

Research Article

Assessment of pesticides use effects on honeybee colonies and its financial impact in some selected districts of Bale Zone, South Eastern Ethiopia

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Abstract

The existence of honeybees in the ecosystem has a significant effect in worldwide agricultural production. While searching for food, the honeybee is often exposed to several contaminants or poisoning materials such as plant protection products like pesticides. The aim of this work was to assess and identify the effect of commonly used pesticides from various groups (herbicides, insecticides, and fungicides) on honeybees' health and their products. For the study, purposive sampling was used in selecting the districts and Rural Kebeles (RKs) while random sampling was used in selecting sample enumeration sites and respondents from each household. For the analysis, SPSS statistical software package version 20 and descriptive statistics were used to determine the effects of pesticides on honeybees. The result showed that from a total of 138 farmers interviewed, 97.1% were pesticide users. Out of the total pesticides used in the area, it was categorized 55.80% as herbicides, 18.80% as insecticides, and 25.36% as fungicides. The current assessment indicated that 72.46% of pesticides were applied in the main cropping season and only 27.54% applied in the second cropping season and 50% of them have chosen early morning (6:00-12:00 am) as an appropriate time to spray. According to this study, 66.67% apply pesticides before the crops blooming, 30.43% both before and during the crops on blooming, and 2.90% of farmers were non-chemical users. As sample respondents reported only 50.7% of the beekeepers located their apiary site by considering the distance between the apiary site and farmland. The current assessment showed that as a negative result of pesticides on honeybees 914, 1012, and 335 loss were recorded due to mass dead, absconded, and dwindled in the study area respectively. It was also assessed that the economic loss that occurred was anticipated due to the honeybees colony dead, absconded, and dwindled were 198,728.15, 220,922.45, and 73,227.49 US\$ respectively in the study districts. The result revealed that 71.7% of sample respondents are not aware of the proper use of pesticides. Therefore, it is important to note that well programmed and organized training is required for both crop producers and beekeeper farmers in Ethiopia and particularly in Bale where the belt of wheat and barley production is very high and requires heavy pesticides.

Introduction

Pesticides are extensively used worldwide in agriculture to protect crops and in public health to control diseases. They include many chemicals, mostly in the classes of insecticides (e.g., organochlorines (OCs), organophosphates (OPs), carbamates (CAs), pyrethroids (PYRs) and neonicotinoids (NEOs), herbicides (e.g., acid herbicides), and fungicides (e.g., azoles) [1]. Many regions of the world have reported honeybee losses in recent years[2]. These deaths are of great concern, because declines in bee populations may have significant

and far-reaching consequences. They could affect for some crops pollination and disturb the stability of the agricultural ecosystems, which also damages beekeepers' prediction, agribusiness and the whole of society livelihoods. Pollination is a very important ecosystem service for food production and maintenance of biodiversity[3].

The increasing demand for food has forced farmers to use more mineral fertilizers and pesticides to generate higher yields [4]. The residues of these substances in the form of contaminants are then transferred into grains, vegetables,



and fruit [5]. While working on flowers, bees are exposed to direct and indirect contact with pesticides which, depending on the mode of action and the concentration of active substance, can lead to sudden death of pollinating insects or cause death within a couple of hours following exposure [6]. It becomes dangerous when the level of pesticides or their residues in a beehive becomes high enough to adversely affect the functioning and development of larvae [7]. Bees are highly susceptible to environmental changes and pollution, which is strongly reflected in the significant decrease of their survival rate [8].

The introduction of pesticide in Ethiopia to control agricultural pests' dates back to the 1960's [9]. Although, the volume fluctuates across the pesticide types, the country on the average imports 3346.32 metric tons of pesticides annually [10]. Using pesticides are widely spread following modern agriculture and areas with high crop farming parts of Ethiopia are yearly receiving different types and amounts of pesticides, especially in the highland of Bale where is the belt of wheat and Barley production in the county, the use of Agricultural pesticides are very high and its impact on honeybees are also very dangerous. Farmers who produce primarily cereals, pulses and horticultural crops are use various types of herbicides, insecticides and fungicides without due consideration of the damage on honeybee colonies. A number of bee colonies either die or abscond from their hives due to the extensive use of agrochemicals [11]. Today unwise application of herbicides and various pesticides are killing number of honeybee colonies annually and thus have become critical in the development of Apiculture sub sector.

Therefore, the aim of this study was to assess and identify the impact of commonly used pesticides for various purposes (herbicides, insecticides, fungicides) on honeybee health and their products in Bale, Southeastern Ethiopia.

Materials and methods

The study was conducted in Bale Zone of Oromia Regional State which is located in Southeastern part of Ethiopia within 7°, 0'N and 39° 45'E and 7°, 30'N and 39°, 30'E of latitude and longitude, respectively [12]. Three districts, namely Agerfa, Goro and Dellomena of Bale Zone had considered for this study. Three Rural Kebeles (RKs) from each district, in total nine RKs were selected as survey sites. From Agerfa 47, Goro 45 and Dellomena 46 and a total of 138 beekeepers from the three districts were interviewed on pre-structured questionnaires for their attitudes and knowledge on the side effects of pesticides on bees' and their products. Also checklists were prepared and framers' perceptions were collected through focused group discussions from each RK.

In addition, pesticides and veterinary drug shops were included in the assessments. The selections of RKs were done based on the potential they have for beekeeping (forest cover/bee forage, existing practices etc), their access to road and service providers, and practices of irrigation for high value crops and pesticides effects. Purposive sampling was used in selecting the districts and RKs while random sampling was

used in selecting sample enumeration sites and respondents from each household.

Data management and analysis

The study was based on single-visit-multiple-subject formal survey methodology. All the collected data were properly coded and entered into an Excel spreadsheet, cleaned, verified and analyzed. The analysis was done using SPSS statistical software package version 20. Descriptive statistics was used to determine the effects of pesticides on honeybees. In addition, tables and graph were used with respect to the given variables, and the analyzed data and the major findings were reported as district's information.

Results and discussions

Demographic characteristics

From the total of 138 households interviewed, 68.84% were beekeepers and 31.16% non-beekeepers. The survey result indicated that majority (68.12%) of respondent's age participated in study was found between 26-65 years. Similar report was reported that the most productive age are actively involved, accommodating experiences from elders and finally become independent beekeepers [13,14]. Regarding the educational level of sample respondents, 6.5% were illiterate, 10.1% were learned basic education, 65.9% attended primary school, 16.7% of them completed secondary school and (0.7%) were complete college education (Table 1).

Table 1: Educational level of Sample Respondents.

No.	Educational level	Frequency	Percentages (%)
1	Illiterate	9	6.5
2	Basic education	14	10.1
3	Primary school (G 1-8)	91	65.9
4	Secondary school (G 9 -12)	23	16.7
5	Complete college	1	0.7
	Total	138	100

Commonly used types of pesticides

Honeybees provide an essential ecosystem service to both natural and agricultural ecosystems worldwide. However, in recent years honeybees are threatened by a number of pesticides poisoning and particularly in developing countries like Ethiopia, the problems are very high due to low awareness of the farmers. From the total 138 sample respondents, 97.1% were pesticides users in crop production and only 2.9% were none pesticides users in the study area. It indicated that majority of the farmers in Bale used pesticides for crop production and they were used as an option of control mechanisms to weeds, insects and fungus(rust). However, the amount and type of pesticides users are differ between agro-ecologies (high, mid and low land) and the numbers and type of pesticides users were higher at high land area according to the respondent response. This report in agreement with previous study conducted by [15].

In the present assessment different types of pesticides were listed by sample respondents in the study area which were commonly used for agricultural crop production. Accordingly they had categorized about 55.80% as herbicides, 18.80% as insecticides, 25.36% as fungicides out of the total pesticides used in the area. This report is in agreement with previous report from Amhara Region of Ethiopia [15]. The major pesticides listed by farmer respondents were Pallas, 2,4-D, Roundup, Topic, Atlantis, Tilt, Natura, Diamethiote, Rexcido and Malathion in the study districts. Similar report were reported from West Shoa of Oromia in Ethiopia major Pesticides (45- OD (Pallas), 2,4-D, U-46, Roundup), (Ridomil), (Malathion/Ethiolathion 50%, Diaznon, DDT, Dursban 48% EC, Karate, Endosulfan, Tilt, and Baylathone) [16]. In Ethiopia, several shops are selling pesticides, and farmers have easy access to pesticides [17]. In addition, pesticides found in drug shops and unions were assessed and its lists with category, target pest and rate of application used were listed in Table 2.

Time of pesticides application

In the study area there are two main cropping season. The current assessment indicated that about 72.46% of pesticides applications are done in August, September, October and November (main cropping season) and 27.54% applications are done in March, April and May (the second cropping season) in the study districts. This result is in agreement with previous report who same case reported from Amhara region of Ethiopia [15]. According to the results of this survey the respondents apply the chemicals as liquid spray were about 50% of the users' prefer in morning 6:00-12:00 as appropriate spray time, 16.67% apply at after noon (1-6 pm) and about 30.43% sprayed at any time of the day. Similar issues reported the majority of the farmers (64.4%) have chosen early morning (before the start of bees' normal activities) as appropriate time to spray [15]. From this result it could be concluded that appropriate time selection is very important to keep the health of honeybees and other insect pollinators. However, during focused group discussions when they were asked "Is time of chemical application have effect on honeybees?" and they replied "YES" specially during afternoon when the sun is shine and the activities of honeybees are very active, its effect are very dangerous. All of the farmers were used Knapsack to spray the chemicals. Also, out of the total interviewed farmer about 74.64% of the respondents apply once, 19.56% twice and 2.9% apply more two times for herbicides control. For insecticides those apply once 17.39%, twice 5.07% and 11.59% applies more than twice for control. For fungicides (Rust and related diseases) apply only once 23.91%, twice 16.67% and more than twice 31.88% respectively as sample respondent replied (Table 3). The same case reported from Bule Hora Districts of Ethiopia majority of farmers use pesticides four times per year [18]. Moreover, some of the respondents mentioned as they were used combination of different pesticides like herbicides with fungicides. When they required why? because they want to save their time and frequency of spraying and other materials like water. From this result it is possible to conclude that as the frequency of pesticide application is rising, its effect on honeybees and their products is increasing and then causes

Table 2: Commonly pesticides found in Drug shops and Union in the study area.

No.	Common Name	Pesticides Category	Target Pest	Rate of Application (L/ha)
1	45-OD Pallas	Herbicides	weed	0.5
2	2,4-D	Herbicides	weed	1.5
3	Topic	Herbicides	Weed	0.012
4	Round up	Herbicides	Weed	3
5	Atlantis	Herbicides	Weed	0.5
6	Karate	Herbicides	Weed	1.5
7	Supergalant	Herbicides	Weed	1
8	Galigal	Herbicides	Weed	0.5
9	Stop	Herbicides	Weed	1
10	Green star	Herbicides	Weed	1
11	Glycell	Herbicides	Weed	3-4
12	Glywoud	Herbicides	Weed	3-4
13	Gallunt	Herbicides	Weed	0.5
14	Diclotop	Herbicides	Weed	0.5
15	Methabenthiazuron	Herbicides	Weed	1.5
16	Terminator	Herbicides	Weed	3-4
17	Glyfose	Herbicides	Weed	3-4
18	Mancozeb	Fungicides	Rust	0.5
19	Natura	Fungicides	Rust	0.25
20	Tilt	Fungicides	Rust	1
21	Ridomel	Fungicides	Rust	2
22	Rexcido	Fungicides	Rust	0.5
23	Tutan	Fungicides	Rust	0.5
24	Jaba	Fungicides	Rust	0.5
25	Confidence	Fungicides	Rust	0.75
26	Nativo	Fungicides	Rust	0.5
27	Rebus	Fungicides	Rust/Fungus	0.5
28	Amstur	Fungicides	Rust/Fungus	0.75
29	Mancolaxyl	Fungicides	Rust/Fungus	0.5
30	Prayor	Fungicides	Rust/Fungus	0.5
31	Matco	Fungicides	Rust/Fungus	0.5
32	Cropaxyl	Fungicides	Rust/Fungus	0.5
33	Baylathion	Fungicides	Rust/Fungus	0.5
34	Trycell	Fungicides	Rust/Fungus	1
35	Malathion/Ethiolathion	Insecticides	Insects	0.75
36	Perfecto	Insecticides	Insects	0.5
37	Dimethiote	Insecticides	Insects	0.5
38	Globe	Insecticides	Insects	0.5
39	alpha-cyproid	Insecticides	Insects	0.5
40	Decis	Insecticides	Insects	0.75
41	Crust	Insecticides	Insects	1
42	Diaznone	Insecticides	Insects	0.5
43	Proven	Insecticides	Insects	0.75
44	Carbaryl	Insecticides	Insects	0.5
45	High way	Insecticides	Insects	0.5
46	Profit	Insecticides	Insects	0.75
47	Helerat	Insecticides	Insects	0.5
48	Agronumbal	Insecticides	Insects	0.5
49	Megabinc	Insecticides	Insects	2
50	Selecrone	Insecticides	Insects	0.5



the farmers uses non-selective chemicals in the area for on un ploughed farm land to use zero tilling and when they sprayed chemicals mass number of honeybees were dead on the field.

According to the present study conducted, only 50.7% of the beekeepers located their apiary site by considering the distance between apiary site and farm land which is annually receiving pesticides and about 49.3% of interviewed farmers were didn't take any consideration when they could establish their apiary sites. Similar report, stated that more than 74% of the beekeepers didn't locate their apiary by considering the distance between apiary site and farm land [15].

Estimated financial loss

As sample respondent mentioned, losses occurred because of pesticides' negative effects on honeybees were calculated by analyzing the number of honeybee colonies dead, absconded and dwindled in 2018/19 (Table 4). In general as sample respondents mentioned 914, 1012 and 335 bee colonies were recorded dead, absconded and dwindled in the study area respectively. But, there are difference among the number of honeybee colonies dead, absconded and dwindled between the assessed districts and the highest loss was reported in Dellomenna district followed by Agerfa district. Similar report had reported the case from East Shoa and West Arsi Zones of Oromia regional state, Ethiopia [21]. Indicating that yearly, beekeepers had lost huge amount of economy from apiculture sub-sector.

From the current assessment the economic loss occurred were anticipated due to the honeybees colony dead, absconded and dwindled were 198,728.15, 220,922.45 and 73,227.49US\$ respectively in the study districts. Different scholars have also documented that; the use of different pesticides could lead to a significant reduction of foraging activity of honeybees [8,22-24]. However, the highest economic loss due to honeybees colony dead and dwindled was recorded in Agerfa district and the highest loss due to absconding was reported in Dellomenna District (Table 5). Likewise, there are variations between the districts in economic loss and the highest loss was recorded in Dellomenna district. However, during survey work other factors didn't considered when collecting the data like migration of honeybees colony, bee diseases, honeybee pests and predators which might results in the total economic reduction or losses from honeybees colony and that is why the total economic loss seems very high.

Extension services

In the current study, from 138 sample respondents 71.7% had no get any kind of training or extension services on how

Table 4: Average honey yields and number of honeybees colony loss occurred in the assessed Districts.

Districts	Average honey yield (kg/col)	Average honey price per kg (USD)	Average No. of honeybees colonies			Total honeybees colony loss
			Dead	Absconded	Dwindled	
Agerfa	16.45	4.39	1529	673	90	2292
Goro	14.53	5.00	797	912	349	2058
Dellomenna	17.24	4.24	416	1451	566	2433
Average	16.07	4.55	914	1012	335	2261

Table 5: Total financial losses reported in USD.

Districts	Loss occurred in USD due to			Total loss in USD
	Death	Absconded	Dwindled	
Agerfa	110,417.50	48,601.03	64,99.40	165,517.93
Goro	57,902.05	66,256.80	25,354.85	149,513.70
Dellomenna	30,408.60	106,064.62	41,373.24	177,846.46
Total economic loss	198,728.15	220,922.45	73,227.49	492,878.09

and when to use pesticides and only 28.3% had get training or extension services. This result indicated that there is huge gap on awareness creation for pesticides users and its impact on honeybees. Similar case was reported as about 93.1% of respondents do not have awareness concerning safe utilization and handling of agrochemicals [16]. Previous studies showed that most of the farmers in Ethiopia do not have awareness about pesticides used and its effect on honeybees and other pollinator insects [15,21]. From this study, it is important to noted that well programmed and organized training is required for both crop producers and beekeeper farmers in Ethiopia and particularly for Bale Zone of Oromia region where is the belt of wheat and barley production is very high which required heavy pesticides.

Conclusion and recommendation

The present study results showed that honeybee colonies and productions are affected by a number of pesticides. In the study area, farmers uses different pesticides to control weeds, insects and fungus. Due to this result, pesticides have caused huge effects in causing massive death of honeybees and falling their products. About 71.7% of the respondents had never get any kind of trainings or extension services concerning honeybee poisoning. Therefore, it is important to note that well programmed and organized training is required for both crop producers and beekeeper farmers in Ethiopia and particularly in Bale where the belt of wheat and barley production is very high which required heavy pesticides. In addition policy makers should know the issues as huge economy lost due to pesticides effect and they must develop and implement effective strategies to minimize the negative of pesticides on honeybees.

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Table 3: Category of pesticides used in percentages.

Spraying times	Types of chemical used in percentages		
	Herbicides	Insecticides	Fungicides/diseases
Once	74.64	17.39	23.91
Twice	19.56	5.07	16.67
More than twice	2.90	11.59	31.88
None-user	2.90	65.94	27.53



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