Also, the evolution of gap rates at the station level was analyzed to show the similarities and differences between the overall sorting gaps rates and the sorting gaps rates by type of defects per packinghouse. Results showed an average of sorting gaps rates of about 38.4% of total Clementine fruit received in packinghouses. Depending on the packaging period, the rates of sorting gaps varied from one packinghouse to another and from one type of gaps to another. The gaps caused by insects presented high levels in the area and at all Berkane studied packinghouses. Fruits processed in the period from October 20th to November 20th, 2019 recorded a very high rate of sorting gaps with 44.5% followed by the period from December 20th, 2019 to January 20th, 2020 with a rate of 40% and the period from October 20th to November 20th, 2019 with 31%. In quest of conceiving strategies to reduce Sorting gaps rates, it is of utmost importance to understand the main factors influencing these rates in all Clementine handling and producing stages.

Keywords: Sorting gap, Citrus fruits, Packinghouse, Causes, Berkane.

Introduction

In Morocco, the citrus fruit sector is of paramount importance in term of national agricultural production. The cultivated area exceeds 129 243 ha, of which 46.42% are oranges, 50.4% small fruits and 3.6 % of lemons (Jaouad et al., 2020). The main citrus production zones are Souss Massa, Molouya Perimeter, Haouz, Gharb and Tadla. The estimated citrus production is around 2.6 million tons (Jaouad et al., 2020). The majority of this production (more than 90%) is intended for the domestic market and for export in fresh state. Exports of fresh citrus fruit reach 715 450 tons. The

main varieties grown are clementine-type varieties such as “Nules”, “Cadoux”, “Nour” and “Sidi Aissa” “Orogrande” and “Fina Berkane”. Orange varieties are mainly dominated by the “Valencia Late” and the “Navels” (Maroc Citrus, 2020). In the Moulouya Perimeter, citrus fruit cultivation covers an area of 22 000 ha, i.e. 41% of the total area occupied by fruit horticulture in this zone in 2020 (Maroc Citrus, 2020). Citrus plantations are mainly concentrated in the Triffa plain (Berkane province) with an area of 17229 ha. According to Morocco Foodex (2017), exports of citrus fruits from Berkane for the 2016-2017 seasons reached 48 659 t, compared to 53 193 t in 2015/2016. The downward trend in Berkane’s citrus exports is the consequence of a set of factors that influence the quantity and quality of fruits destined for export. The increase in the rate of sorting gaps in Berkane’s packinghouses seems to be one of the main factors governing Berkane’s exports quantities (ORMVAM, 2017).

External markets impose high quality requirements. In order to facilitate the export marketing of citrus fruits, the fruits to be exported must meet a set of requirements. Citrus fruit for export must be whole; free of bruises and/or extensive healed cuts; healthy; not affected by rotting or deterioration such as to make it unfit for consumption; clean; practically free of any visible foreign matter, pests, damage caused by pests affecting the flesh, signs of drying and dehydration, damage caused by low temperature or frost, abnormal external moisture, foreign smell and/or taste; the development and condition of the citrus fruit must be such as to enable it to withstand transport and handling; and to arrive in satisfactory condition at the place of destination (CEE-ONU, 2018). For this reason, it is necessary to determine the causes of sorting gap in order to optimize the quantities to be exported and reduce the rate of sorting gap, which is still high in all Moroccan citrus-growing regions. The problem, which can constitute a significant economic loss on a small scale (for farmers) and on a large scale (for the country) because of the increased use of already limited natural resources such as irrigation water, electricity, fertilizers, chemicals and labor, is a major concern in Morocco (Heitz et al., 2011). In general, for citrus fruits, the causes of sorting gaps at packinghouses are of physical or phytosanitary types. Physical causes are all defects related to lesions or injuries due to physical factors such as harvesting defects (injuries, presence of stalk), physiological defects (deformation, rough skin, thin skin), defects due to climatic hazards (frost, hail, sunstroke) or size defects (very small size, very large size). Phytosanitary causes are all defects due to pests (Medfly, California scale, snail, others) and fungal diseases (rot, fumagine) (Heitz et al., 2020). In Berkane region, 20 citrus packing Packinghouses are listed in the register of citrus packers. These packinghouses are either in the form of cooperatives made up of several member farmers, or as single-farmer packinghouses with service provision options for large growers. The present study was conducted in the Berkane (Triffa plain) area to assess the causes of sorting gap in five citrus packing Packinghouses.

Materials and methods

Citrus packinghouses

To cover the main citrus growing localities (Ahfir, Slimania, Laatamna, Boughriba, Madagh) of the Triffa Plain (Figure 1), out of the 20 packinghouses, 5 Packinghouses were selected for the present study namely: Yacoubi Packinghouse (35°00’22.3”N 2°11’16.1”W), Sonia-Kirat Packinghouse (34°56’56.0”N 2°21’26.4”W), Alouahda Packinghouse (34°53’27.3”N 2°31’01.8”W), Ennasr Packinghouse (34°54’32.5”N 2°29’35.5”W) and Oukouiss Packinghouse (35°00’06.3”N 2°16’05.5”W) (Figure 1).

Figure 1: Localization of the five Pakinghouses studied in Berkane region (Google maps)

Figure 1:

Sampling and sorting gaps assessment

An in-depth analysis of the sheets and databases filled in by the packers' supervisors for this study was carried out. In order to follow the evolution of the sorting gaps and the variations of different causes of gaps, the packaging season was divided into 3 periods for all the Packinghouses. The first period is the first 30 days of packaging, this period starts from October 20 to November 20 (Period 1), during which the fruits to be packaged are early harvested and require a transit through the degreening room of an important duration (from 4 to 6 days) to ensure the transformation of chloroplasts into chromoplasts and to reach the color of the skin desired for export. During this period, 32655 fruits were sampled for control, an average of 6531 fruits per packinghouse. The second period (Period 2), during which the fruits to be packed require only a short transit (less than 48 hours) in the degreening chamber; it is a period during which 3.444 fruits were sampled for control. The third is the final period (Period 3) of 30 days before the end of the harvest, the harvested fruits are mature and can be packed without undergoing degreening, during this Period, 34234 fruits were controlled. The total number of fruits sampled is 17977 to 23266 with an average of 20187 fruits per packinghouse, or 224 fruits sampled per day in each packinghouse (Figure 2).

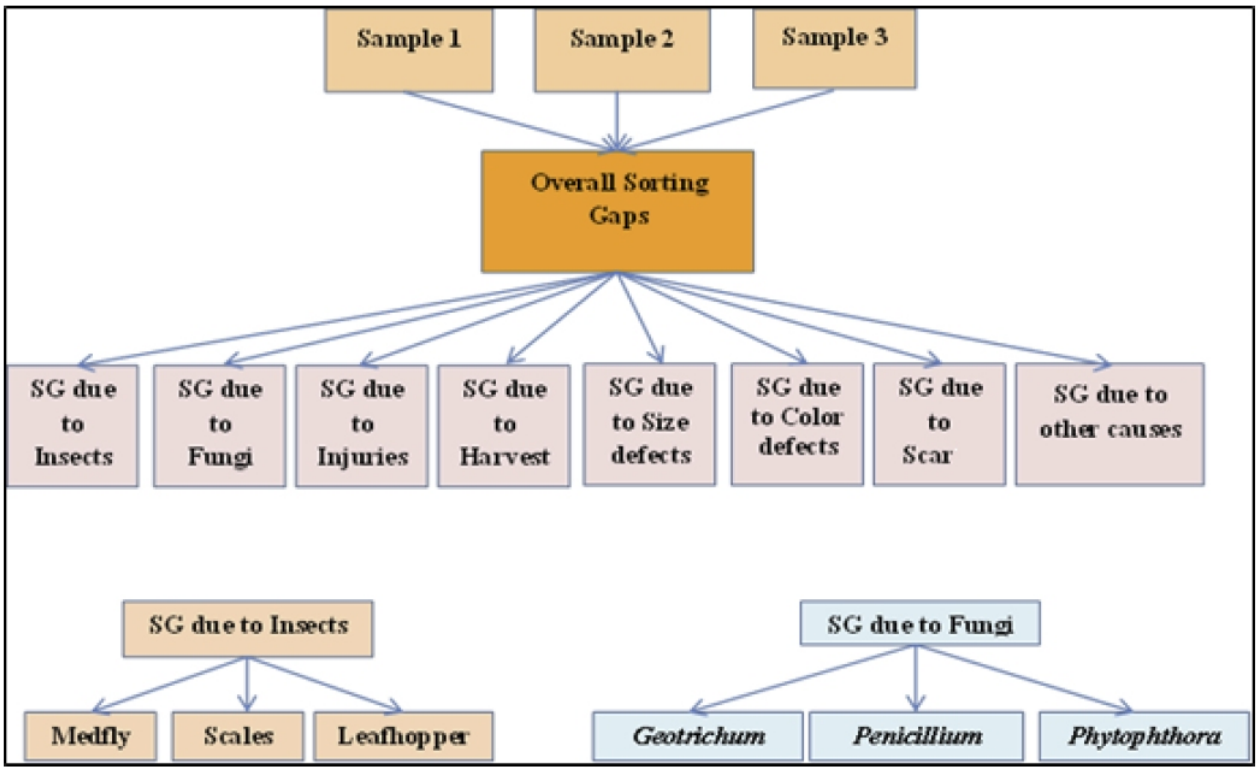

Figure 2: Sampling scheme for estimating Sorting gaps (SG) rate in the packinghouses

Figure 2:

A total of 15 databases were recovered with 3 databases per packinghouse. Each database includes the following elements: Packinghouse name, Period number, sampling day, number of fruits sampled, total sorting gaps and sorting gaps due to insects, fungi, injuries, picking defects, size defects, color defects, mottling, and others defects (Figure 2).

The fruits constituting sorting gaps were determined by naked eye control by observing the anomalies present on their surfaces (Figure 3). The rate of sorting gap was calculated according to the following formula (Belabess et al., 2020):

Data analysis

The analysis of collected data had been performed using IBM SPSS statistics version 23 software and Microsoft Excel program. The comparisons of variance rates were performed using Tukey's multiple comparison test. P-values less than 0.05 were considered statistically significant.

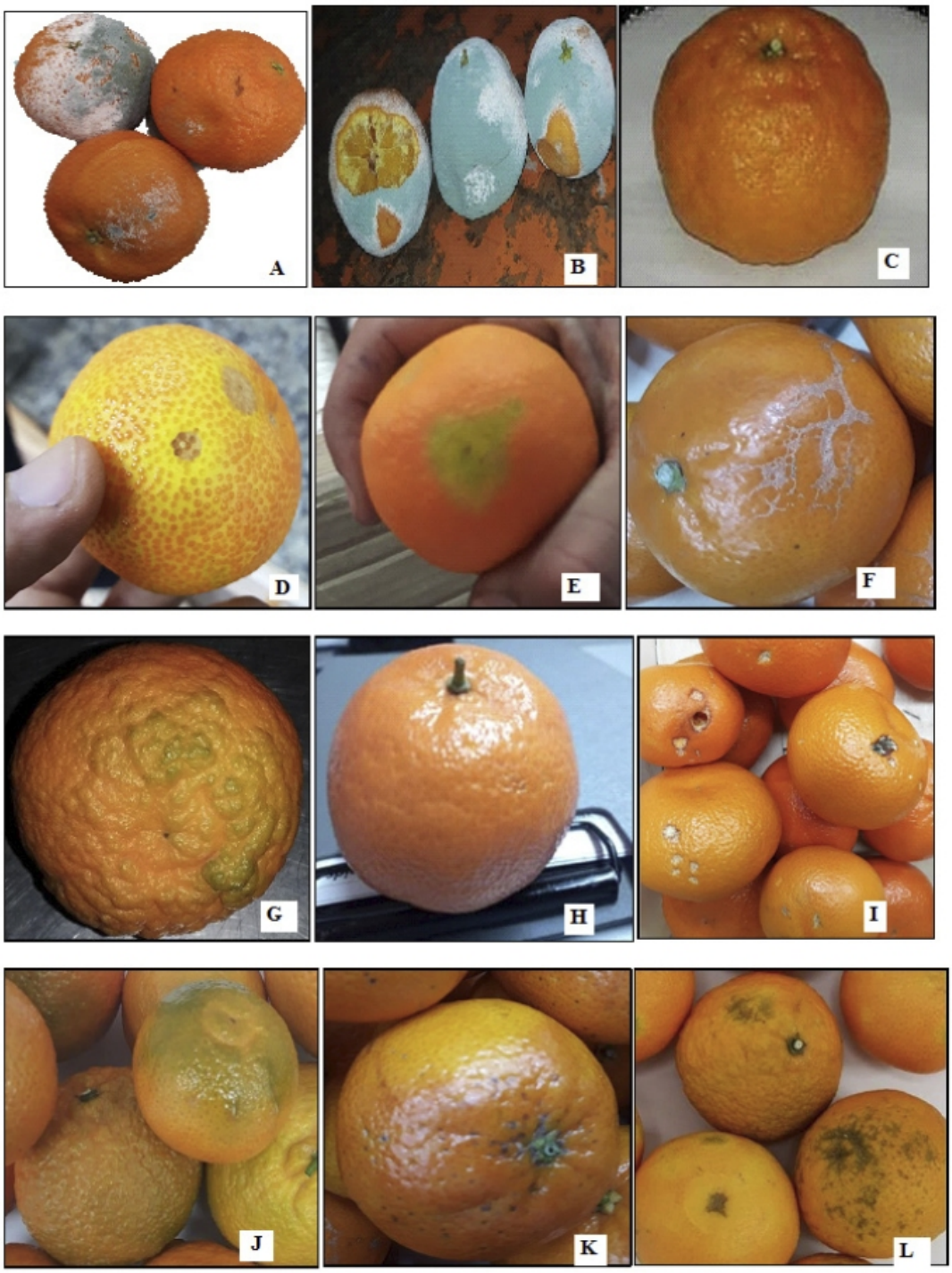

Figure 3: images of main defects causing sorting gaps in Clementine packinghouses of Berkane region ; fungi (A and B); Rough skin (C and G); Mefly punctures (D); Oleocellosis (E); Scars (F); long peduncle (H); Snail blemishes (I); Color defect (J); Red scale (K); Mites (L)

Figure 3:

Results

Overall rate of clementine sorting gaps in the studied packinghouses

Out of a total of 100 933 fruits of clementine sampled from the five packinghouses, 38785 presented imperfections (defects) that made the fruits unsuitable for export, thus an average rate

of 38.4 %. A part of these differences is commercialized in the local market while another part composed mainly of rotten fruit is considered as waste.

Overall rate of sorting gaps by packaging period

Results showed that the first period recorded a very high rate of sorting gaps with 44.5%, which means that about a half of the production delivered by citrus growers to the packinghouse will be excluded from export, followed by the third period with a rate of 40% and the second period with 31%. The harvesting season, the condition of the fruit during harvest, and the passage through the degreening chamber seem to influence the rate of sorting gaps from one period to the other (Figure 4).

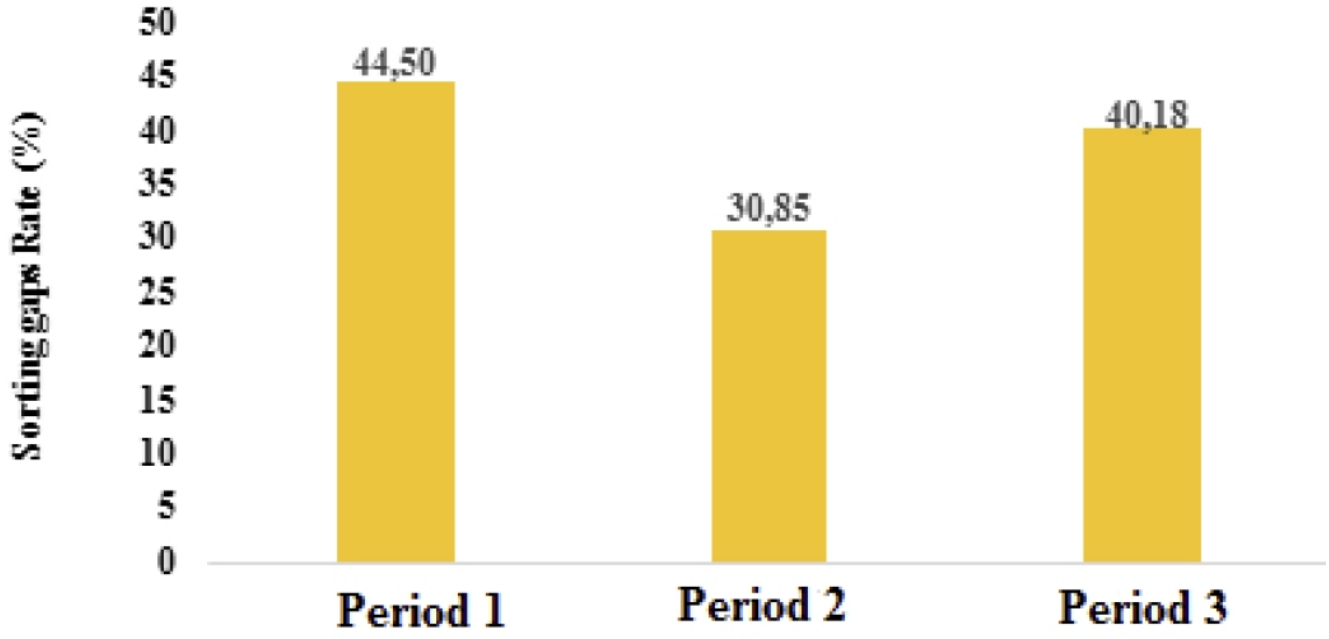

Figure 4: Average of sorting gaps rate per period

Figure 4:

Total rate of the sorting gaps per packing Packinghouse

The results revealed that the Yacoubi packinghouse came first with an average rate of 44.8% followed by the Alouahda with 41.7 %, then the Sonia-Kirat with 38.4%, the Ennasr Packinghouse with 36.7 % while the Oukouiss packinghouse recorded the least sorting gaps level with an average rate of 30%. (Figure 5).

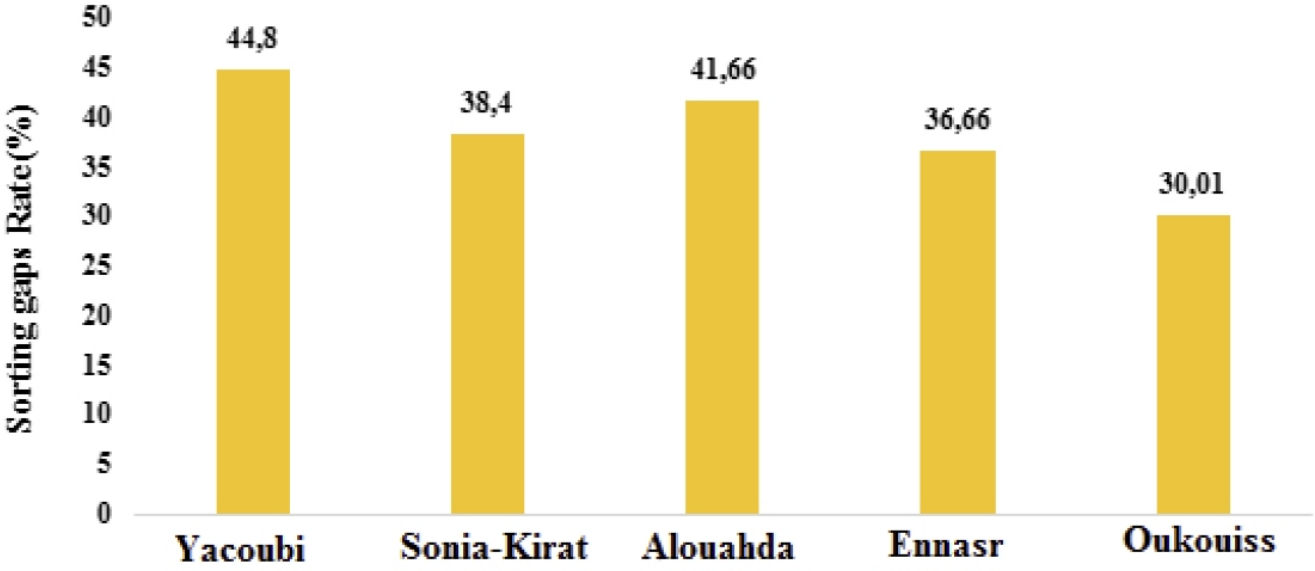

Figure 5: Average of Sorting gaps rate per packinghouse

Figure 5:

Identification of the causes of the most frequent sorting gaps in the five selected packing Packinghouses

The analysis of the data obtained from the 15 databases filled in by the Packinghouse managers allowed to develop an identification of the causes of the most frequent sorting gaps in the Berkane region. Out of a total of 100933 fruits sampled, 38785 presented deficiencies that made these fruits as sorting gaps and are therefore removed from the packaging chain. The causes of the gaps that were detected during the three packaging periods of the five Packinghouses are due to several defects which are classified in eight categories: insects, fungi, injuries, harvesting defects, size, scars, coloring and other defects. The study showed that the degree of regeneration of sorting gaps varied from one category to another, from one packinghouse to another and from one period to another.

Average of sorting gaps rate per defect type and per packinghouse

The average rate of sorting gaps for all packing houses is about 38.4%. The calculation of averages by defect category showed that defects resulted by insects in the Packinghouses are the major cause of sorting gap, with an average rate of 19.8 %, followed by fungi, with an average rate of 13.1 %, size with an average rate of 12.6%, mottling with a rate of 12.2%, picking defects with 11.7%, other defects in the other category with 10.7%, injuries 10.6% and color defects come last with an average rate of 9.25% (Figure 6A).

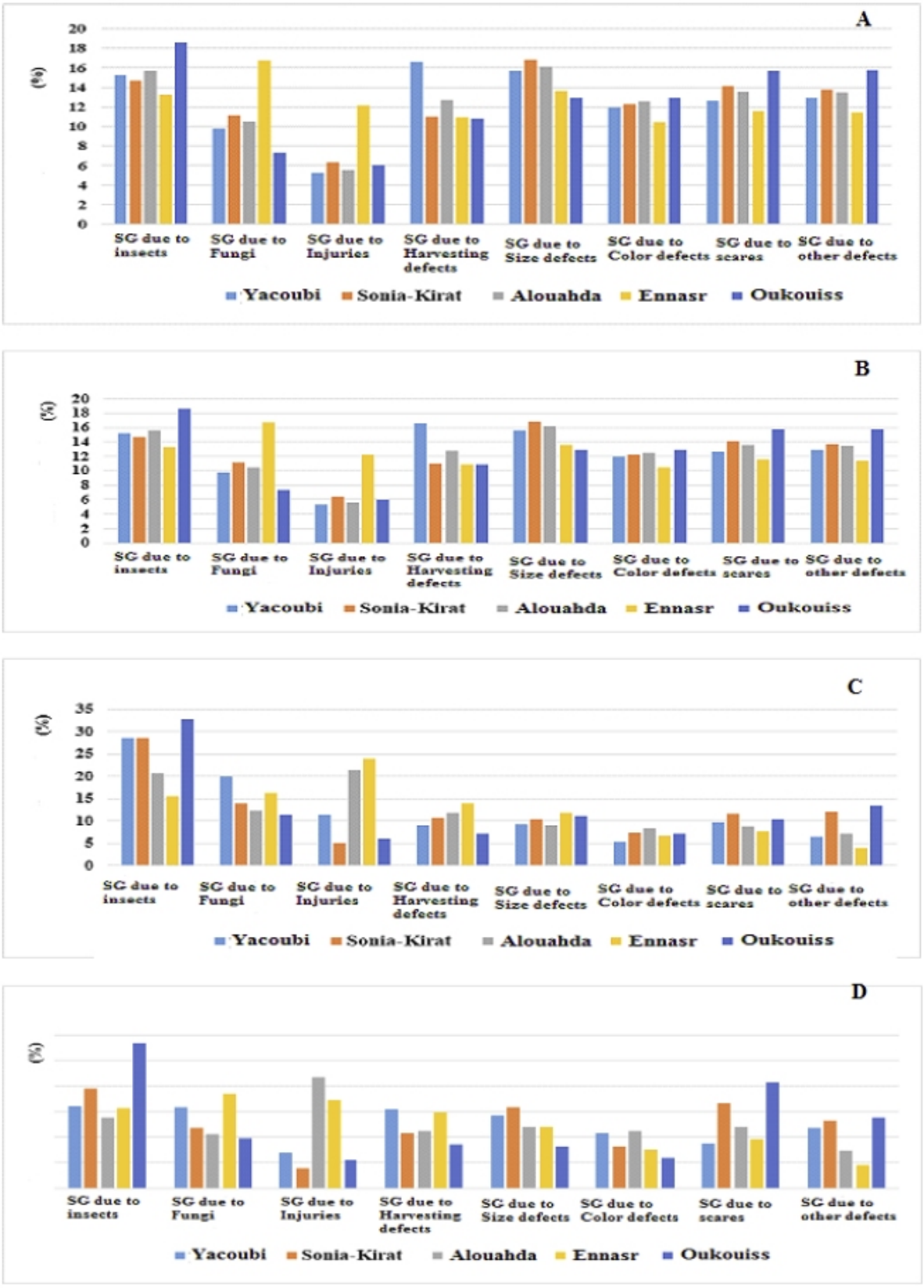

Figure 6: Rate of sorting gaps by types by packinghouse for overall season of exports (A) during period 1 (B) period 2 (C) and period 3 (D)

Figure 6:

The analysis of defects by Packinghouse showed that insect damage were the major defect in the five Packinghouses with a maximum rate of 26.6% for the Oukouiss Packinghouse while the minimum rate was 14.87% recorded in the Ennasr Packinghouse.

Rate of sorting gaps per defect type, period and packinghouse

Period 1

During this period, the average of sorting gap rate recorded was 44.5%, i.e. a rate of 48.1% for the Yacoubi packinghouse, 44.4% for the Sonia-Kirat packinghouse, 45.9% for the Alouahda packinghouse, 45.3% for the Ennasr packinghouse and 38.5% for the Oukouiss packinghouse (Figure 6B).

During this Period the major defect of the gaps varies from one Packinghouse to another, at the Yacoubi Packinghouse it was gaps due to harvesting defects that constituted the major defect with a rate of 16.6%, while for the two Packinghouses Sonia-Kirat and Alouahda, the gaps due to the size have a rate of 16.8% and 16.1% respectively. Fungi for the Ennasr Packinghouse reached 16.7% and at the Oukouiss Packinghouse, insect gaps were the most important defect with 18.6%.

Calculations of the average rates of defects due to each category showed that insect defects were the major concern for the first Period with an average rate of 15.5% of the total fruit defects, followed by size defects with 15%, then come the differences due to mottling and the category named other with an average rate of 15.5% for each of them, then the gaps due to harvesting defects with 12.4%, then the gaps due to color defects with a rate of 12.0%, the gaps due to fungi with 11% and finally the gaps due to injuries with a rate of 7.1 %.

Period 2

Out of 34044 fruits sampled, results showed that 10498 had been excluded from the packaging chain, representing 30, 27% of the overall inspected fruits. The rates of removed fruits varied from one packinghouse to another, with a rate of 33.0% in Yacoubi, 28.0% in Sonia Kirat; 39,1 % in Alouahda; 29,8% in Ennaser while Oukouiss showed a lower rate than other packinghouses with 20,7% (Figure 6 C).

At the three Packinghouses Yacoubi, Sonia-Kirat and Oukouiss, the major defect in sorting gaps is represented by insects with respective rates of 28.5%, 28.5% and 32.9%, while at the Alouahda and Ennasr Packinghouses, injuries constituting the major sorting gap problem with rates of 21.5% and 24.0% respectively. The average rates of sorting gaps during the second period showed that insects represent the major defect in the regeneration of sorting gaps with a rate of 25.2% followed by fungi defects with 14.8% then defects due to injuries with 13.6% followed by harvesting defects with 10.5% then defects due to grading with an average rate of 10.4%, then mottling with 9.7%, defects due to the other category with 8.6% and finally defects due to discoloration with a rate of 7.0%.

Period 3

The average rate reached during this period is around 40.2%. The rates of sorting gaps recorded for each packinghouse; in relation to the total fruit controlled are 53.4% for the Yacoubi Packinghouse, 42.2% for Sonia-Kirat, 40.8% for Alouahda, 35.0% for the Ennasr Packinghouse and 30.3% for the Oukouiss Packinghouse. Fruits with imperfections were checked for defects type identification and estimation was made according to the defect category (Figure 6D).

For three Packinghouses, Yacoubi, Sonia-Kirat and Oukouiss, insect causes are the major defect with a rate of 16%, 19.6% and 28.5% respectively, while for the Alouahda Packinghouse the primary defect is represented by injury causes with a rate of 21.7% and for the Ennasr

Packinghouse, fungi causes constituted the major defect with a rate of 18.4%. The average sorting gap rate by defect type showed that insects were the most important cause of the gaps in comparison to other defects with an average rate of 18.7%, followed by mottling with 13.5%, fungi sorting gaps with 13.3%, and gauge gaps with 12.0%, 45.0%, the gaps due to harvesting defects come next with an average rate of 12.2%, followed by gaps due to injuries with 11.0%, gaps due to defects in the other category come before last with a rate of 10.1% and finally gaps due to discoloration defects with an average rate of 8.7%.

Classification of the causes of sorting gaps by category

The Analysis of the databases of the Packinghouses in the study showed that sorting gaps are due to a number of causes classified into eight categories in descending order according to the rate of sorting gaps in each category. Eight categories of imperfections were distinguished and were classified in descending order, insects 19.8%; fungi, 13%; size defects, 12.6%; scars, 12.2%; picking defects, 11.7%; other defects 10.7%; injuries defects 10.6% and discoloration defects 9.2%.

Category of sorting gaps due to insects

This category represents an average rate of 19.8% of the total fruit rejected and includes differences due to Medfly, scale insects and leafhoppers. In the five Packinghouses a total of 7027 fruits were discarded as they represent defects due to insects and 2699 fruits among them are due to Medfly; 2561 are due to leafhoppers and 1767 fruits represent defects due to scale insects, with rates of 38.1%, 36.5% and 25.3% respectively. The rates of sorting gaps due to each insect vary from one Period to another according to biological cycles. The following graph represents the evolution of the damage due to each insect (Figure 7A).

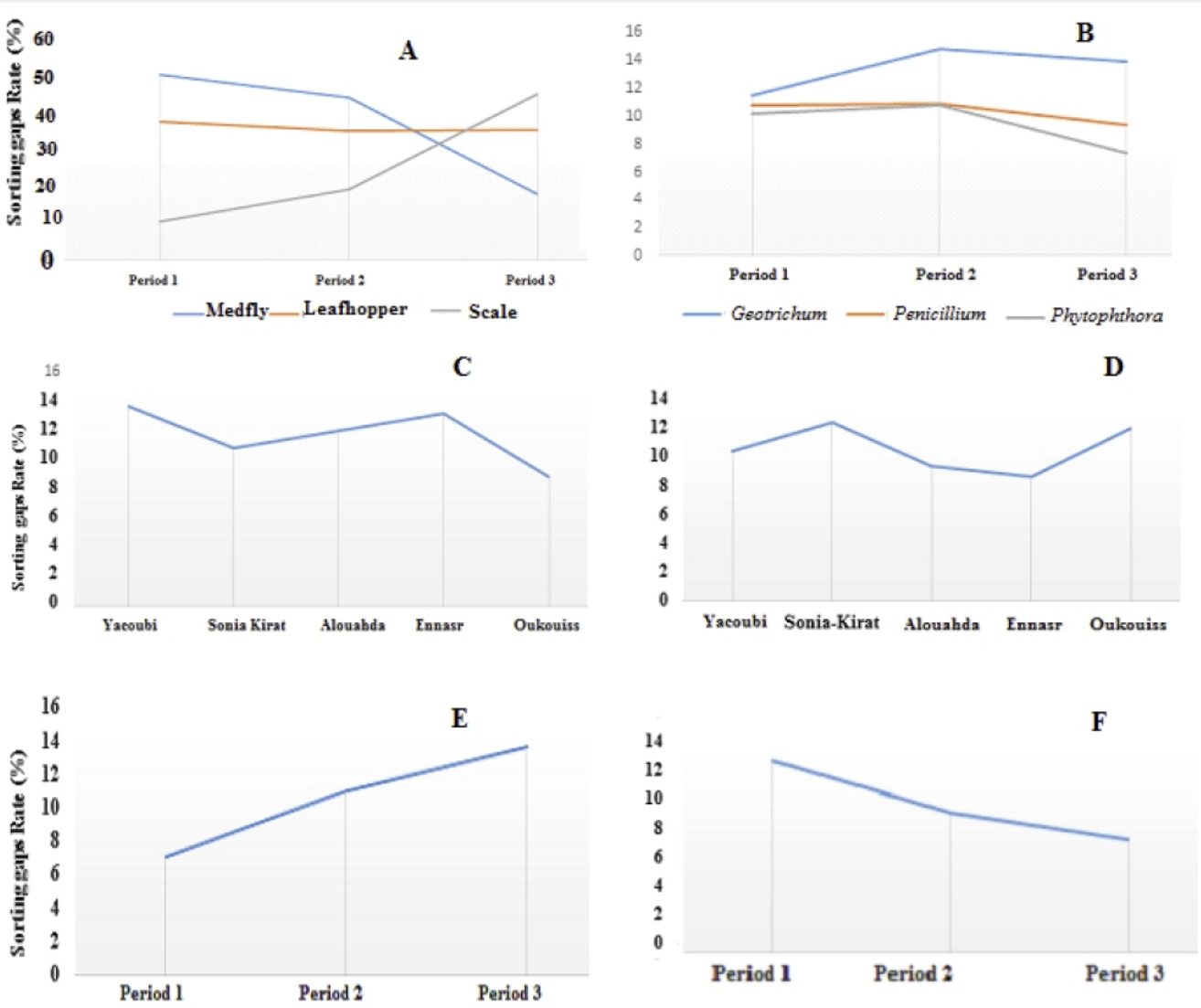

Figure 7: Evolution of sorting gaps due to main insects (A); due to fungi (B) by period; Rate of sorting gaps due to harvesting defects by Packinghouse (C); Rate Gaps due to other defects (D) per packinghouse; Rate Gaps due to color defects (E) and Injuries (F) by period

Figure 7:

The first Period is the peak of the losses due to Medfly because conditions are favorable for its development, then the damage begins to regress as the temperature decreases and the insect becomes less active towards the Period 3. Medfly represents a percentage of 6.9% of the total sorting gaps, while leafhopper gaps remain stable during the three conditioning Periods and represent a rate of 6.6% of the total sorting gaps. The sorting gaps due to scale insects progress from the first Period to the third Period and represent a percentage of 4.5% of the total sorting gaps (Figure 7A). Medfly is a major problem for farmers and for citrus exports in general, as it is listed as a quarantine pest in most of Morocco's citrus importing countries. The insect was the cause of the temporary suspension of citrus exports to the United States of America in February 2016 due to the presence of some larvae of the Medfly in a batch of clementine exported to that country (ONSSA, 2016).

Category of gaps due to fungi

They cause surface and pulp imperfections that are often formed during infection of immature fruit during the growing season (Brown, 1998). This category includes gaps due to Geotrichum,

Penicillium and Phytophtora, they represented an average rate of 13.1% of the total gaps. In the five packinghouses, 5090 fruits representing imperfections due to fungi were discarded, 2054 fruits among them due to Geotrichum, 1591 due to Penicillium and 1458 due to Phytophtora. With rates of 40.3%, 31.2% and 28.6% respectively in relation to the total fungi gaps. Figure 7B represents the evolution of fungal damage.

The results showed that the rates of sorting gaps calculated for each fungus are different from one to other and according to the period. The gaps due to Geotrichum sp were progressive towards Period 2 and Period 3, and increased after the fruit has passed through the degreening chamber and when the fruit becomes mature. Defects caused by Geotrichum sp represented a rate of 5.2% of the total sorting gaps. The results showed that the Penicillium sp gaps were practically stable during the three packing periods and represented a rate of 4.1% in relation to the total gaps while for Phytophtora sp the results show that the rate of gaps remains stable during the first and second Periods and then it showed a slight decrease towards the Period 3. The rate of sorting gaps due to this kind of fungus represented a percentage of 3.7% of the total gaps.

Category of sorting gaps due to nonconformity of size

Fruit discarded in this class are often fruit that is smaller or bigger than the size required by the standards of the requesting market. This defect is mainly related to cultural practices at the orchard level, especially nutrition and the high fruit load of the tree or the applications of some hormones. This category generated a sorting gaps rates varying between 12.0 and 17.0 % for all Packinghouses (Figure 6A).

Category of sorting gaps due to Scars

It is a category that includes the differences due to mottling caused by the wind, especially since the Moulouya region is a coastal area so there is always wind, hence the interest in installing windbreaks and the elimination of dead wood at the tree. Defects of marbling can also be due to insects, especially Thrips. But in the study area traps of surveillance were set in citrus orchards and no records of Thrips captures were noted. This rate varied between 11.0 and 15.0% for all packinghouses (Figure 6A).

Categories of gaps due to harvesting defects

This category includes sorting gaps due to the presence of a long peduncle or the absence of the calyx. The gaps due to this category are related to the level of qualification of the workers, the harvesting equipment and the level of supervision of the sites, which justifies the variation in the rates of sorting gaps due to picking defects between growers (Figure 7C).

The results showed that the Yacoubi and Ennasr Packinghouses have a high rate of sorting gaps due to this category compared to the other Packinghouses, particularly the Oukouiss Packinghouse which has the lowest rate among the five Packinghouses. Indeed, these defects could easily be avoided by choosing experienced workers for harvest who are correctly qualified to respect the picking instructions and guidance.

Category that includes other defects

In this category are grouped defects due to physiological disorders such as embossing, swelling, thin skin, the presence of seeds, defects due to mites, and imperfections caused by bursting. The results showed that the differences due to this category are variable from one Packinghouse to another (Figure. 7D). This difference is mainly due to the levels of cultural techniques adopted in each orchard and mastering of good cultural practices.

Category of Sorting gaps due to color defects

Sorting gaps rates related to fruit discoloration defects were more important at the beginning of the picking season (first Period), which is normal because the fruits are picked green at this time and go through the degreening operation (Figure 7E).

Injury Gap Category

This category includes all sorting gaps due to injuries caused by physical damage during the fruit handling (harvesting, transportation, packaging,..). The results showed that the gaps due to this category were variable in an evolutionary manner from one period to the other (Figure 7F). This evolution is justified by the resistance of the fruits to handling and transportation, during the first period because the harvested fruits are immature and withstand physical damage well, while during the second and third Period the fruits are fully mature and withstand handling in orchards, Packinghouses and transport very poorly. However, when the fruits are green the risk of causing oloecellosis by handling is very high.

Effects of the period and the packinghouse on sorting gaps rate

Periods

The rates of sorting differences calculated for each of these waves showed that there is a significant difference between Wave One and Wave Two and between Wave Two and Wave Three, while there is no significant difference between Wave One and Wave Three (Figure 8).

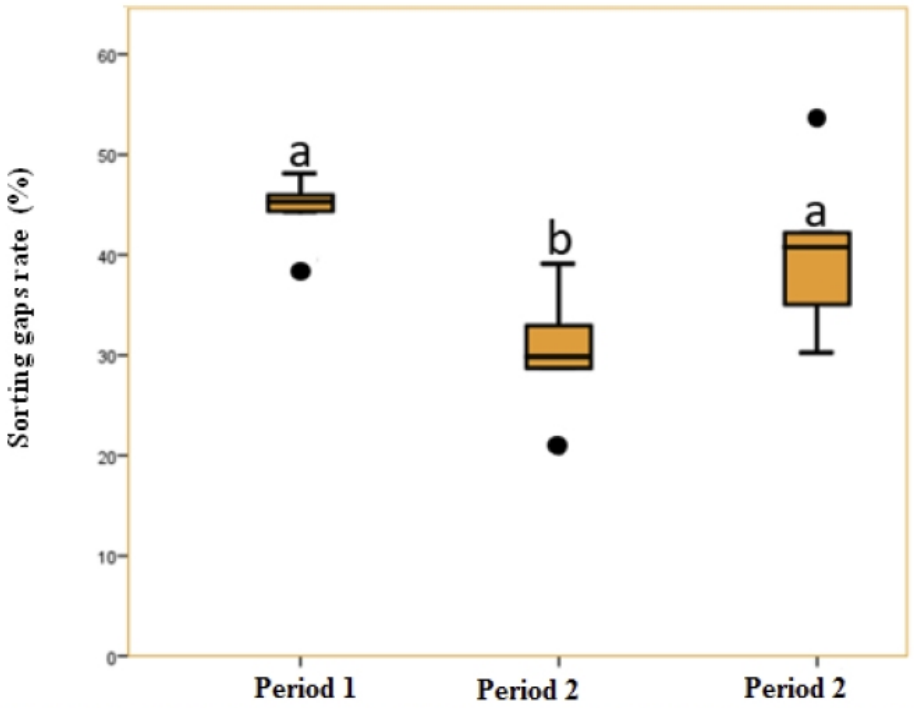

Figure 8. Distribution of citrus fruit sorting gap rates recorded during the three packing Periods. (The horizontal line inside the box-plot indicates the value of the median (50% quantile), the box-plot itself delimits the 25% and 75% quantiles, and the lines represent the normal range of values; the points below and/or above correspond to outliers. Lower case letters indicate significant differences between periods)

Figure 8:

Packinghouses

The results of the calculation of the rates of sorting differences for each Packinghouse showed that the Yacoubi Packinghouse presents a significant difference only with the Oukouiss Packinghouse

and no significance between the other Packinghouses, while the Oukouiss Packinghouse presents a significant difference with the Yacoubi Packinghouse and the Alouahda Packinghouse and no significance with the other two Packinghouses Sonia-Kirat and Ennasr (Figure 9).

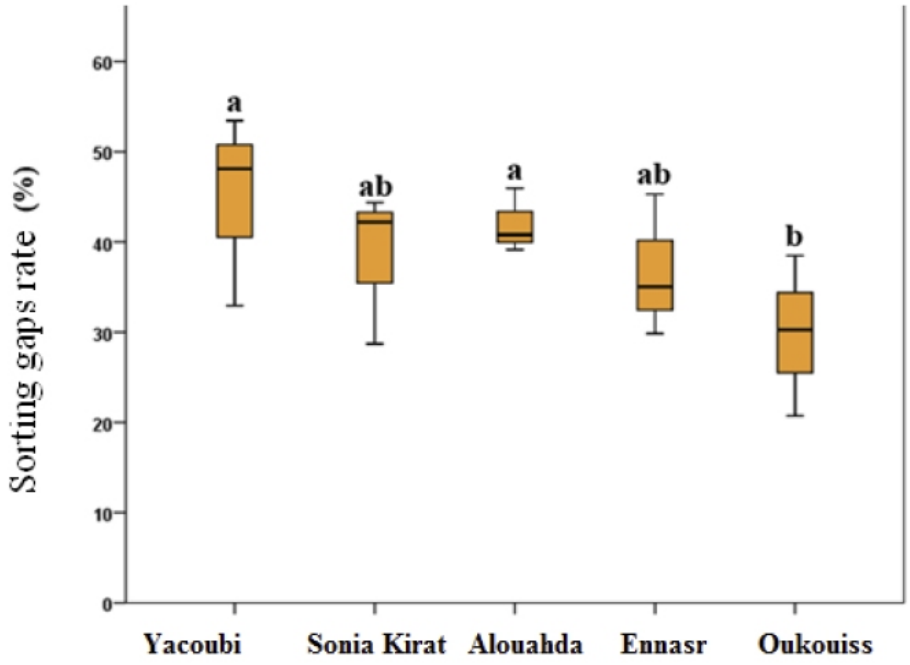

Figure 9. Distribution of rates of citrus fruit sorting gaps recorded at the five packing Packinghouses selected for the study.(The horizontal line inside the box-plot indicates the value of the median (50% quantile), the box-plot itself delimits the 25% and 75% quantile, and the lines represent the normal range of values. Lower case letters indicate significant differences between Packinghouses)

Figure 9:

Discussion

The results of the database processing showed that the rejection of citrus fruits in the packing Packinghouses is due to several causes and that the rate of sorting gaps varied from one Period to another and from one Packinghouse to another, with a rate of 44.4% for the Period 1; 30.8% for Period 2 and 40.1% for the Period 3. Furthermore, the finding showed that the percentage of sorting gaps recorded in the five packinghouses allowed to identify the average rates which are: 44.8% for the Yacoubi Packinghouse, 41.66% for the Alouahda Packinghouse, 38.4% for the Sonia-Kirat Packinghouse, 36.66% for the Ennasr Packinghouse and 30% for the Oukouiss Packinghouse. The average rate of overall sorting gaps recorded for the campaign was 38.4%. Eight categories of imperfections were distinguished and were classified in descending order, insects 19.8%; fungi, 13.0%; size defects, 12.6%; scars, 12.2%; picking defects, 11.7%; other defects 10.7%; injuries defects 10.6%; color defects 9.2%.

Degreening (operated or not operated) is a factor that had a significant effect on the rates of sorting differences recorded in the packing Packinghouses. The magnitude of the sorting gap rates reveals defects that are difficult to identify when the fruit rind is still green (e.g. Oleocellosis, injuries and water-spot) (Belabess et al., 2020). It has been shown that the treatment of fruit with ethylene gas favours the development of certain diseases such as green rot in California (Smilanick et al., 2006). There has been a decrease in the rate of gaps during the second Period of harvest, that is the ideal time for harvesting on the one hand the fruit has reached physiological maturity

and therefore it becomes less vulnerable. At full maturity, other causes of gaps can occur such as embossing and swelling and the development of fungi due to the sugar level and the decrease in acidity.

The rates of sorting gaps also vary by packinghouse; this can be explained by the level of cultural practices deployed by the citrus growers and the handling in the packaging chain from upstream to downstream. In the region of Agadir, despite the homogeneity of soil and climate conditions, a significant difference between the rates of sorting differences is observed in the majority of producers Asfar (2011).

Sorting gaps due to insects are the major problem, followed by those of fungi depending on the season and locality. This fact was noted by Baali (2009) in the Gharb region on fruits of “Blood Washington” and “Valencia late” California scale, sand-lice, snails and thrips are the majority, followed by harvesting defects, especially for “blood Washington”, due to inappropriate climatic conditions and then mottling and size defects (Belabess et al., 2020). However in Souss Asfar (2011) found that marbling is the major defect of sorting gaps, followed by defects related to climatic hazards, picking defects and poor coloration. Our results join a study, carried out in the region of Berkane, found that insect damage, physical and chemical damage and picking defects are in the peak of the categories of imperfections observed on the surface of citrus fruits, followed by physiological disorders and fungal damage (Belabess et al., 2020).

In addition to these factors there are the normative quality requirements imposed by foreign markets, which have become more, demanding due to increasingly fierce competition from other Mediterranean countries (Belabess et al., 2020). Moreover, the new marketing trends specified by the World Trade Organization (WTO) require a high quality of the products to be exported (Londhe et al., 2013).

Conclusion

Considering that pests and physical and chemical damage represented mainly by scars that may be due to the wind, insect pests (e.g. thrips) and/or agricultural machinery used for example in phytosanitary treatments are among the main causes of the differences in citrus fruit sorting in the Berkane region, and that knowledge of the bio-ecology of pests is considered a first step in the fight against them, it would be particularly important to focus on the bio-ecology of the pests that are reported in the present study to be most prevalent in the Berkane region (California scale, mealy bug, green leafhopper, mites, citrus leaf miner, snails and Medfly) and to look for sustainable alternatives for the protection of orchards and Integrated pest Management. Medfly damage is of great strategic importance for the sector because the interception of a live larva in a shipment to the USA or Russia could jeopardize the entire citrus export chain through a total or partial suspension of exports from Morocco to one of these destinations. It is unavoidable to give the necessary attention to the phytosanitary management of this dreadful pest to avoid these direct and indirect economic consequences.

Some destinations of exported fruits require fruit without any post-harvest fungicides. To provide such fruit, care must be taken in the orchards and during packing, shipping and storage to minimize decay and blemishes. Furthermore, implementing and adopting proper cultural practices during fruit growth and development can result in production of recommended quality fruit with fewer post-harvest defects. The adoption of IPM practices, and reasoned fertilization, and sanitation of orchards can reduce disease pressure in the orchards and chemical sprays in pre-harvest and post harvest (Brown, 1998). In the packinghouse, the proper sanitation helps to decrease reliance on pesticide applications. Minimizing injuries to fruit during the handling through the chain of process of packaging from the tree to final product should effectively reduce fungi establishment. Traceability can help to identify causes of pre-harvest and postharvest diseases and allow adopting a future approach of managing decay and control strategy.

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