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RESEARCH – *post-print* version

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Knowledge about Pesticides Use and Consumption of Fruit and Legumes in Growers and Consumers in the Province of Nador, Morocco. Results from a Survey Study.

Conocimientos sobre el uso pesticidas y el consumo de frutas y legumbres en agricultores y consumidores en la provincia de Nador, Marruecos. Resultados de una encuesta.

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HIGHLIGHT

- From the 100% people surveyed, 91%, 74%, 64% and 38%, consume potatoes, onions, tomatoes, and carrots, respectively. In terms of fruit, 84%, 75%, 69%, consume bananas, apples, and oranges, respectively and few of them consume strawberries, kiwi, pear and avocado.
- About 53% of the consumers surveyed know the meaning of organic fruits and vegetables. When asked if they know pesticides, 6% know about pesticides as fertilizers, 35% know about them as medicines while only 59% know about them as poisons.
- For the 50 farmers surveyed, 90% of them had no training in pesticides and their applications. About 34% do not use any means of precaution when applying pesticides. Also, 98% of them know the pre-harvest product application time (DAR).
- Around 48% of the surveyed growers buy pesticides according to their previous experiences, 38% buy according to the recommendation of retailers, and 8% buy them according to the price. Finally, 31% of the surveyed growers had fertility and sterility issues.

ABSTRACT

Introduction: Pesticides are increasingly used in agriculture to protect crops against diseases, insect pests, weeds, etc. Pesticides leave residues and chemical active material, which can affect the health of consumers. Several epidemiological studies have demonstrated a link between pesticide residues in fruits and vegetables and disease infestations in humans and problems related to sterility, allergies, and even carcinogenic diseases. Consumer awareness and the application of strict legislation about the application of pesticides in agriculture remain as a good alternative to face this issue.

Methods: This survey was carried out in the region of Nador, North-East of Morocco. It is a quantitative study of a representative sample made up of 100 consumers and 50 farmers in relation to fruit and vegetables and the use of pesticides.

Results: Most consumers are not aware of the danger of pesticides and residues in fruits and vegetables. In addition, the survey revealed that potato, tomato, apples, and bananas are the most consumed. These foods are usually characterized by a high rate of application of

pesticides and with a higher rate of pesticides residues. In addition, surveys carried out in farmers, revealed that they consider the economic and agronomic interest of the application of these pesticides without considering the residual effects on health. Moreover, a high rate of sterility was observed among these surveyed farmers (31%).

Conclusions: The consumers are less aware of the danger of pesticides. The choices of farmers are only accentuated on the aspect of economic use of these products and not on the health and environment.

Keywords: Pesticides; Pesticides Residues; Pesticide Exposure; Risk Assessment

RESUMEN

Introducción: Los pesticidas se usan cada vez más en la agricultura para proteger los cultivos contra enfermedades, plagas de insectos, malezas, etc. Varios estudios epidemiológicos han demostrado una relación directa entre los residuos de plaguicidas en frutas y verduras y la contracción de enfermedades en humanos, siendo las más frecuentes las asociadas con problemas relacionados con la esterilidad, las alergias e incluso las enfermedades carcinogénicas. La concientización del consumidor y la aplicación de una legislación estricta sobre la aplicación de pesticidas en la agricultura siguen siendo una buena alternativa para enfrentar este problema.

Metodología: Esta encuesta se llevó a cabo en la región de Nador, al noreste de Marruecos. Se trata de un estudio cuantitativo de una muestra representativa formada por 100 consumidores y 50 agricultores, en relación con las frutas y hortalizas y el uso de plaguicidas.

Resultados: La mayoría de los consumidores no son conscientes del peligro de los pesticidas y residuos en frutas y verduras. Además, la encuesta reveló que la papa, el tomate, la manzana y el plátano son los más consumidos. Estos alimentos suelen caracterizarse por una alta tasa de aplicación de plaguicidas y con una mayor tasa de residuos. Además, las encuestas realizadas a los agricultores revelaron que estos últimos tienen en cuenta el interés económico y agronómico de la aplicación de estos plaguicidas, pero no sus efectos residuales sobre la

salud. Asimismo, se observó un alto nivel de esterilidad entre estos agricultores encuestados (31%).

Conclusiones: Los consumidores son menos concienciados respecto al peligro de estos plaguicidas. Las opciones de los agricultores sólo se acentúan en el aspecto del uso económico de estos productos y no en la salud y el medio ambiente.

Palabras clave: Plaguicidas; Residuos de Plaguicidas; Exposición a Plaguicidas; Medición de Riesgo.

INTRODUCTION

Since the industrial revolution after the Second World War, the pesticide manufacturing industry has continued to expand[1] to provide the inputs and active ingredients to eliminate all kinds of production enemies such as diseases[2], insect pests[3] and weeds[4], and allow producers to maintain their agricultural yields and to deal with these biotic enemies[5]. Pesticides cannot be placed on the market or used without authorization[6]. However, according to the World Health Organization (WHO), approximately one billion of human beings are affected by acute poisoning through contact with pesticides[7]. For this, there are national and international organizations that evaluate the potential risks of the use of active substances in pesticides on health and environment.

Pesticides are classified according to the targets for which they are intended: fungicides to destroy *fungi*, herbicides to fight against harmful plants, molluscicides against slugs, insecticides to eliminate insect pests, nematicides to fight against nematodes and acaricides to control mites. Generally, these pesticides contain active ingredients that play a role in crop protection and food preservation[8]. The classification of pesticides is based on several criteria such as: toxicity, function, chemical composition, origin, and mode of action[9]. Pesticides are also grouped according to their sources: organic (terpenes), inorganic (sulfates) and synthetic (organochlorines)[10].

Pesticide poisoning is a public health problem and can be occur in a direct way especially by the contamination of air and water (underground and surface) and can affect more people who live in rural settings[11]. The immediate effects of pesticide exposure include headaches; tingling of the eyes and skin; nose and throat irritation; itchy skin; the appearance of diarrhoea; abdominal pain; nausea and vomiting blindness and very rarely death[12]. The degrees of intoxication and the organs affected are related to the type of pesticide in question. Organophosphorus compounds inhibit acetylcholinesterase resulting in acute toxicity[13], while organochlorine compounds are toxic to the nervous system and sensitize the myocardium to catecholamines[14]. However, the relationship between exposure to pesticide residues and the appearance of certain epidemics in the region is difficult to establish, especially in the case of the lack of mechanistic arguments. Several epidemiological studies carried out have shown the intervention of certain active substances in the development of certain diseases for humans (Cancer, Diabetes type 2, reproductive disorders, etc.)[15]. Pesticide residues have been

found in the blood of cancer patients compared to normal individuals[16]. Pesticides have been linked to leukemia, brain cancer, lymphoma, breast cancer, prostate, ovaries, and testes[17]. The presence of pesticides in the body for a longer period affects reproductive abilities by altering the levels of male and female reproductive hormones[18]. Neurodegenerative diseases are caused by pesticides such as Alzheimer's and Parkinson's disease, usually neurotoxic effects[19]. Long-term exposure to pesticides damages the immune system and can cause hypersensitivity, asthma, and allergies[20].

Fruits and vegetables are among the most widely consumed agricultural foods and the amount as well as the percentage of this consumption compared to other foods differs from region to region and from culture to culture. However, the success of the production of these fruits and vegetables by the producers in terms of yield and quality requires a weekly application of several active ingredients of pesticides (fungicides, insecticides, herbicides etc.)[21]. For example, for an apple scab disease, around ten chemical treatments are necessary to remove just one spot on the apple[22]. The vine requires about fifty applications of active ingredients[23-26]. Also, such production of fruits and vegetables requires the application of several pesticide active ingredients and repeatedly (sometimes every 5-6 days). Currently, in the pesticide market, there are about a hundred active ingredients used. Some active ingredients have been removed from the international market because of the discovery of their harmful residual effects on human health after being used for decades, like "Dimethoate". Furthermore, certain fruits and vegetables contain more pesticide residues because of their susceptibility to diseases and pests[27].

What makes this phenomenon more vulnerable is that the consumer is not aware of this problem of pesticide residues in food and especially fruits and vegetables[28]. In undeveloped countries, the consumer does not give much importance to the application of pesticides and to the residual effect on fruits and vegetables. However, in developed countries, the opposite occurs, where consumers take seriously this issue in consideration. This could be explained by several reasons such as the standard of living and social status, the internal legislation of each country in terms of application of pesticide standards on the local fruit and vegetable market, the level of education of consumers, etc. The objective of this study, considered for our knowledge as the first in this topic and in this region, is to survey several consumers and producers of fruit and vegetables in the region of Nador, located in the north-east of Morocco,

in relation to their consumption rates of fruit and vegetables and in relation to their knowledge on pesticides and level of chemical residues in fruits and vegetables.

METHODS

This is a quantitative study of a representative sample made up of consumers and farmers in relation to fruit and vegetables and the use of pesticides. The collection of information was carried out at boulevards, streets, districts, markets, supermarkets, shops, homes and at the level of the various municipalities of the city of Nador (35°10'7.019"N2°55'39.301"W) or rural: Nador, Bni Ansar, Al Aaroui, Selouane, Zaio, Arekmane, Cap de l'eau, Farkhana, Bni Chiker, Zeghanghane and Bouarg. Questionnaires (Appendix 1) were distributed to 100 fruit and vegetable consumers and 50 farmers. The targeting was not random but had the rationale of interviewing a large population from different regions of the country as well as different intellectual, economic, and socio-cultural levels. For each person, an interview of 10 to 15 minutes was carried out to clearly explain the purpose of this survey and how to answer any question relating to it. Once the interview was completed, the questionnaires were subsequently completed anonymously to ensure client privacy and any awkward or intrusive questions were eliminated. The techniques for collecting data and information were composed of several specific questions, single, double, and multiple choice, prepared to obtain reliable and representative results.

Ethical considerations were taken during this study: (i) citizens were completely free to accept or refuse to participate in the survey; (ii) respect for the privacy of participants; (iii) the results were presented anonymously, and all participants had the right to consult the questionnaires and read them carefully. The following criteria were taken during the surveys: gender, age, school level, category of fruit and vegetables consumed, knowledge of organic products and pesticides, the percentage of consumers suffering from diseases and allergies, and type of disease. For farmers, other questions were asked in relation to, reading of labels by the producer, level of training in agriculture, knowledge of the DAR (delay for pesticides application before harvest), and precautions taken by farmers before treatment, level of knowledge of the active ingredient, criteria for choosing products, type of pesticides used and type of reproductive disorders existing among these farmers. The questionnaires were sorted, analyzed, and then illustrated in the form of diagrams and graphs using Microsoft Office Excel 2007.

RESULTS

The surveys were carried out, for the 100 consumers, 74% men and 26% women, of which 96% are adults, 3% adolescents and 1% children. Figure 1 shows that 21% are illiterate and 25%, 28% and 26% had primary, secondary and higher education, respectively. About 53% of these consumers know the meaning of an "organic" fruit or vegetable (data do not show).

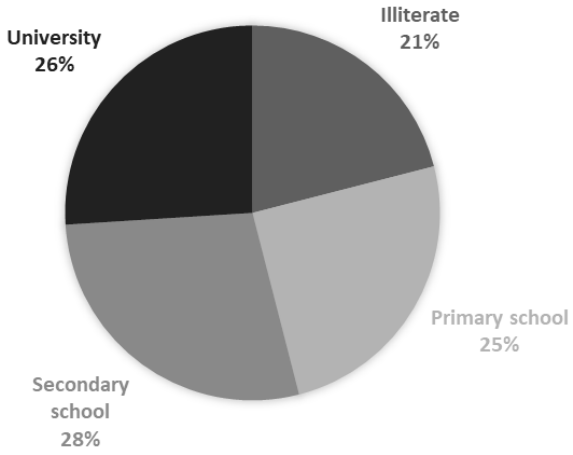
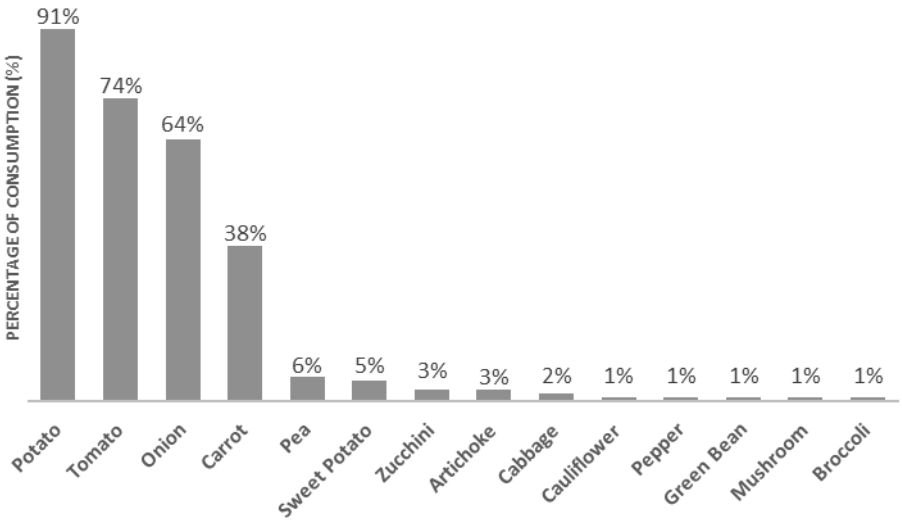


Fig. 1. Education level of consumers of fruits and vegetables surveyed.

As for the consumption of vegetables, 91%, 74%, 64% and 38% consumed potatoes, onions, tomatoes, and carrots, respectively. Few consumers (1 to 6%) consumed other vegetables such as peas, sweet potatoes, zucchini, green beans, peppers, etc. (Fig. 2-a). In terms of fruit consumption, 84%, 75%, 69% respectively consumed bananas, apples, and oranges and few of them consumed strawberries (17%), kiwi (8%), pear (7%), avocado (7%), lemon (3%) and the 1% consumed other fruits such as mango, pomegranate, and watermelon (Fig. 2-b). When asked if they know about pesticides, 6% know about pesticides as fertilizers, 35% know about them as medicines while 59% know about them as poisons (Fig. 3). In addition, the respondents showed that 21% were sick, of which 7%, 6%, 5% and 1% had allergies, hypertension, diabetes, and headaches, respectively (data do not show).

a)



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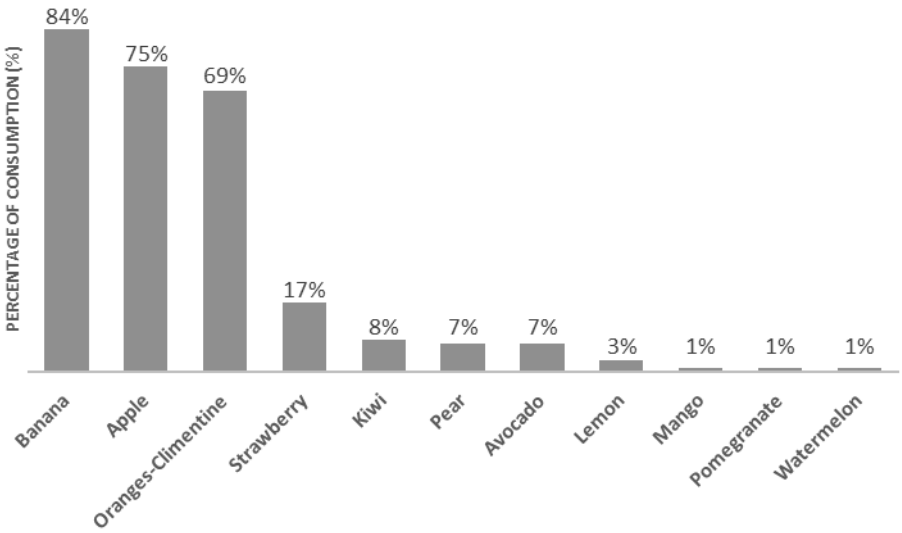

Fig. 2. Percentage of consumption of vegetables (a) and fruits (b) by the people surveyed.

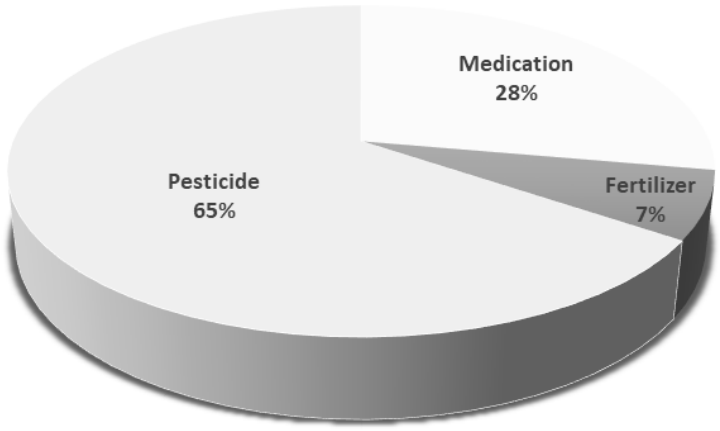

Fig. 3. Level of knowledge of the consumers about the signification of “Pesticide”.

As for the second part concerning the 50 farmers surveyed (100% are men), 90% of them had no training in pesticides and their applications. Figure 4 shows that 34% of them did not use any means of precaution when applying pesticides, 20% used small traditional means of precaution and 46% used masks, boots, vests, gloves, and others means of prevention when applying pesticides. Also, 70% of these producers know the active ingredients and the usefulness to fight against diseases, pests, and weeds and 98% know the pre-harvest product application time (DAR).

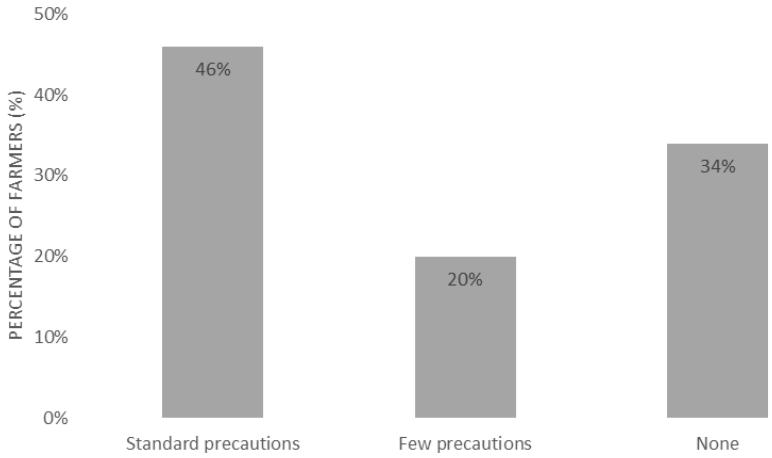

Fig.4. Percentage of farmers surveyed who respect sanitary precautions before treatments.

Regarding the choice of the producer of products and active ingredients, 48% bought these chemicals according to their previous experiences in terms of production, 38% bought them according to the recommendation of retailers, and 8% bought them according to the price and 2% according to experts (Fig. 5). Finally, this study showed that 31% of the producers surveyed had fertility and sterility problems (data do not show).

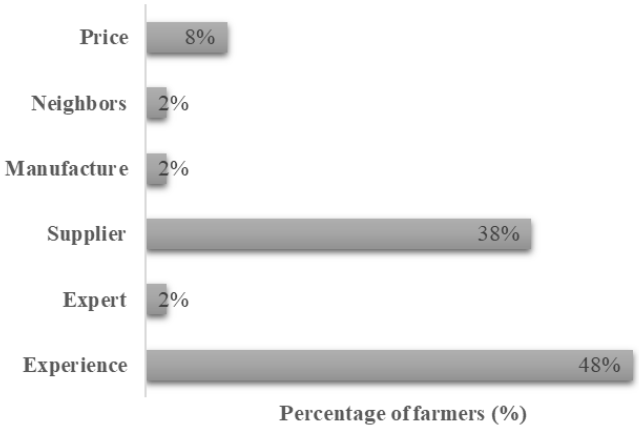

Fig.5. Criteria for choosing pesticides by the farmers surveyed, according to the recommendation of their experience, expert, price, supplier, manufacture and neighbors.

DISCUSSIONS

This study showed that consumers surveyed in the Nador region consume more potatoes and tomatoes as vegetables and apples and bananas as fruits. These products are among the foods with the highest rates of pesticides. Several studies[29-31] have shown that these fruits and vegetables require several applications of insecticides and fungicides due to their sensitivities to *fungi* (downy mildew, powdery mildew, botrytis, scab) and insects (moths, mites, aphids, codling moth, etc.). For example, potato producers apply 10 to 12 treatments of active materials based on anti-mildews and systemic insecticide active ingredients based on Imidacloprid, Chlorpyrifos, Deltamethrin, etc. Similarly, tomato is also characterized by an antifungal and anti-insect program highly loaded with active material, which increases the level of residues in the fruit[32]. For example, *Tuta absoluta* presents an insect pest for tomatoes and growers can sometimes apply systemic insecticide products in the field against *Tuta absoluta*, which can go up to every 4 to 5 days when humidity and temperature are very high in summer. In addition, these climatic conditions increase the speed of maturation of tomatoes, which makes it difficult to respect the DAR. Regarding fruit, studies have shown that the apple has one of the fruits that contains more pesticides[33-34] due to sensitivities to certain insects such as codling moth[35] and apple scab[36]. These surveys also showed that few consumers have a high level of training and few of them know the repercussions of these pesticides on health. Moreover, these surveys showed that 21% of these consumers have diseases and allergies. More precise and long-term epidemiological studies will be needed to verify the correlation between the residues of active ingredients in food and the risk rate of reaching chronic diseases and allergies. Although other scientific studies have shown that there is a correlation between pesticide residues and the risk of reaching diseases and allergies[37].

The second part of these surveys with the 50 farmers showed that they do not consider the effect of pesticides on human health, despite their knowledge of DAR, active ingredient, agronomic effect, etc. The survey showed that the producer's interest in pesticides is an economic and agronomic interest in relation to price and effectiveness in controlling diseases and production enemies. This study demonstrated a lack of training and awareness among producers regarding the harmful effects of pesticides on human health and the residual effects. As far as farmers' health is concerned, they do not take too many precautions when

applying pesticides, even when using basic means of prevention (gloves, glasses, protective vests, etc.). This study showed that there is an absence and awareness of the dangers of applying pesticides. Finally, the survey results showed an increase in the rate of sterility among producers, which is 31%. This study could not relate cause and effect due to the lack of enough information, means and time to carry out such a study. On the other hand, this trend of increasing sterility in rural areas has been demonstrated in several previous studies and research[38-39].

CONCLUSIONS

This study reported results of a survey completed with consumers and growers located in the province of Nador, regarding the consumption of fruits and legumes and their consciousness about pesticides residues. This survey permits to know the types of these most used vegetables and fruits; and this will give an indication about the active materials of pesticides used in this area. Moreover, the results showed that very few consumers and growers are aware of the danger of pesticides. As shown, the choices of pesticides of the farmers focus more on the economic aspect of the product and not on their effects on health and environment. Finally, the questions concerning diseases, allergies and fertility problems cannot reveal any conclusions concerning the "cause and effect" relationship of pesticides. Therefore, more in-depth epidemiological studies will be needed in the future.

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AUTHORS' CONTRIBUTIONS

"K.A, B.F-Z and S.S-E contributed to the creation and design of the study, designed the statistical plan, and interpreted the data. K.A and S.S-E performed the literature search, performed the analyses, and wrote the first draft with the help of G.H, and B.F-Z. All authors critically reviewed this and previous versions of the document".

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CONFLICTS OF INTEREST

There is no conflict of interest in this work study.

REFERENCES

(1) Matthews GA. A History of Pesticides. CABI International. 2018.
(2) Tronsmo AM, Collinge, DA, Djurle A, Munk L, Yuen J, Tronsmo A. Plant pathology and plant diseases. CABI International. 2020.
(3) Schoonhoven LM, Joop Loon, JA, Dicke M. Insect-plant biology. Oxford University Press, 2nd edition. 2006.
(4) Zimdahl R. Fundamentals of weed science, 5th Edition. Academic Press, Elsevier. 2018.
(5) Upadhyay, S. K. , Singh, S. P. . Molecules and Methods for the Control of Biotic Stress Especially the Insect Pests — Present Scenario and Future Perspective. In: Shanker, A. K. , Shanker, C. , editors. Abiotic and Biotic Stress in Plants - Recent Advances and Future Perspectives. London: IntechOpen; 2016. 10.5772/62034
(6) Uram C. International regulation of the sale and use of pesticides. Northwestern Journal of International Law and Business. 1990;10(3): 460-478.
(7) World Health Organization. L'utilisation des pesticides en agriculture et ses conséquences pour la santé publique. Genève. 1991.
(8) Shimshoni JA, Bommuraj V, Chen Y, Sperling R, Barel S, Feygenberg O, et al. 2020. Postharvest fungicide for avocado fruits: antifungal efficacy and peel to pulp distribution kinetics. Foods. 2020;9:124. 10.3390/foods9020124.
(9) Akashe M, Pawade U, Nikam A. Classification of pesticides: a review. International Journal of Research in Ayurveda and Pharmacy. 2018;9:144-150. 10.7897/2277-4343.094131
(10) Kaur R, Mavi GK, Raghav S. Pesticides Classification and Its Impact on Environment. International Journal of Current Microbiology and Applied Sciences. 2019;8(3):1889-1897. 10.20546
(11) Sarker A, Akbor MA, Nahar A Hasan M Towfiqul Islam AR, Abu Bakar Siddique M. Level of pesticides contamination in the major river systems: A review on South Asian countries perspective, Heliyon. 2021;7(6):12p. 10.20546.
(12) Mwabulambo SG, Mrema EJ, Ngowi AV Mamuya S. Health symptoms associated with pesticides exposure among flower and onion pesticide applicators in Arusha Region. Annals of Global Health. 2018;84(3):369-379. 10.29024/aogh.2303.

(13) Thabet H, Brahmi N, Kouraïchi N, Elghord H, Amamoub M. Intoxications par les pesticides organophosphorés: nouveaux concepts Réanimation. 2009;18: 633-639. 10.1016/j.reaurg.2009.05.006.
(14) Thany SH, Reynier P, Lenaers G. Neurotoxicité des pesticides : Quel impact sur les maladies neurodégénératives?. Médecine/sciences. 2013;29:273-8, doi:10.1051/medsci/2013293013.
(15) Nicolopoulou-Stamati P, Maipas S, Kotampasi C, Stamatis P, Hens L. Chemical pesticides and human health: the urgent need for a new concept in agriculture. Frontiers in public health. 2016;4:148. 10.3389/fpubh.2016.00148.
(16) Bedi JS, Gill JP, Kaur P, Sharma A, Aulakh RS. Evaluation of pesticide residues in human blood samples from Punjab (India).” Veterinary world. 2015;8(1):66-71. 10.14202/vetworld.2015.66-71
(17) Chiu YH, Williams PL, Gillman MW, Gaskins AJ, Mínguez-Alarcón L, Souter I, et al. Earth study team: association between pesticide residue intake from consumption of fruits and vegetables and pregnancy outcomes among women undergoing infertility treatment with assisted reproductive technology. JAMA Internal Medicine. 2018;8(1):17-26. 10.1001/jamainternmed.2017.5038.
(18) Bassil KL, Vakil C, Sanborn M, Cole DC, Kaur JS, Kerr KJ. Cancer health effects of pesticides: systematic review. Canadian Family Physician. 2007;53(10):1704-1711
(19) Yan D, Zhang Y, Liu L, Yan H. Pesticide exposure and risk of Alzheimer's disease: a systematic review and meta-analysis. Scientific Reports. 2016;6:32222. 10.1038/srep32222
(20) Hoppin JA, Umbach DM, Long S, London SJ, Henneberger PK, Blair A, et al. Pesticides are associated with allergic and non-allergic wheeze among male farmers. Environmental Health Perspectives. 2017;125(4):535-543. 10.1289/EHP315.
(21) Jeyanthiand H, Kombairaju S. Pesticide Use in Vegetable crops: frequency, intensity and determinant factors. Agricultural Economics Research Review. 2005;18:209-221. 10.22004/ag.econ.58472.
(22) Lahlali, R., Moinina, A., Ezrari, S., Maclean, D., & Boulif, M. Apple Scab Disease severity in the sais region of morocco and its sensitivity to three commercial fungicides. Notulae Scientia Biologicae. 2019;11(2):249-257.
(23) Komarek M., Cadkova E., Chrastny V., Bordas F, Bollinger JC. Contamination of vineyard soils with fungicides: a review of environmental and toxicological aspects. Environment International. 2010;36:138-151. 10.1016/j.envint.2009.10.005.
(24) Gill HK, Garg, H. Pesticides: environmental impacts and management strategies,” in Pesticides–Toxic aspects, eds S. Solenski, M L Larramenday, and L Marcelo (Norderstedt: Books on Demand). 2014;187-230. 10.5772/57399.
(25) Provost C, Pedneault K. The organic vineyard as a balanced ecosystem: improved organic grape management and impacts on wine quality. Scientia Horticulturae. 2016; 208:43-56. 10.1016/j.scienta.2016.04.024.

(26) Tsakirakis AN, Kasiotis KM, Charistou AN Arapaki N, Tsatsakis A, Tsakalof A. Dermal and inhalation exposure of operators during fungicide application in vineyards, evaluation of coverall performance. Science of the Total Environment. 2014;47:282-289. 10.1016/j.scitotenv.2013.09.021.
(27) Sungur S, Tunur C. Investigation of pesticide residues in vegetables and fruits grown in various regions of Hatay, Turkey. Food Addit Contam Part B Surveill. 2012;5(4):265-7. 10.1080/19393210.2012.704597.
(28) Epp A, Michalski B, Banasiak U, Bö GF. Pesticide residues in food. public perceptions in Germany, A Summary Report. BfR Wissenschaft, Federal Institute for Risk Assessment. Berlin. 2011.
(29) Brun S, Sauphanor G. Pesticide use in current and innovative apple orchard systems. Agronomy for Sustainable Development, Springer Verlag/EDP Sciences/INRA. 2011;31(3):541-555. 10.1007/s13593-011-0003-7.
(30) Okonya, JS, Kroschel J. A cross-sectional study of pesticide use and knowledge of smallholder potato farmers in Uganda." BioMed Research International, 2015;759049. 10.1155/2015/759049.
(31) Raada S, Mazouz H, Boulif M. Phytosanitary practices of apple growers in the Ifrane province of the Middle Atlas of Morocco and perspectives of improvement. Revue Marocaine de Protection des Plantes. 2019;13:19-33.
(32) Lozowicka B, Abzeitova E, Sagitov A, Kaczynski P, Toleubayev, K, Li, A. Studies of pesticide residues in tomatoes and cucumbers from Kazakhstan and the associated health risks. Environmental monitoring and assessment. 2015;187(10): 609. 10.1007/s10661-015-4818-6.
(33) Mahdavi V, Eslami Z Molaee-Aghaee E, Peivasteh-Roudsari L, Sadighara P Thai VN, et al. Evaluation of pesticide residues and risk assessment in apple and grape from western Azerbaijan Province of Iran. Environmental Research. 2022;203,111882. 10.1016/j.envres.2021.111882.
(34) Pirsaheb M, Fattahi N, Rahimi R, Sharafi K, Ghaffari HR. 2017. Evaluation of abamectin, diazinon and chlorpyrifos pesticide residues in apple product of Mahabad region gardens: Iran in 2014, Food Chemistry. 2017;231:148-155. 10.1016/j.foodchem.2017.03.120.
(35) Pszczolkowski MA, Brown JJ. Enhancement of insecticides against codling moth (Lepidoptera: Tortricidae) with l-aspartate in laboratory and field experiments, Journal of Economic Entomology. 107(3):1163-1171. 10.1603/ec13446.
(36) Chatzidimopoulos M, Lioliopoulou F, Sotiropoulos T, Vellios E. Efficient control of apple scab with targeted spray applications. Agronomy. 2020;10:217. 10.3390/agronomy10020217.
(37) Falak R, Sankian M, Varasteh AR. The Possible Role of Organophosphorus Pesticides in Augmentation of Food Allergenicity: A Putative Hypothesis. Research Journal of Environmental Toxicology. 2012;6:88-100. 10.3923/rjet.2012.88.100.

(38) Neghab M, Momenbella-Fard M, Naziaghdam R, Salahshour N, Kazemi M, Alipour H. The effects of exposure to pesticides on the fecundity status of farm workers resident in a rural region of Fars province, southern Iran. Asian Pacific Journal of Tropical Biomedicine. 2014;4(4):324-328. 10.12980/APJTB.4.2014C586.
(39) Roeleveld N, Bretveld R. The impact of pesticides on male fertility. Current Opinion in Obstetrics and Gynecology. 2008;20:229-233. 10.1097/GCO.0b013e3282fcc334.