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ASSESSMENT OF STRAWBERRY CULTIVATION MANAGEMENT (GHARB AND LOUKKOS)

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Abstract

The study surveyed 11 phytosanitary boxes and 37 strawberry growers in Gharb and Loukkos, North-West Morocco, to understand strawberry crop management issues, practices, and farmers' knowledge. Chemical pest management is achieved using a variety of pesticides, with fungicides being the most common. However, less than 30% of growers have adequate education on pesticide use. Integrated pest and disease management is shared by 56% of farmers in Loukkos and 42% in Gharb. Over 70% are willing to introduce biological control as a new phytosanitary approach. Thus, the phytosanitary statue of strawberry cropping fields seemd disquieting, even potential hazards for the environment, farmers and consumers in Gharb-Loukkos perimeter are expected.

Keywords: Variety, North-west Morocco, Loukkos, Gharb, Strawberry, Phytosanitary, Management.

1. INTRODUCTION

The use of plant protection products in agriculture dates back to antiquity: the use of sulfur appears to date back to ancient Greece (1000 BC) and arsenic was recommended by Pliny, a Roman naturalist, as an insecticide. Plants known for their toxic properties were used as PPPs (e.g., aconites, in the Middle Ages, against rodents) [1]. With the advent of synthetic pesticides about 50 years ago, some sought that crop pests would be defeated and eradicated [2]. This has not happened. In fact, increasing pesticide use has resulted in outbreaks of secondary pests and pest resurgence following the development of pesticide resistance has cropped up. But, that doesn't discount the fact production increase in the quantity and quality of agricultural commodities is continuously dependent on pesticide usage which attenuates the impact of the devastating infestation [3]. Pesticides are chemical substances that control organisms considered harmful to human activities. They are mainly intended to protect crops and have allowed the development of a model of agriculture known as "modern". Conventional agriculture based on an intensive production model is entirely based on the use of these chemical products [4, 5, 6].

Although the use of pesticides increases production yields by eliminating or reducing crop predators, it causes hazardous issues to the population health, the environment, the quality of agricultural products, and the ecological environment as a result of the disappearance of a large number of wild animal and plant species as well as the contamination of water, soil and air [5, 7, 8, 9, 10]. According to the Poison Control Centre of Morocco, acute pesticide poisoning is frequent in Morocco and pesticides are the second most common cause of intoxication in the country over19 years (1989 and 2007). Moreover, during the period in question (2008-2016), CAPM recorded 11,196 cases of acute pesticide intoxication, i.e., 10.7% of all cases collected during

the same period (all causes combined); and an average annual incidence of 3.57 cases per 100,000 inhabitants [11]. Accidental pesticide poisonings are most often related to agricultural pesticides (54%) [12, 13, 14, 15]. The World Health Organization (1992) reports that roughly three million pesticide poisonings occur annually, resulting in 220,000 deaths worldwide. Both economically and in terms of human life, these poisonings represent an enormous cost to society. This study covered two irrigated areas, among the most important in Morocco viz, the Loukkos perimeter and the Gharb region, both of which are known for their intense and diversified agricultural activity.

Vegetable production in winter and spring is concentrated on five essential speculations: potatoes, melons, watermelons, tomatoes, and strawberries [12, 16]. The latter occupies a total area of 3140 ha in both areas, of which about two-thirds are located in the Loukkos perimeter [13, 15]. Currently, strawberry cultivation occupies, in terms of area, the third position among irrigated vegetable crops after melon and potato, and in terms of tonnage, the strawberry sector provides 17% of the vegetable production in Loukkos [12, 13, 15]. Many diseases caused by fungal pathogens are responsible for heavy quantitative and qualitative losses occurring in the strawberry fields of both zones [17, 18, 19, 20, 21,22, 23] in addition to bacteria [24], weeds [24, 25, 26], and pests (Nematodes, Mites, Aphids) [23, 24, 25]. Farmers use pesticides as the only means of control against these enemies of strawberry plants in Gharb and Loukkos [24, 26]. A previous survey has noted the massive use of pesticides for crop protection as well as a lack of information among farmers about adequate phytosanitary practices to adopt [27]. The investigating questionnaire aimed to assess the level of knowledge, perceptions regarding the introduction of new disease control methods, farm practices adopted along strawberry growing season by managers of phytosanitary companies and farmers in Gharb and Loukkos perimeter.

2. MATERIAL AND METHODS

The Gharb plain and the Loukkos perimeter are located in northwestern Morocco (Figure 3). The Gharb region is located on the Rabat-Tangier axis. It covers an area of 893,860 ha, 68% of which is useful agricultural area (Harbouze et al., 2019; Anonymous, 2005). The Loukkos perimeter is located between the Tangier region and the Gharb. It covers 256,000 ha, 57% of which is useful agricultural land. Before starting the study, the questionnaire was administered with a face-to-face interview method between October and December of the strawberry season 2013-2014, after the informed consent of the participants was obtained.

The target respondent on a farm was often either the farm manager responsible for making agricultural decisions or farmer. Farmer participatory in study were randomly chosen from 7 localities in Gharb province (Ouelad Mesbah, Grafda, Ouled Aguil, Dlalha, Aanabsa, Gnafda and Lalla Mimouna) with 21 farmers in Gharb and 16 farmers in 6 localities of Loukkos (Boucharen, Ouelad Hamou, Legdira, Zlaouza, Laouamra and Drader road) (Figure 1). The managers of 4 phytosanitary boxes in Laouamra (Loukkos perimeter) and in 7 phytosanitary boxes in Dlalha (Gharb region) were also included in this survey.

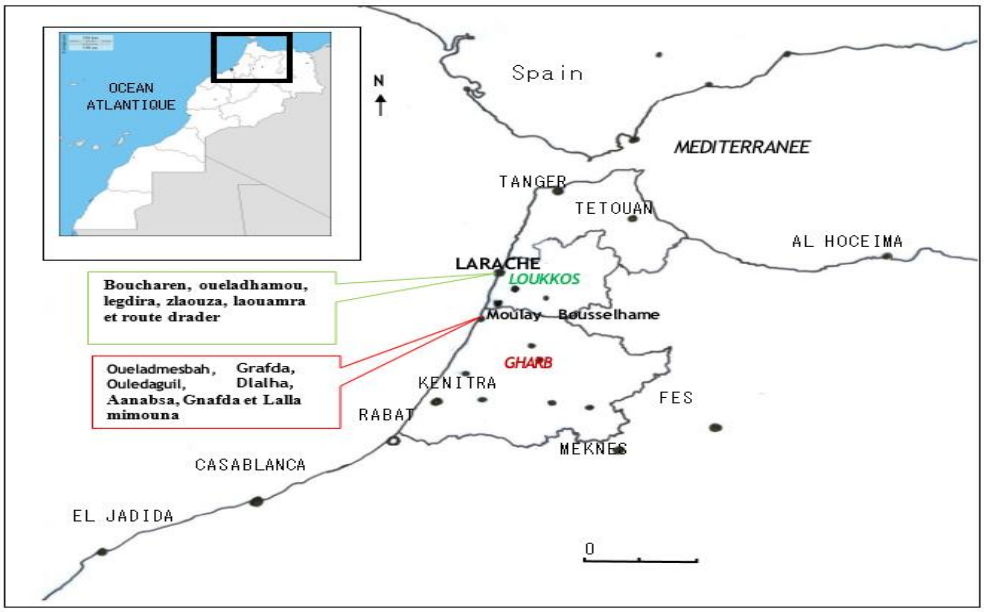

Fig 1: Location of the study areas in Gharb and Loukkos

3. RESULTS AND DISCUSSION

The questionnaire was created by the researchers. It consists of two parts questioning the farmer's age, educational level, occupational characteristics, and knowledge about the typology of the different agrochemicals applied, the most diagnostic methods, the main phytosanitary problems encountered in the field, and the different control measures adopted. At the end of the study, all of the 44 targeted farmers and managers were reached. The data were analyzed using the Excel for Windows program. All 44 farmers and managers included in the study were male. Four out of seven gharb manager's, are agricultural technicians, two have a scientific degree, and one is an agricultural engineer. In Loukkos, three dealers are agricultural technicians, and one is an agricultural engineer (Figure 2). As a key driver of commercial activity and economic recovery in the two perimeters of Gharb and Loukkous, the expansion of strawberry production has revived the installation of multiple phytosanitary boxes very close to strawberry farms to meet growing demands for the chemical products, irrigation equipment, fertilizers and certified plant material adopted by the producers (Figure 3).

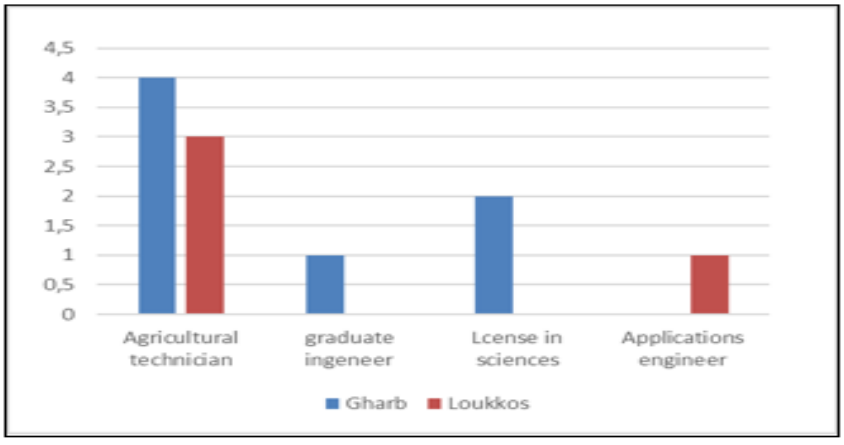

Fig 2: Distribution by education level of phytosanitary boxes managers

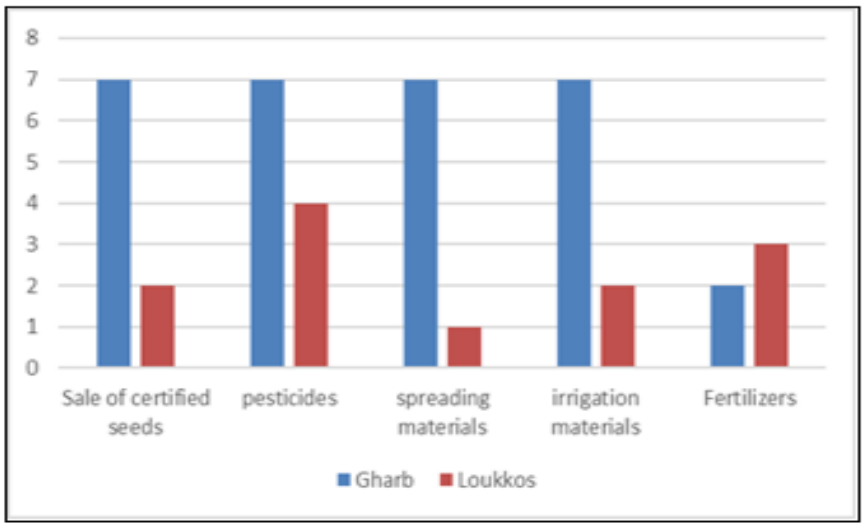

Fig 3: Distribution by sale activites in Gharb and loukkos phytosanitary boxes

At the same time, cultural and chemical measures are needed to lessen the negative impacts of phytosanitary issues. As a result, the availability of a wide range of strawberry varieties can help to lengthen the offer period and avoid those who are most susceptible to bacterial and fungal species. In this context, for sale, the variety profile is composed with three varieties according to gharb retailers. Camarosa and Festival varieties represents the tendency of all farmers- or 90% of them. Splendor and Sabrina are less requested; hence, the cultivation of Splendor is confirmed by 42.85% and 28.57% of the whole Gharb manager's. In the Loukkos perimeter, camarosa and festival are equally requested (Figure 4).

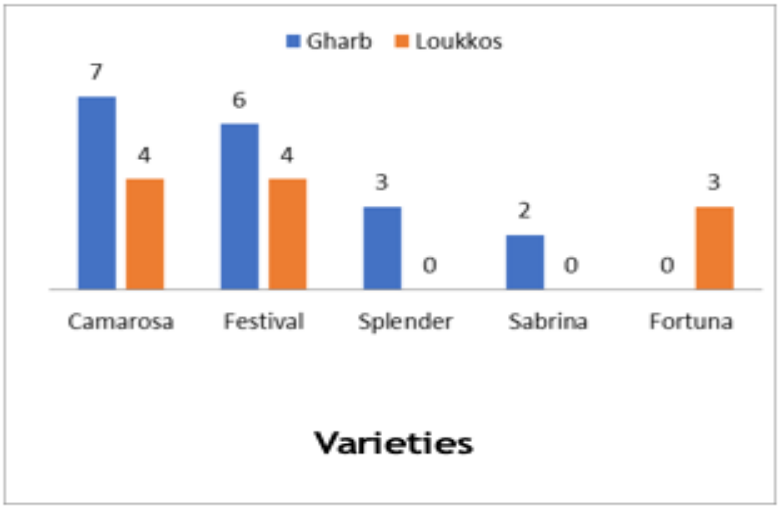

Figure 4: Distribution by requested variety in Gharb and loukkos exploitations according to phytosanitary boxes managers

Farm-level protection practices of strawberry pests and diseases in Morocco involve exclusively chemical synthetic products in both areas. Farmers' resort to these chemicals, the most formulation and nature have been detailed below. On these issues, two opinions were moved forward by the managers of phytosanitary boxes, the first one, liquid formulation is the only option for the farmers while the opinion of the 2nd group is shared between liquid and solid formulation (Figure 5).

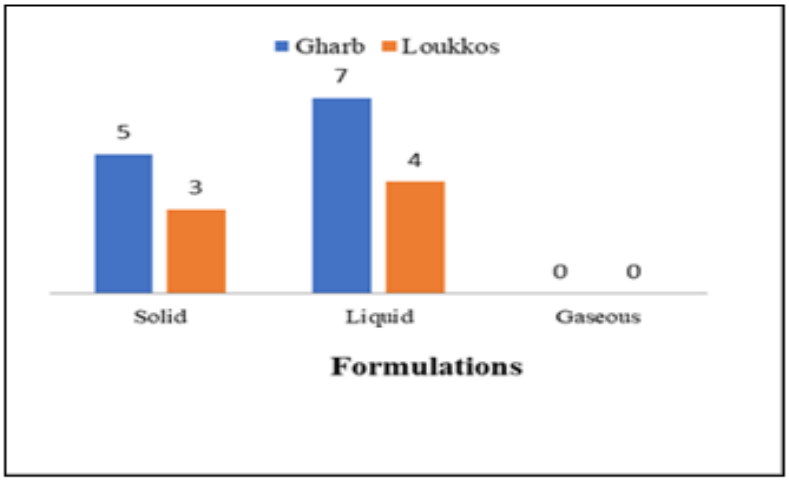

Fig 5: Perceptions of sellers Pesticide about used formulations used

Regarding pest and disease management, phytosanitary boxes respondents indicated that farm-managers in Gharb use fungicides (38.4%) more than insecticides (33.3%), both more popular than herbicides (27.7%). In contrast, farmers in Loukkos bought fungicides and insecticides instead of herbicides (11.1%) (Figure 6).

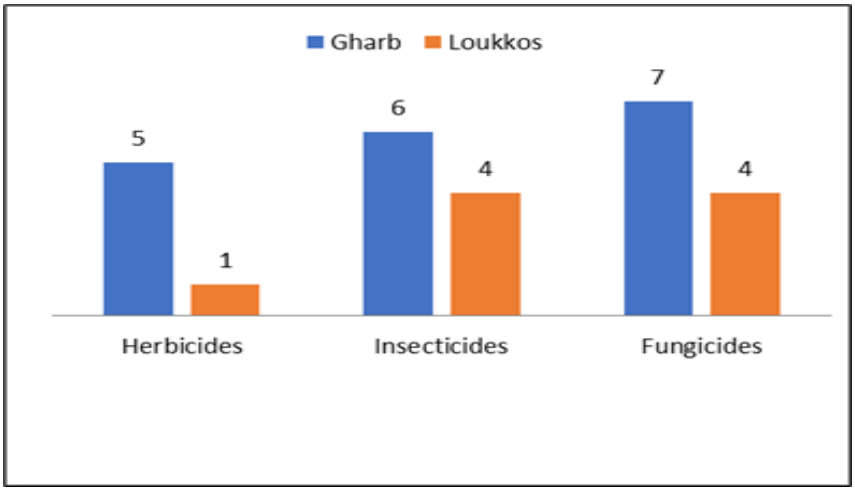

Fig 6: Estimations on sold products according to phytosanitary

Among these chemicals, nitrogenous heterocycles and dithiocarbamates are of the most sales in Gharb while in Loukkos, they are in favour of dithiocarbamates (Table 1).

Table 1: The registered fungicides with best sales by the agents of the phytosanitary boxes in the region of Gharb and Loukkos

Active Ingredients	Chemical Family	Formulation	Gharb	Loukkos
Bupirimate	Nitrogenousheterocycles	EC	1	0
Mancozeb	Dithiocarbamate	WP	3	2
Azoxystrobin	Nitrogenousheterocycles	SC	1	2
Maneb	Dithiocarbamate	WP	2	1
Penconazole	Nitrogenousheterocycles	EC	2	0
Hexaconazole	Nitrogenousheterocycles	SC	1	2
fenhexamid	Amides	WG	0	2

Best sales of registered insecticides were for synthetic pyrethroides followed by avermectines in the Gharb and Loukkos pesticide boxes (Table 2). For weeds control, three chemicals sales offering, among which the Amino-phosphonates are largely bought (Table 3).

Table 2: The registered insecticides with best sales by the agents of the phytosanitary boxes in the region of Gharb and Loukkos

Active Ingredients	Chemical Family	Formulation	Gharb	Loukkos
Abamectin	Avermectine	EC	2	1
Deltamethtine	Synthetic pyrethroides	EC	2	2
Dicofol	Carbinols	WP	1	0
Cyperethrine	Synthetic pyrethroides	EC	5	2

Table 3: The registered herbicides with best sales by the agents of the phytosanitary boxes in the region of Gharb and Loukkos

Active Ingredients	Chemical Family	Formulation	Gharb	Loukkos
2,4 D	Aryloxy- acetic acid derivatives	EC	0	1
Linuron	Substitutes utreas	WP	0	1
Glyphosate	Amino- phosphonates	SL	4	1
Paraquat	dipyridiles	SL	2	0

And used by farmers (Table 4), while the second choice is for dipyridiles found to be the favourite by farmers (Table 4).

Table 4: The registered herbicides with best sales by farmers in the region of Gharb and Loukkos

Active Ingredients	Chemical Family	Formulation	Gharb	Loukkos
Glyphosate	Amino- phosphonates	SL	5	7
Paraquat	dipyridiles	SL	16	9

According to sellers' opinions high costs are registered due to fungal diseases, more frequent with the predominance of oidium (100%) at the level of the two perimeters followed by grey rot whose occurrence not exceed 71% at the level of Gharb (Figure 7).

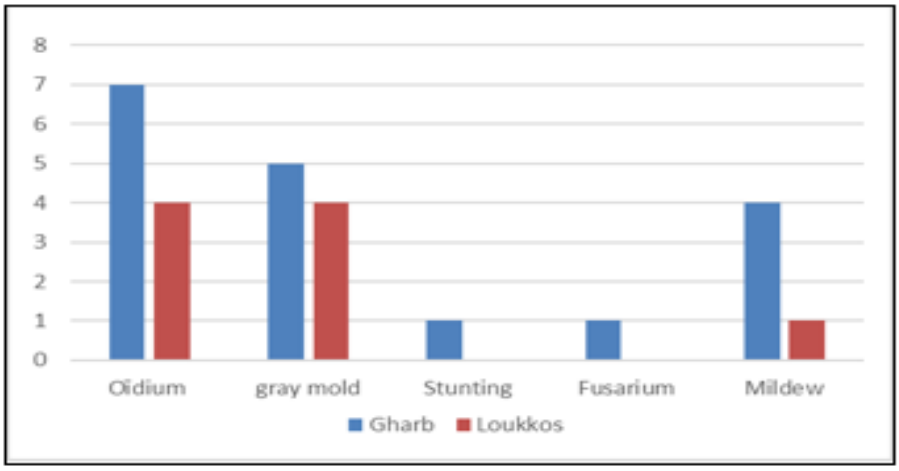

Fig 7: Prevalence of fungal diseases in both areas according to dealers estimations

Weeds are also a serious problem in strawberries farming, where perennial and biennial weeds occur either in Loukkos perimeter (63%) or the Gharb exploitations (54%) (Figure 8)

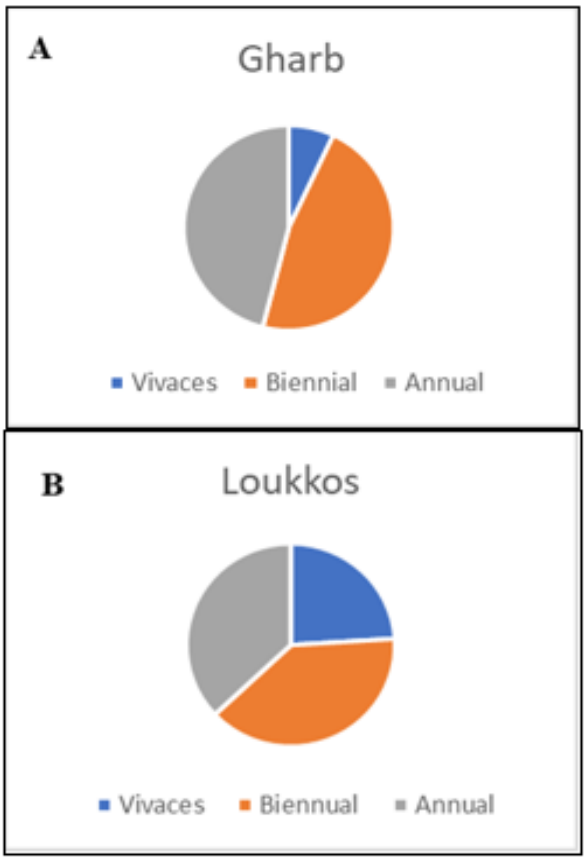

Fig 8: Frequency appearance of weeds in strawberry plots Gharb (A) and Loukkos (B)

However, the above percentage of fungal disease occurrence depend on decisions formally based on diagnosis method adopted. It was noted that the majority of growers draws out on visual observation and physical examination of the diseased strawberry plants when being brought to phytosanitary boxes, which even influences the choice of appropriate ingredient active and its rate that should be applied to cope with disease development at right time.

Besides, phytosanitary managers, farmers represents a main component of this farming system, their characteristics, perceptions, agricultural knowledge's play decisive role in cropping production success. 100% of the surveyed farmers who were included in the study were male and were over 18 years.

Of the 21 farmers in Gharb, 7 are illiterate, one has Koranic schooling, 4 were primary school graduates, 3 have attended college, 2 have non-agricultural higher education, 2 have agricultural higher education and 2 are agricultural technicians. Of the 16 farmers in Loukkos, 5 are illiterate, 1 have attended college, 2 are agricultural technicians, and 8 have achieved a higher agricultural education (Figure 9).

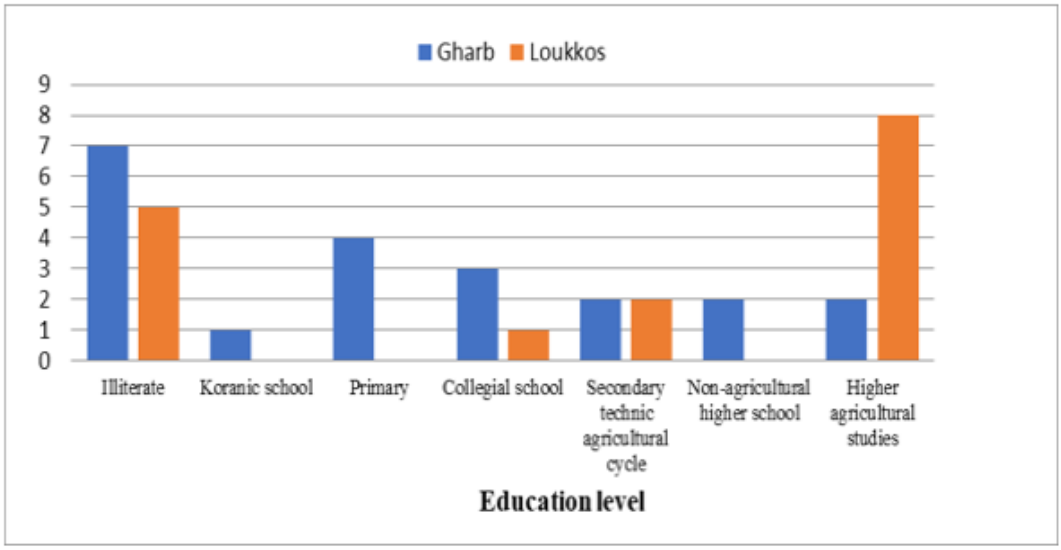

Fig 9: Number of strawberry farmers in gharb and loukkous exploitations per each level of education

The results show that there was difference between farmers for cropping system acre varying between 1 and 32 ha and type either open field, tunnel nantais or under high plastic tunnel.100% of strawberry fields are under tunnel nantais in Loukkos perimeter but in Gharb, 67% of cultivated areas are in tunnel nantais and 33% are under high plastic tunnel (Figure 10).

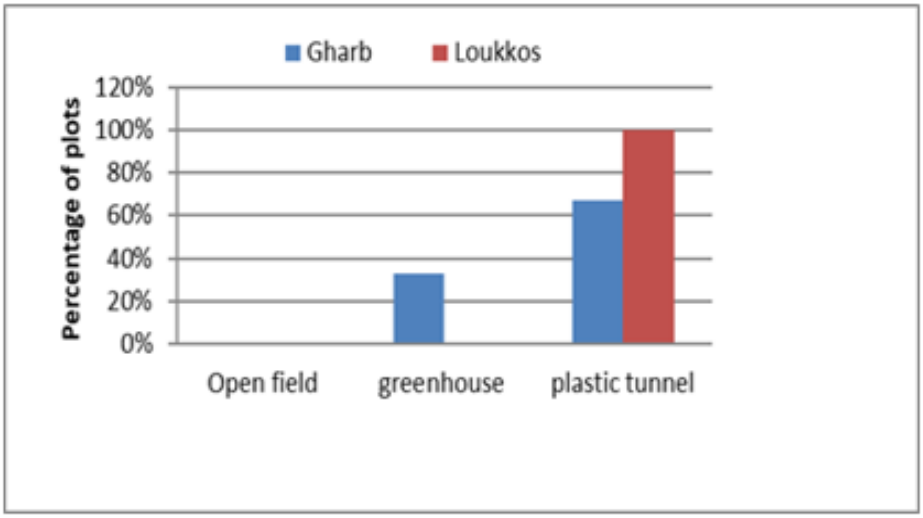

Fig 10: Cropping systems used by growers in Gharb and Loukkos areas

Among strawberry varieties cultivated in the region Gharb-Loukkos, Festival, San Andrea, Fortuna, Splendor, Venicia, Camarosa, Sabrina with a dominance of Camarosa 34% in Gharb production fields, 25% in those of Loukkos followed by Festival almost 23% in both regions (Figure 11).

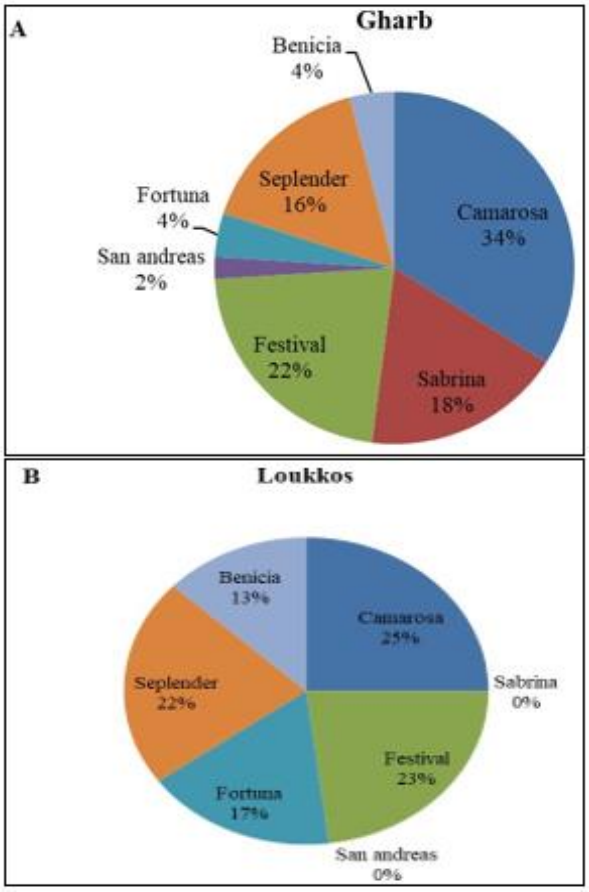

Fig 11: Percentage of the most cultivated varieties by growers of Gharb (A) and Loukkos (B)

On the control of key strawberry pests and fungal diseases, farmers underlined many pest organisms in the Gharb exploitation such as aphids 71.42% and Thrips 57%, mites and aphids represent 75% in Loukkos, while noctuids represent 14.28% (Gharb) and 50% (Loukkos) and nematodes 28.57% (Gharb) (Figure 12).

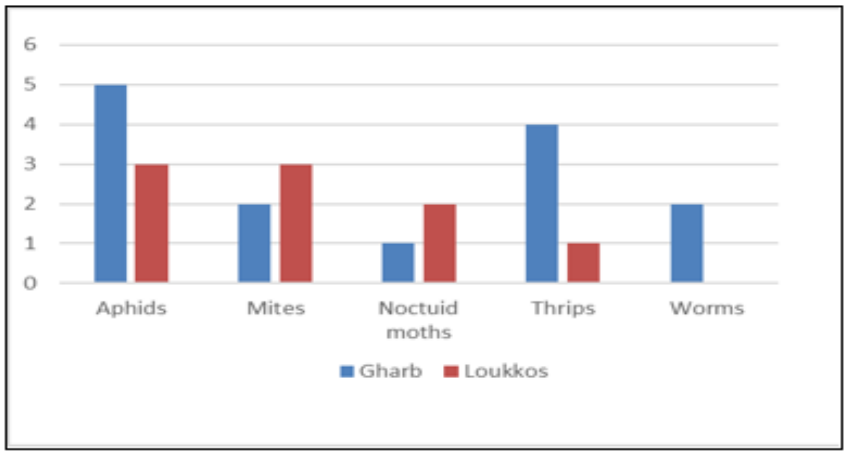

Fig 12: Dealers' perceptions regarding the occurrence frequencies of strawberry pests

Against nematode threats, 90% of growers in the Gharb region proceed to soil disinfection while 10% did not see the necessity of it. In the perimeter of Loukkos, 96% of strawberry growers disinfect the soil (Figure 13).

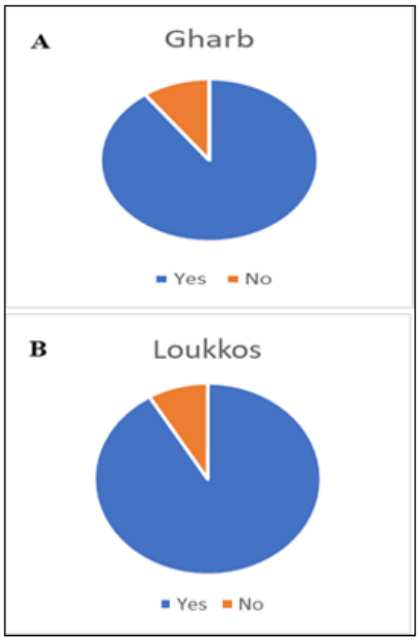

Fig 13: Percentage of farmer-operators of soil disinfection at Gharb (A) et Loukkos strawberry's plantations (B)

Moreover, weeds are a permanent concern for farmers in Gharb and Loukkos fields where 7% and 24% are faced with perennial weeds respectively compared with 39% from biennial weeds in Loukkos and 47% in Gharb. While annual weeds occurred at 37% and 46% of strawberry fields in Loukkos and Gharb respectively (Figure 14).

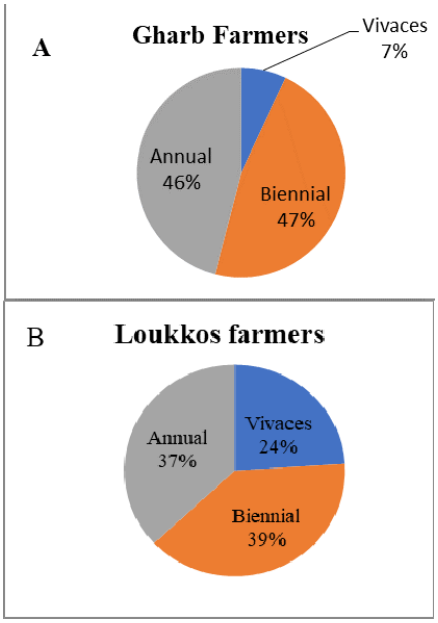

Fig 14: Weed's prevalence in the Gharb (A) and Loukkos (B) strawberry fields according to farmers

According to farmers, three control methods are commonly achieved in Gharb and loukkos plots when it is necessary.

Cultural practices:

Not expensive practices are adopted by farmers to avoid weeds. The majority of ghrab farmers (80%) proceed by not planting strawberries in fields that are already infested against 100% of Loukkos ones. When they have been asked about applying a safe control measure, between 95% (Gharb) and 100% (Loukkos) of them believe that plant spacing by leaving a good distance between plants and rows is profitable for strawberry production. Additionally, 67% of growers in Gharb and 94% in loukkos use adequate fertilization in a timely manner and 100% of farmers in both regions irrigate at the right time (Figure 15).

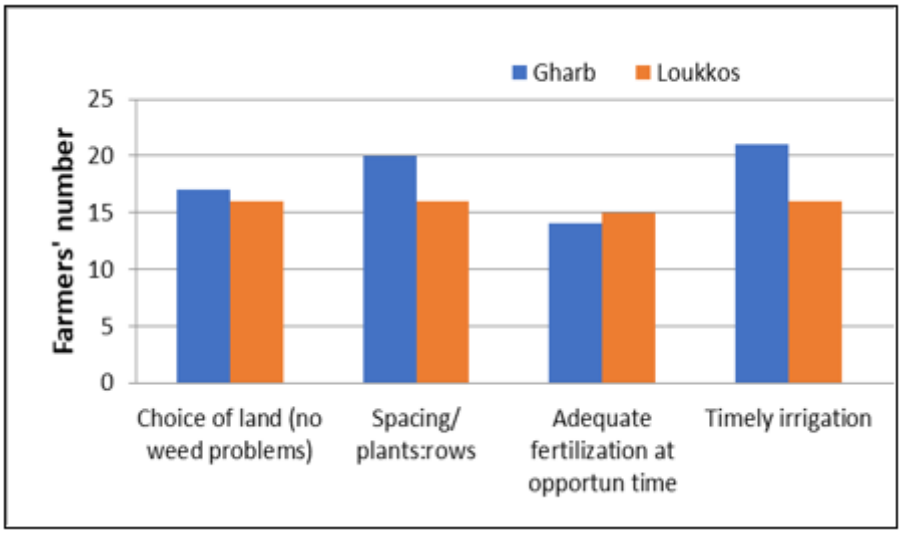

Fig 15: Distribution of Farmer's number by cultural practice applied in Gharb and Loukkos strawberry fields

Preventive approach: the measures mostly used by farmers in Gharb (57%) and Loukkos (19%) is the cleaning of farm equipment before moving to another field, while only farmers in Gharb (5%) use weed-free straw (Figure 16).

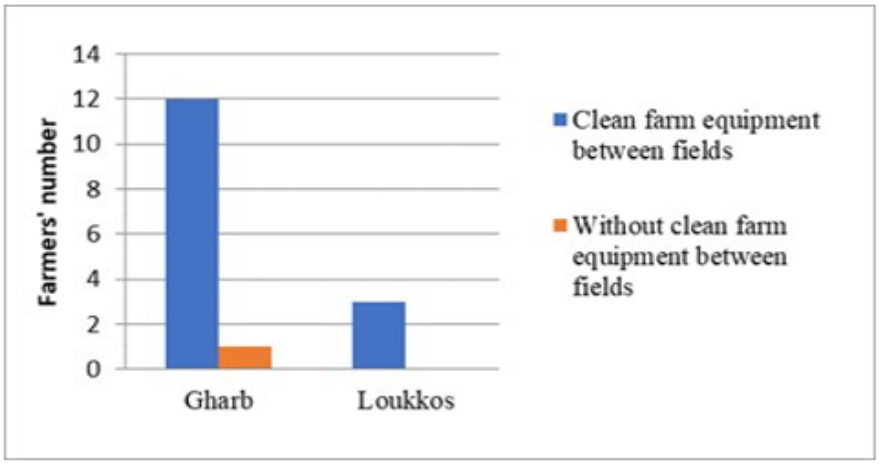

Fig 16: Farmers' number opting for applying preventive methods in strawberry exploitations of Gharb and Loukkos

Mechanical weed management: 93% of farmers in Loukkos and 81% in the Gharb region tilled the soil. The harrowing is done by 100% of farmers in Loukkos and 33% in Gharb, and hand weeding is done by 100% of farmers in both regions these are the most methods used by farmers and in a periodic way. On the Loukkos perimeter, 62.5% of the surveyed farmers used hoeing, 56.57% used mowing while 29% of farmers in the Gharb region used hoeing (Figure 17).

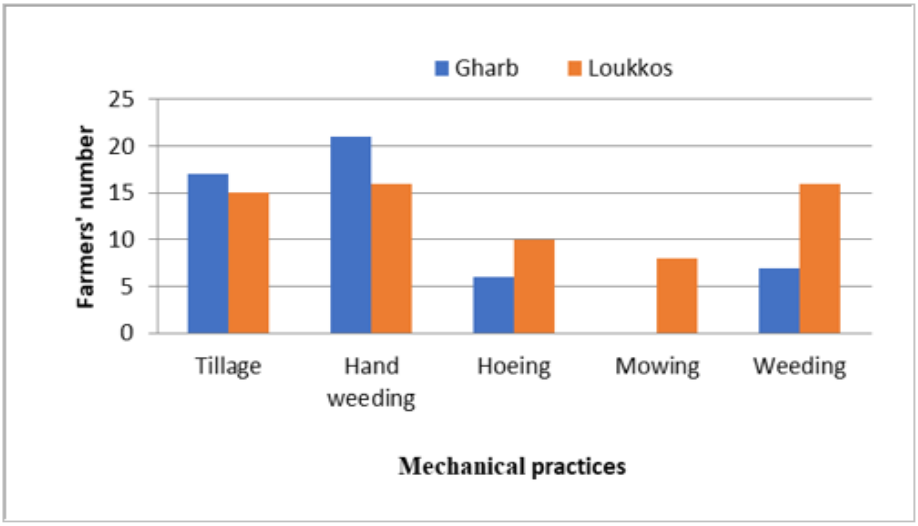

Fig 17: Farmers's number by mecanical practice in use in Gharb and loukkos exploitat

Chemical control

The management of key strawberry pests and fungal diseases begins by applying fumigation and soil disinfection with chemical methods by using Metam sodium at 95% of Gharb exploitations while dichloropropene is used by 70% of farmers in the loukkos exploitations (Figure 18).

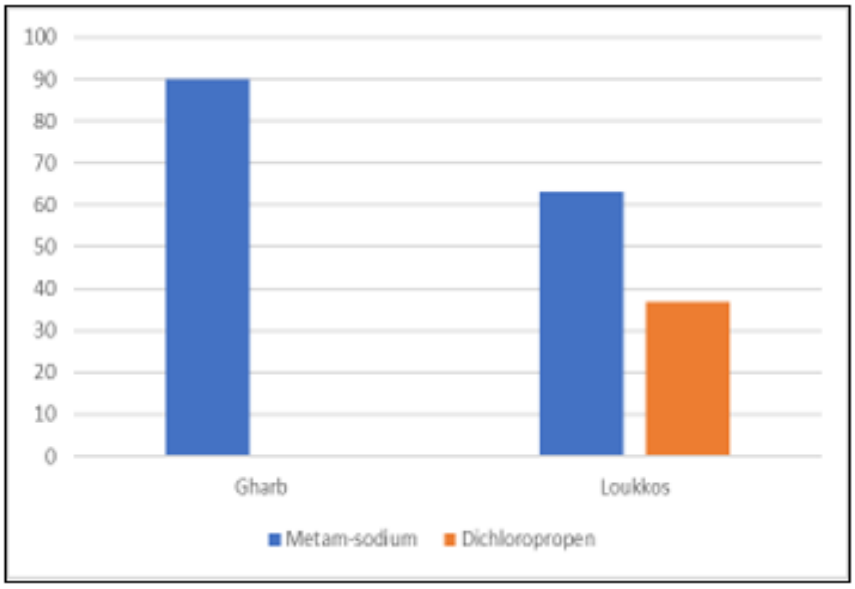

Fig 18: Percentage of farmer-operators of fumigation by metam-sodium and dichloropropen in Gharb and Loukkos exploitations

Against weeds, the current survey confirmed that 68% of farmers in Gharb and 60% in Loukkos treat chemically at pre-planting period as compared to 32% of the farmers in Gharb and 40% in Loukkos who applied post-planting treatments (Figure 19).

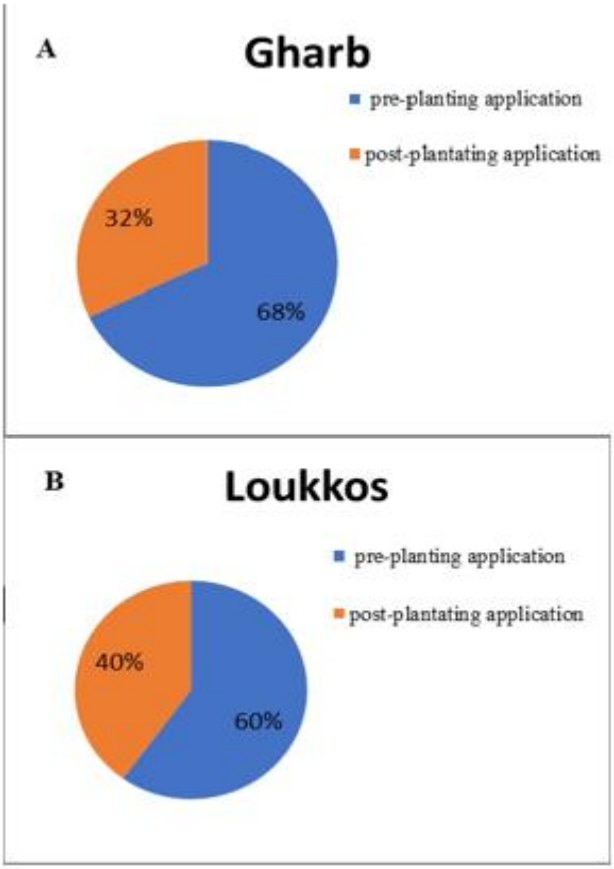

Fig 19: Percentage of farmers operators pre and post- planting treatment in strawberry fields of Gharb (A) and Loukkos (B)

During cropping season, Paraquat and Glyphosate are the two most used active ingredients for weed control in both regions by farmers (Table 4).

Farmers and phytosanitary boxes' managers shared the same statement concerning the most common fungal diseases in these two study areas. Powdery mildew and gray mold occurred at percentage of 100% followed by anthracnose 80% at the level of Gharb, 69% at the level of the Loukkos perimeter and crown rot 62% (Gharb) 31% (Loukkos). By contrast to these, mildew has a weak percentage appearance (Figure 7).

A total of 23 and 19 fungicides belonging to 14 families, are inventoried in strawberry farms of Gharb and loukkos respectively. Among them, 2 chemical families viz, Carboxamides followed by Hydroxy-anilides had the wide use against the causal agent of gray mold disease (14%) and (10%) in Gharb farms as do the Loukkos farmers (24.56%). To overcome the serious problems of Oidium, Loukkos farmers treat with fungicides from Triazinones (21.05%) and Strobulirines (14.03%) families (Table 5). Regarding the choice of plant protection products to control of the major pests encountered in both regions Thrips 95% (Gharb) and 13% (Loukkos), Mites 10% (Gharb) and 50% (Loukkos), Aphids 52% (Gharb) and 81% (Loukkos), Noctuidae 10% (Gharb) and 62.5% (Loukkos), nematodes 14% (Gharb) and 50% (Loukkos) (Table

6), the 21 farmers surveyed in Gharb, pointed out 19 available commercial products from 12 chemical families. The most used are chloronicotiniles (11.1%) or their derivatives (16,67%) for controlling whitefly and aphids, furthermore, Carbamates (9,72%) that attack pucerons, Codling moth, leafminer, or Hydroxyd- 4-coumarine (9.72%) against rodents in Gharb plots. While in the 16 farms of Loukkos,11 commercial products were used, they belong chemical families of which the most used are propene derivative (19.56 %) or Organo-phosphate (15.22%) trageting nematodes and insects of soil respectively (Table 6) In Gharb plots, it was shown that 90% of farmers have an atomizer tank needed to spray pesticides on crop while in loukkos, farmers used sprayers (62%) and atomizers (38%) (Figure 20).

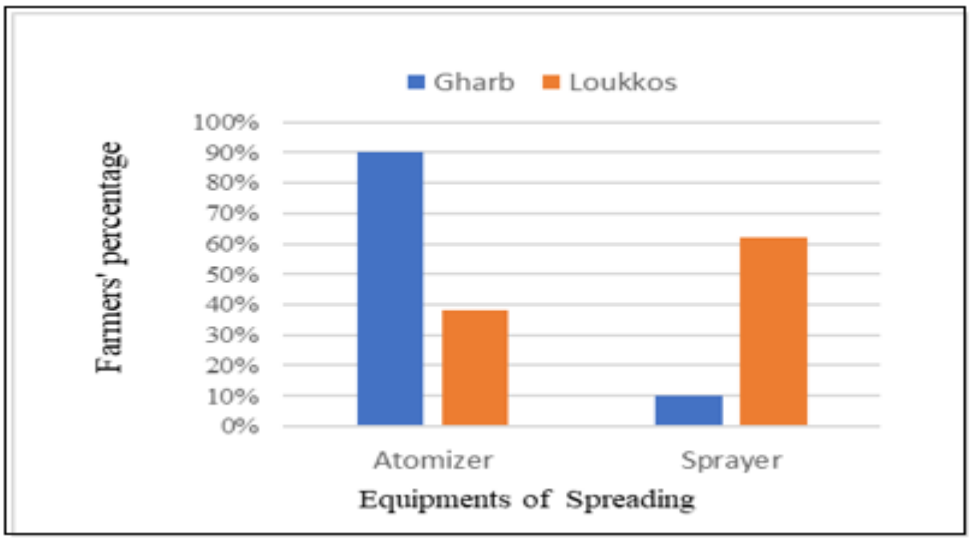

Fig 20: Atomizer and sprayer use among Gharb and Loukkos farmers

The results of the study showed that 100% of farmers in both regions respect the pre-harvest interval treatment. This means that most farmers are aware of the health risk of pesticides to consumers. 56% of farmers in the Loukkos perimeter and 42% in the Gharb region use integrated pest and disease management. However biological control of strawberry pests has not been well implemented among the respondents. The study showed that more than 70% of farmers in both regions are willing to use biological control. The growing of strawberry's farming has increased the demand for phytosanitary products and strawberry varieties diversification. In this regard, the participants in the current survey argued that they opted for large variety array to cover the entire cycle and better meet market requirements. The intensive strawberry cultivation in Gharb and loukkos areas also implies the massive use of phytosanitary products noted by almost farmers in our survey. In Loukkos, Abbou et al. (2021) [29], stated an intensive use of pesticides, justified by high number of products used and by high average frequency of pesticide treatments per production cycle. But according to Bouterfas et al. (2020) [30], crop protection products can be used irrationally by farmers. Naamane et al. (2020) [31] have found that 75% of farmers in the Casablanca-Settat region do not know how to use pesticides.

A wide range of active ingredients has been reported by interviewed farmers for the management of various phytosanitary problems. Chemical families such as pyrethroids, avermectin, and our results do not corroborate those reported earlier which indicate that herbicides account for more than 50% of the pesticides used worldwide, followed by fungicides and insecticides [32].

Table 5: Characteristics of registered fungicides and use frequencies among the total surveyed farmers in the Gharb region and the Loukkos

Specialty	Active ingredients	Chemical Family	Formulation	Usages	Targeted mechanisms	Mode of action	Action	Use percent/ ∑ Gharb's farmer	Use percent/ ∑ Loukkos farmers
Teldor	Fenhexamid	Amine (hydroxy-anilides)	WG	Gray mold	Acts on cell division and microtubule formation	Contact	Preventive	10%	24,56%
Thiogri 70	Thiophanate-méthyl	H.A (Benzimidazoles)	WP	Oidium, gray mold, Fusarium disease		Systemic	Preventive, curative	5.38%	0
Benlate	Benomyl	H.A (Benzimidazoles)	WP	oomycetes			Preventive, curative	4.62%	0
Laskor 50	Carbendazime	H.A (Benzimidazoles)	EC	oomycetes			Preventive, curative	2.31%	0
Switch	Cyprodinil+Fludioxonil	H.A Anilinopyrimidines+phenyl - pyrrols	WG	Gray mold	Inhibition of germination, elongation of a germ tube, and mycelial hyphae	Systemic + contact	Preventive, curative	2.31%	0
Aliette	Phosétyl-aluminium	O. Ph Phosphonates	WP	mildew		Systemc	Preventive, curative	8.46%	8,72%
Turbo ZM	Mancozèbe	Dithiocarbamates	WP	Alternaria disease, pourriture grise	Multi-siteinhibitors of spore germination	Contact	Preventive	5.38%	0
Agrithane DG			WG					3.84%	0
Manèbe 80	Manèbe		WP					0,77%	0
Manéfol 80			WP					2.31%	0
Previcur N	Propamocarbe-hydrochloride	Carbamates	SL	Crown rot	Affecting lipid biosynthesis			0,77%	0
Systhane	Myclobutanil	Triazinones	EC	oidium	Sterols Biosynthesis (IBS of group I)	Systemic	Preventive, curative	10 ;76%	21,05%
Rubigan	Fénarimol	H.A Pyrimidines	EC			Contact	Preventive, curative, eradicant	3,07%	0
Hexa 5% SC	Hexaconazole	H.A Triazoles	SC	oidium	Affecting lipid biosynthesis	Systemic	Preventive, curative, eradicant	3 ;84%	0
Bayfidan 250EC	Triadiménol		EC					5.38%	3,51%
Olymp	Flusilazole		EW				Preventive, curative	0%	1,57%
Topas 100EC	Penconazole		EC					2 ,31%	3,51%
Score 250EC	Difénoconazole		EC	Alternaria disease, Oidium				6,92%	3,51%
Sabithane	Dinocap+Myclobutanil	Amines (Phenol derivatives)+Triazinones	EC	oidium	uncoupling of oxidative phosphorylation +sterol biosynthesis (IBS of group I)	Contact + Systemic	Preventive, curative, eradicant	1,53%	0

Luna	Fluopyram+ Trifloxystrobine	Benzamide pyramide+H.A (strobilurins)	WG	Gray mold	+Inhibition of mitochondrial complex III	Systemic + Penetrant	Preventive, curative	1,54%	14,,03%
Stroby WG	Krésoxium-méthyl	H.A (strobilurins)	WG	oidium	Acts on respiratory processes, Inhibition of mitochondrial complex III	Contact	Preventive, eradicant	6,92%	1,57%
Signum	Boscalid+ Pyraclostrobin	Carboxamides (Nicotinamides) + H.A(Morpholines)	WP	Botrytis	Mito II +acting on sterol biosynthesis	Penetrant + Systemic	Preventive, curative, Eradicante	10,77%	3,5%
Ortiva	azoxystrobin	Strobilurins	SC	Oidium	Mitochondrial complex III Inhibitor	systemic	Preventive, curative, Eradicant	0,77%	14,03%

Table 6: Registered insecticides used by farmers in the Gharb region and the Loukkos perimeter

Specialties	Active Ingredients	Chemical Family	Formulation	Uses	Parts treated	Targests	Mode of action	Action	Number of farmers (Gharb)	Number of farmers(Loukkos)
Karaté 5EC	Lambda-cyhalothrine	Pyrethroids of synthesis	EC	Aphids, noctuids	leaves	Modulation at the level of the sodium channel	Contact	Ing/ n- syst	9,72 %	4,3 4%
Orytis	Acrinathrine		EW	Thrips	leaves		Contact		1,39%	0%
Decis	Deltamethrine		EC	Nematodes of soil	leaves		contact		5,56%	0%
Talstar 10EC	Bifenthrine		EC	whitefly, aphids, acariens, Codling moth	leaves		contact		1,39%	0%
Actara 25 WG	Thiamethoxam	Neonicotinoids	WG	whitefly, aphids	leaves	Acts on the synapse and neurotransmitters (acetylcholine receptor	contact	syst	5,56%	0%
Confidor	Imidaclopride	Derivatives of chloronicotinile	SL	whitefly, aphids	leaves	Acts on the synapse and neurotransmitters (acetylcholine receptor antagonist)	contact	Ing/ syst	16,67%	2,1 7%
Calypso	Thiacloprid	chloronicotinyls	SC	aphids	leaves	Acts on synapses	contact	Ing /	11,1%	19,

480SC						and neurotransmitters		syst		56 %
Salvador	Méthomyl	Carbamates	WP	whitefly, aphids Pucerons, Codling moth, leafminer	leaves	Inhibitors of acetylcholine esterase	contact	Ing / syst	9,72%	
Ghlala (MO)	Metaldehyde	Metaldehyde	GB	Snails, Slugs			contact	Ing	4,17%	6,5 2%
Klerat pellets (RA)	Brodifacoum	Hydroxyd-4-coumarine	RB	Rodents		Causing a hemorrhage in the rodent's body, death by		A-cog	9,72%	2,1 7%
Condor F (N)	1,3-Dichloropropèn	Derivatives of propene	EC	Nematodes Of soil	Soil treatme	Fumigant, nematicide action	contact	Ing / n-syst	0%	19, 56 %
Reldan 40EC	Chlorpyriphos méthyl	Organo-phosphorés	EC	Aphids, noctuids	Stored commo	Acts on the synapse and neuromediators (inhibition of achesterase)	contact	Ing / n-syst	2,78%	0%
Dursban	Chlorpyriphos -éthyl		EC	Insectes of soil	leaves		contact	Ing / n-syst	4,17%	15, 22 %
Némacur 240CS (N)	Phenamiphos		CS	Nematodes, insectes, fungi weeds	Treatm ent of soil	Nematicide, Inhibition of cholinesterase	contact	Syst,	4,17%	0
Avaunt 150 EC	Indoxacarbe	Oxadiazines	EC	noctuids Thrips	leaves	Action on axonal transmission	contact	Ing / n-syst	2,78%	0
Vertico 018EC	Abamectin	Avermectines	EC	Acariens	leaves	Activation of the chloride ion channel (GAB Aergic synapses)	Contact	Ing / n-syst	1,39%	8,6 9%
Abamec									2,78%	6,5 2%
Vertimec									5,56%	8,6 9%
Tracer 480SC	Spinosade	Spinozines	SC	thrips	leaves	Acts through inhibition of cholinergic receptor	Contact	Ing / n-syst	1,39%	6,5 2%

Ingestion: Ing; systemic: Syst; non-systemic: n-syst; Anticoagulant: A-cog

In agreement with Betnan et al., (2015) [24], the results showed that the majority of farmers in the Gharb and Loukkos regions used metam sodium as a good fumigant for soil disinfestation followed by dichloropropene.

Indeed, strawberry growers in the exploitations of this region suffer from several fungal diseases, weeds, and pests.

Farmers confirmed the problem posed by perennial and biennial weeds which is difficult to control because they have a network of roots that can emit new shoots. The active ingredients of the most used herbicides against weeds in strawberry plots are Paraquat which acts by inhibiting of photosynthesis, and Glyphosate which as a contact herbicide disrupts the synthesis of aromatic amino acids, these two herbicides act by foliar penetration and migration [33, 34, 35]. The factor risks of resistance development can be increased if the treatments are poorly done or are successions of doses too low to properly control the older plants [35].

In addition, the strawberry crop is heavily aggressed by thrips, mites, aphids, noctuids, nematodes, drosophila, snails, and rats encountered in the two regions studied, which allows farmers to use synthetic chemicals belonging to different families, of which pyrethroids, derivatives of chloronicotiniles and nitrogen heterocycles. These chemical families act by contact and ingestion on physiological functions (block of nerve impulse transmission) [34]. They have a limited efficacy to control thrips [36, 37, 38]. In agreement with Al betnan et al, (2015) [24], the farmers in Gharb and Loukkos strawberry fields used derivate of propene as a fumigant for reducing the damages caused by nematodes.

The occurring fungal diseases reported by interviewed farmers included oïdium, gray mold and anthracnose. However, many diseases caused by fungal species have been previously cited as affecting strawberry production such as powdery mildew caused by Sphaerotheca macularis, and crown rot caused by Phytophthora cactorum [38, 39], telluric infections caused by a complex of soilborne pathogens including Phytophthora. Sp., Verticillium dahlia, and Rhizoctonia solani [18, 21, 22, 24, 40]. The farmer respondents are unfortunately unaware of the emergence of resistance cases after pesticides application. The repeated use of the most used fungicides against gray mold and anthracnose causal agents as well as oidium leads to resistant strains development [19, 41, 42, 43, 44, 45, 47, 48, 49, 51, 52].

In this study, a screening of the applied phytosanitary products is carried out at the level of the perimeter of Gharb and Loukkos, allowed to show that the chemical control in the cultivation of strawberry trees is ensured by 38 chemical products belonging to 18 chemical families among which 50% are insecticides, 38.88% are fungicides and 11.11% are herbicides. These data are identical to those represented in the survey of pesticide use by suppliers and farmers in Gharb and Loukkos [27]. The diagnosis methods practiced by the dealers do not allow for a proper assessment of the different constraints, which plague the environment and consumer health.

The presented study indicates that strawberry growers in the Gharb-loukkos area use a large array of pesticides for pests, weeds, and fungal disease management. However, due to the low levels of education of the majority of participants in this investigation, and restricted knowledge towards appropriate practices, they will adopt bad attitudes and not use pesticide in accordance with regulation laws.

The negligence of the growers to exploit product label information constrained them to use any non- graduated materials. In this situation, no correct dose could ever be used can lead to high treatment costs, inefficient disease or pest control and resistance issue.

The bad diagnosis, lack of training on the correct amount of chemicals that should be used. can explain the high occurrence of fungal attacks and pests on strawberry fields which results in overuse of chemical and accentuate risk factors for the consumer. These considerations show that the use of pesticides in both areas must be taken more seriously.

It will be paramount for farmers and managers of phytosanitary boxes to receive training on crop pest characteristics and the use of the main phytosanitary products, to establish contacts with research institutes and technical services of the ministry in charge of agriculture, and to read the phytosanitary index published by the Moroccan Association of Plant Protection (AMPP).

It is recommended that ONSSA (National Office for the Sanitary Safety of Food Products) and ONCA (National Agricultural Council Office) strengthen the system of supervision of producers through the generalization of good agricultural practices. Education, training, and information on the use of pesticides and their residues should be made available to farmers in the agricultural perimeter. In addition, more investigations are needed to evaluate the potentially toxic effects of the most common pesticides used to control strawberry pests. The diagnosis methods practiced by the dealers do not allow for a proper assessment of the different constraints, which plague the environment and consumer health.

The presented study indicates that strawberry growers in the Gharb-loukkos area use a large array of pesticides for pests, weeds and fungal disease management. However, due to low levels of education of the majority of participants in this investigation, and restricted knowledge towards appropriate practices, they will adopt bad attitudes and not use pesticide in accordance with regulation laws.

The negligence of the growers to exploit product label information constrained them to use any non- graduated materials. In this situation, no correct dose could ever be used can lead to high treatment costs, inefficient disease or pest control and resistance issue.

The bad diagnosis and the non-respect for the used doses constitute risk factors for the consumer. These considerations show that the use of pesticides in both areas must be taken more seriously.

It will be paramount for farmers and managers of phytosanitary boxes to receive training on crop pest characteristics and the use of the main phytosanitary products, to establish contacts with research institutes and technical services of the ministry in charge of agriculture, and to read the phytosanitary index published by the Moroccan Association of Plant Protection (AMPP).

It is recommended that ONSSA (Office National de la Sécurité Sanitaire des Produits Alimentaires) and ONCA (Office National des Conseil Agricole) strengthen the system of supervision of producers through the generalization of good agricultural practices. Education, training and information on the use of pesticides and their residues should be made available to farmers in agricultural perimeter. In addition, more investigations

are needed to evaluate potential toxic effects of the most common pesticides used to control strawberry pests.

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