Pests and Pesticide Use in Flower Farms in Ethiopia

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Abstract

Floriculture is making a remarkable contribution to the Ethiopian economy. Currently the country is exporting cut flowers of roses, carnation, *Geranium* and *Chrysanthemum* cuttings, *Gypsophylla*, *Hypericum* and other bed plants to Europe. America, Middle-East and lately to Russia. Among these, roses are most dominant and contribute to 80% of the total cut flower production and export. Pests are among the most important production and quality limiting factors in flowers. The major ones are downy mildew (*Peronospora sparsa*), powdery mildew (*Sphaerotheca pannosa*) and gray mould (*Botrytis cinerea*), bacterial blight (*Erwinia chrysanthemi*), spidermites (*Tetranychus urticae, Pononychus* sp.), flower thrips (*Frankniella* sp.), cotton aphids (*Aphis gossypii*), flea beetles, sciaride fly (*Bradysia* spp.), leaf hoppers, termites and leaf minors (*Liriomyza* spp.). Flower production relies on intensive use of pesticides. Due to lack of pesticides registered for flowers in the country the government made special arrangement for importing pesticides without following the formal registration procedures until the local efficacy data will be generated by research. Currently pesticides already in use by the flower farms are being assessed and evaluated by the Ethiopian Institute of Agricultural Research (EIAR) and selected ones be recommended for registration. Surveys showed that 202 pesticides were in use to control pests in flower farms. Of these 168 (83.17%) were selected and recommended for registration. So do two stickers, 12 hormones, three post harvest handling agents, and one pH-reducer. Hereafter the newly coming flower pesticides are expected to be subjected to the regular pesticide testing and registration procedures of the country.

Introduction

Flower production in Ethiopia started around Ziway in 1984 by a Deutch grower in State operated farms. The production was concentrated on summer flowers and had reached to size of 159 ha in the year 1987, but declined sharply to 8 ha in 1999 (Adhanom 2006). To date more than 120 companies are registered to produce flowers of which nearly 40 have started exporting their products (Lemlem, 2006; Tsehay Azage personal communication). At present, over 1000 hectares of land is under flower production in greenhouses and open fields. Although the flower industry is a relatively new venture to Ethiopia, it has made remarkable contributions to the economy of the country within a short period of time. The sector has created more than 25 000 job opportunities at different levels. It has increased the diversity of exported commodities for foreign currency earning.

A number of factors limit flower production, the complex pest problems being the most important (Larson 1992). These pest problems require long- and short-term control strategies. As floriculture is a new venture in Ethiopia, emphasis was given mainly to pesticides for the control of its pests. But, there is no pesticide registered for use on flowers in the country. Lack of appropriate greenhouses in the research institutions prohibited the evaluation of pesticides to generate local efficacy data required for registration. Attempts made to conduct trials in greenhouses of the commercial flower farms were not successful because of the interferences made

due to the routine pesticide applications and other activities. These activities affected treatments and collection of data for pesticide testing (Eshetu Bekele personal communication). On the other hand, the special decree issued by the Ethiopian government in 1990 prohibits the import, production and distribution of pesticides not registered in the country based on local efficacy data.

However, the flower farms were exempted from this requirement and were allowed to import all kinds of pesticides required for flower farms. Consequently, numerous pesticides have been imported and are being imported, and some of them are being traded in the market. This situation need not continue for long because of the risks associated with such practices. A simple case in point is the accumulation of obsolete pesticides, which is costing the country a huge amount of foreign currency to incenerate them elsewhere in developed nations where they have the facilities to do so. The problem was raised and discussed by the concerned bodies in different forums and an agreement was reached among stakeholders that pesticides which are already in use by the farms should be assessed and evaluated by the Pesticide Research Committee (PRC) of EIAR and selected pesticides be recommended for registration in the country. Therefore, the objectives of this study were to make inventory of pesticides and related chemicals (hormones, pH-reducing agent and post-handling agents) currently in use in flower farms and make recommendations for the registration of selected pesticides based on established criteria such as Milieu Programma Sierteelt (MPS) Code List 2006 of Kenya, Tanzania and Uganda, MPS Code List 2006 of Holland, MPS Code List 2005 of Ethiopia and Kenya Pesticides Registration Booklet 2006. Moreover, taking the inventory of pests in flower production was an objective of this survey.

Survey Methodology

Surveys on pests and pesticide use in different flower farms of Ethiopia were made in February and April 2006. List of farms were obtained from the Plant Protection and Regulatory Department (PPRD) of MOARD, Addis Abeba. Visits were made to select farms that have started exporting flowers. The survey in February and April 2006 covered 12 and 23 farms, respectively.

During both surveys questionnaires were issued and distributed to each of the farms to be filled out by the concerned plant protection experts. Moreover, discussions were made with relevant individuals in the different farms. The efficacy of each pesticide used in the farms on the pests they were intended to control were rated using a 1-3 scale by protection experts of the farms, where 1= most effective, 2= very effective and 3= effective. Pesticides mentioned by the different farms were listed and checked for their registration in the:

1) Milieu Programma Sierteelt (MPS) Code List 2006 of Kenya, Tanzania and Uganda,
2) MPS Code List 2006 of Holland,
3) MPS Code List 2005 of Ethiopia, and
4) Kenya Pesticides Registration Booklet 2006.

Data were also collected on the type of flowers grown, production capacities, pest problems, pesticides in use and problems associated with their use, their efficacy, and growers' perception.

Results

Types of flowers grown and associated pests

Table 1 depictes the types of flowers produced in the surveyed farms with their respective location and production area. The most common flowers produced in the different farms in Ethiopia are roses, *Geranium* cuttings and other bed plants, carnation, *Chrysanthemum* cuttings, *Gypsophylla* and *Hypericum*. Carnation is produced by DRY business and Ethiopian Magical Farm. Spirit PLC and Jericho produce *Gypsophylla*, while Maranqua Plants produces *Chrysanthemum* cuttings. Red Fox Ethiopian and Ethiopian Cuttings produce *Geranium* and other bed plants of more than 100 species. The majority of farms (77.2%) were producing roses. About 74% of the total area was coved by roses while other flowers and bed plants were produced on 26% of the area (Table 1).

Pests were one of the most important bottlenecks of flower production in general. The tolerance limit is almost nil for all pests due to their damage on the esthetic value of flowers. Based on their frequency of occurrence and their importance in the farms, they were grouped as major, medium and minor pests.

Table 1. Lists of flower farms surveyed in 2006

No	Name of farms	Location	Total farm size (ha)	Current farm size (ha)	Type of flower grown
1	A Flower	Holetta	14	4	Roses
2	Abyssinia Flowers	Sendafa	17	12	*Hypericum inodum*, *Eryngium* sp.
3	Arsi Agri. Mechanization Service	Holetta	12	10	Roses
4	Dire Highland Flower	Holetta	35	5	Roses
5	Dugda Floriculture Development	Debre Zeit	20	12	Roses
6	DYR Business	Teji	30	6	Carnation
7	ENYI Ethio Rose	Kara Kore	35	15	Roses
8	ET Highland Flora	Sebeta	21.1	12.2	Roses
9	Ethio Agri. Ceft	Holetta	28	7.1	Roses
10	Ethio Dream	Holetta	8.5	8.5	Roses
11	Ethiopian Cuttings	Koka	94	20	Geranium & other bed plants
12	Ethiopian Magical Farm	Sendafa	20	10	*Hypericum inodum*, Carnation
13	Flowerensis Ethiopia	Koka	20	2	different ornamental plants (100 species)
14	Garad	Holetta	28	2.4	Roses
15	Golden Rose Agro Farm	Tefki	7	7	Roses
16	Holetta Rose	Holetta	15	10	Roses
17	J.J. Kottari	Sululta	35	4.2	Roses
18	Jericho Flowers	Menagesha	7	3	*Gypsophylla*, Roses
19	Joy Tech	Debre Zeit	40	13	Roses
20	Linssen Rose	Addis Alem	40	30	Roses
21	Mam Trading	Sendafa	40	5	Roses
22	Maranque Plants	Sodere	30	4	*Chrysanthemum* (cuttings)
23	Menagesha Flowers	Menagesha	32	5	Roses
24	Metrolux Flowers	Holetta	22	2.6	Roses
25	Minaye Flowers	Debre Zeit	20	6	Roses
26	Oda Flower	Alem Gena	20	6	Roses
27	Red Fox Ethiopia	Koka	100	24	*Geranium* & other bed plants
28	Rose Ethiopia	Holetta	22	13	Roses
29	Sheba Flowers	Melka Kunture	20	5	Roses
30	Siete Agro	Addis Alem	13.13	7.5	Roses
31	Spirit Plc	Debre Zeit	11.7	11.5	*Gypsophylla*
32	Summit Agro Industry	Wonji	75	16.5	Roses
33	Top Flowers	Holetta	13	8	Roses
34	Yosef Firdu Flower (Joeflower)	Holetta	10.3	6	Roses
35	Zeway Roses	Zeway	28	27	Roses

The most prevalent arthropod pests reported in flower farms were spider mites (*Tetranychus urtcae* and *Pononychus* sp.), thrips (*Frankliiniella* sp.), aphids (*Aphis gosypii*), leafhoppers, sciaride flies (*Bradysia* spp.) and different caterpillars (Table 2). Among these, spider mites were the most important while flower thrips, cotton aphids and caterpillars (different species) were classified as medium pests on roses. Flower thrips and cotton aphids were reported to attack all types of flowers.

The diseases recorded on flowers in the country are presented in Table 3. Downy mildew (DM), powdery mildew (PM), gray mold (*Botrytis* blight), *Rhizoctonia* stem rot, *Fusarium* and *Phytophthora* blights were the most frequently recorded and important diseases in the sector. Nematodes especially root knot nematodes were noted on roses and *Gypsophylla* (Table 3).

Pesticides

A total of 96 products consisting of insecticides, acaricides and nematicides were in use in the flower industry of which 77 (80.21%) were recommended for registration (Table 4). From the recommended chemicals 72, 3 and 2 products were registered in MPS-Code-List 2006 of Kenya, Tanzania and Uganda/, MPS-Code List 2006 of Holland and Kenya Pesticides Registration Booklet 2006, respectively. Forty products recommended for registration are in use against red spider mites.

Nineteen products were rejected because they are neither in MPS-Code List 2006 Kenya/Tanzania/Uganda and Holland) nor registered in Kenya (except Temik) (Table 5). Though Temik is included in MPS list the growers agreed not to use it in the country due to its toxicity. Devipan and Thionex were rejected because they were prohibited by the MPS.

Table 2. Major arthropod pests recorded on flowers in Ethiopia

Flower plants	Arthropod	Scientific name	Status
Roses	Two-spotted Spider mite*	*Tetranychus urticae*	major
	Red spider mite*	*Pononychus* sp	major
	Flower thrips*	*Frankliniella* sp.	medium
	Cotton aphid *	*Aphis gossypii*	medium
	Caterpillars	different species	medium
Hypericum	Flower thrips	*Frankliniella* sp.	major
	Cotton aphid	*Aphis gossypii*	major
	White fly	*Trialeurodes vaporarium*	major
	Flea beetles	?	major
	Flower thrips	*Frankliniella* sp.	major
Carnation	Cotton aphid	*Aphis gossypii*	major
	White fly	*Trialeurodes vaporarium*	major
Geranium/ other bed plants	Flea beetles	?	major
	Flower thrips	*Frankliniella* sp.	medium
	Sciaride flies	*Bradysia* spp.	major
	White fly	*Trialeurodes vaporarium*	medium
	Caterpillars	different species	medium
	Cotton aphid	*Aphis gossypii*	minor
Gypsophylla	Two-spotted Spider mite	*Tetranychus urticae*	major
	Red spider mite	*Pononychus* sp.	major
	Flower thrips	*Frankliniella* sp.	major
	Cotton aphid	*Aphis gossypii*	major
	Leaf hoppers	?	major
	Termites	?	major
	Leaf minors	*Liriomyza* spp.	major
Chrysanthemum	Cut worms	*Agrotis* spp.	major
	Two-spotted Spider mite	*Tetranychus urticae*	major
	Red spider mite	*Pononychus* sp.	major
	Flower thrips	*Frankliiniella* sp.	major
	Cotton aphid	*Aphis gossypii*	major

*Mohammed Dawd, Shimelis Getnet & Waktola Wagari 2004, ?= unknown

Table 3. Major diseases recorded on different flowers in Ethiopia

Flower plants	Diseases	Causal agent *	Status
Roses	Downy mildew	*Peronospora sparsa*	major
	Powdery mildew	*Sphaerotheca pannosa* var. *rosae*	major
	Botrytis blight	*Botrytis cinerea*	major
	Black spot	*Diplocarpon rosae*	minor
	Rust	*Phragmidium* sp.	minor
	Crown gall	*Agrobacterium tumefaciens*	minor
	Dieback	*Diplodia* sp.	minor
	Cankers	?	minor
	Root knot nematodes	*Meloidogyne* spp.	minor
Hypericum	Rhizoctonia stem rot	*Rhizoctonia solani*	major
	Fusarium wilt	*Fusarium oxysporum* f.sp. *dianthi*	major
	Botrytis blight	*Botrytis cinerea*	major
Carnation	Rhizoctonia stem rot	*Rhizoctonia solani*	major
	Fusarium wilt	*Fusarium oxysporum* f.sp. *dianthi*	major
	Botrytis blight	*Botrytis cinerea*	major
	Fusarium stem rot	*Fusarium* spp.	Minor
Geranium and other bed plants	Powdery mildew	?	major
	Botrytis blight	*Botrytis cinerea*	major
	Root & crown rot	*Rhizoctonia solani*	major
	Root & crown rot	*Pythium ultimum*	major
	Phytophthora	*Phytophthora* spp.	major
	Alternaria leaf spot	*Alternaria tenuis*	minor
	Downy mildew	?	minor
Gypsophylla	Rhizoctonia stem rot	*Rhizoctonia solani*	major
	Fusarium Wilt	*Fusarium oxysporum*	major
	Phytophthora crown rot	*Phytophthora parasitica*	major
	Powdery mildew	?	minor
	Nematodes	*Meloidogyne* spp.	minor
Chrysanthemum	Gray mold	*Botrytis cinerea*	major
	Bacterial blight	*Erwinia chrysanthemi*	major

* ?= unknown

Fungicides

A total of 104 fungicides were in use by growers of which 89 products (85.58%) were recommended for registration (Table 6). Similarly, 81 products were found in MPS Code List 2006 of Kenya, Tanzania & Uganda/, one product in MPS Code List 2006 of Holland, three products in MPS Code List 2005 of Ethiopia and four products registered in Kenya 2006.

Fifteen fungicides were rejected because they were not found in any of the MPS-Code Lists used (Table 7). Since methyl-bromide is an extremely toxic, its importation was considered to be decided case by case by the Crop Protection and Regulatory Department of MOARD. Methyl bromide is being banned in the developed countries.

Herbicides, stickers and hormones

Two herbicides, two stickers, 12 hormones, three post harvest handling agents, and one pH-reducer were suggested for registration for use in floriculture (Table 8).

Table 4. List of insecticides, acaricides and nematicides recommended for registration

No	Active ingredient	Trade name	RK	Code	*Efficacy	Target Pests
1.	Abamectin	Akrimactin 1 8 EC		3098 Eth	1	Spider mites
2.	Abamectin	Dynamec 1.8 EC	K1	3069	1.2	Spider mites, aphids & thrips
3.	Abamectin	Spidermec 018 EC	K1	3290	1.2	Spider mites, thrips
4.	Abamectin	Vertimec		3231	1	Spider mites, thrips
5.	Abamectin	Abalone 18 EC	K1	3442	2	Spider mites
6.	Abamectin	Romectin	K1	3418	1	Spider mites
7.	Acephate	Ace	K1	3329	1.7	Aphids, thrips, caterpillars, whitefly
8.	Acephate	Orthene 75 SP	K1	3027	2	Aphids, thrips, caterpillars
9.	Acetamiprid	Golan 20% SC	K1	3490	1.3	Aphids, thrips, leaf minor, flea beetle
10.	Acetamiprid	Mospilan 200 SP	K1	3491	2	Aphids
11.	Acrinathrin	Rufast 75 EW	K3	3118	1	Spider mites, aphids, thrips
12	Alpha-cypermethrin	Fastac 10 EC	K1	3013	2.2	Spider mites, aphids, thrips, caterpillars, whitefly
13.	Amitraz	Kilitac		3423	1.9	Spider mites, whitefly
14.	Amitraz	Mitac 20 EC	K1	3025	1.4	Spider mites, whitefly
15.	Azadrachtin	Achook 0 15 EC	K3	3302	-	Caterpillars, nematodes
16.	Azocyclotin	Peropal 25 WP	K2	3018	-	Thrips, spider mites
17.	*Bacillus thuringiensis*	Turex 50 WP		11702 Holland	1	Caterpillars, whitefly
18.	*Bacillus thuringiensis*	Xentari	K1	3084	-	Caterpillars
19.	Beta-cyfluthrin	Bulldock 25 EC	K1	3196	2.5	Thrips
20.	Bifenazate	Floramite 240 SC	K1	3313	2	Spider mites
21.	Bifenthrin	Brigade 25 EC	K1	3066	2	Spider mites, aphids, thrips, caterpillars, whitefly
22.	Bifenthrin	Talstar 100 EC	K1	3364	1	Spider mites, thrips
23.	Bromopropylate	Neoron 500 EC	K1	3111	1	Spider mites
24.	Buprofezin	Applaud 40% SC	K1	3373	1	Whitefly
25.	Cadusafos	Rugby 100 ME	K3	3176	1	Nematodes
26.	Carbofuran	Furadan 350 ST	K1	3368	1	Termites
27.	Chlorphenaphyr	Secure 36 SC	K3	3089	1.5	Spider mite, caterpillars, whitefly
28.	Chlorpyrifos	Dorpas		3278	2	Caterpillars
29.	Chlorpyrifos	Dursban 4 EC	K1	3011	2	Caterpillars
30.	Chlorpyrifos	Pyrinex 48 EC	K1	3294	2	Caterpillars
31.	Clofentezin	Apollo 50 SC	K1	3068	1.4	Spider mites, aphids

32.	Cypermethrin	Polytrin C 440 EC	K1	3232	1.5	Aphids, spider mites
33.	Cypermethrin	Sherpa 5% EC	K1		2	Thrips
34.	Cyromazine	Trigard 75 WP	K1	3061	1.7	Leaf minor, spider mites
35.	Deltamethrin	Decis 25 EC	K1	3008	1	Aphids, thrips, caterpillars
36.	Diafenthiurion	Mercur 500	K1 2006	3465	1.3	Spider mites, caterpillars, whitefly
37.	Diafenthiurion	Pegasus 500 SC	K3	3249	1.2	Spider mite, caterpillars, whitefly
38.	Diazinon	Diazinon 60 EC		3280	1.8	Aphids, thrips, caterpillars
39.	Diazinon	Diazol 60 EC	K1	3133	1.3	Aphids, thrips, caterpillars, whitefly, nematodes, termites, cutworms
40.	Dicofol	Kelthane 18.5 EC	K1	3041	-	Spider mites
41.	Dicofol	Mitigan 18.5 EC	K1	3071	2.3	Spider mites
42.	Dienochlor	Pentac Aqua 480	K1	3017	2	Spider mites
43.	Dimethoate	Dimethoate 40 EC	K2	3236	2	Aphids, thrips
44.	Ethoprophos	Mocap 10 GS	K1	9271/ 12516 Holland	-	Nematodes
45.	Fenamiphos	Nemacur 5G	K2	3073	1	Nematodes
46.	Fenazaquin	Magister 200 SC	K3	3285	1.7	Spider mites
47.	Fenazaquin	Pride 200 SC	K3	3093	2.2	Spider mites
48.	Fenbutatin oxide	Torque 50 WP	K1	3029	2.2	Spider mites
49.	Fentin acetate 54% + Maneb 28%	Brestan 60 WP	K2	3377	3	Nematodes
50.	Flufenoxuron	Cascade 10 DC	K2	3136	2.3	Spider mites
51.	Hexythiazox	Nissorun 10 EC	K3	3092	1.8	Spider mites
52.	Imidacloprid	Confidor 200 SL	K1	3196	1.4	Spider mites, aphids, thrips, caterpillars, whitefly, termites
53.	Imidacloprid	Gaucho 350 FS	K1	3252	1.5	Aphids, thrips, caterpillars, whitefly
54.	Indoxacarb	Avaunt 300/150 SC	K1	3272	-	Caterpillars
55.	Lambda-cyhalothrin	Karate 17.5 EC	K1	3024	1.3	Aphids, thrips, caterpillars, whitefly, leaf minor, flea beetle, spider mites
56.	Lambda-cyhalothrin	Lambdex 5% EC	K1		2	Aphids, thrips, leafhoppers, caterpillars, leaf minors
57.	Lufenuron	Match 50 EC	K1	3260	1.7	Caterpillars, whitefly
58.	Methiocarb	Mesurol 500 SC	K1	3007	1.6	Aphids, thrips, caterpillars, whitefly
59.	Methiocarb	Methiocarb		10256 Holland	-	Spider mites
60.	Methomyl	Methomex 90 SP	K2	3004	1	Aphids, thrips, caterpillars, whitefly
61.	Methomyl 90%	Lannet 90 WS	K1	3003	1.1	Aphids, thrips, caterpillars, whitefly
62.	Omethoate	Folimat 500 SL	K1	3148	1	Aphids

63.	Oxamyl	Vydate 10 L	K1	3022	1	Spider mites, aphids, thrips, caterpillars, whitefly, leaf minor
64.	Oxymatrin	Oxymetrin 2.4 SL		3533	1.3	Spider mites, aphids, thrips, caterpillars, termites, leafhoppers
65.	Primicarb	Pirimor 50 DG	K1	3151	2	Aphids
66.	Pyrmidifen	Miteclean 10% SC		3492	1	Spider mites
67.	Profenofos	Selecron 720 EC	K1	3394	1	Spider mites, thrips
68.	Propargite	Omite 57 EC	K1	3026	1.5	Spider mites
69.	Spinosad	Tracer 480 SC	K3	3251	1	Thrips, caterpillars
70.	Spiromesifen	Oberon SC 240	K1	3436	-	Spider mites
71.	Tau fluvalinate 24%	Mavrik AF	K3	3352	2	Spider mites, aphids, thrips, leaf minor
72.	Tebufenpyrad	Oscar 20 SC/ 200 EC	K3	3239	1.6	Spider mites
73.	Tetradifon	Tedion V-18 EC	K1	3028	1.8	Spider mites, thrips
74.	Thiacloprid	Calypso SC 480	K1	3375	2	Spider mites, aphids, thrips
75.	Thiamethoxam	Actara 25 WG	K1	3250	1	Aphids, caterpillars, whitefly
76.	Thiocyclam	Evisect S	K1	3012	1.5	Aphids, thrips, caterpillars, whitefly, leaf minor
77.	Thiophanate-Methyl	Topsin M	K3	3161	3	Nematodes

Remarks:
RK = Registered in Kenya, K1 = fully registered in Kenya, K2 = provisional registered in Kenya, K3 = temporarily registered in Kenya, - Not given, 1 = most effective, 2 = very effective, 3 = effective by farm protection experts

Table 5. List of rejected insecticides, and acaricides

No	Active ingredient	Trade name	RK	Code	Efficacy scale	Target Pests
1.	Abamectin 1.8	Boom			1	Spider mites, thrips
2.	Aldicarb	Temik 15 G growers rejected	K1	3001	1	Spider mites, aphids, thrips, nematodes, termites
3.	*Bacillus thuringiensis* var *kurstaki*	Bio-T-Plus EC			1	Cutworms
4.	Benfuracarb	Oncol				Thrips
5.	Cyhexatin	Lintex WP			2	Spider mites
6.	Cypermethrin	Tarcip 20 EC			2	Caterpillars
7.	Cyromazine	Topgard WP			1.5	Leaf minor
8.	Dichlovos	Divipan 100 F	K2		1.3	Aphids, thrips, caterpillars, whitefly, spider mites
9.	Emamectinbenzoate	Proclaim			1	Spider mites, caterpillars
10.	Endosulfan	Thionex 35 EC -band	K1	3067	1.5	Spider mites, aphids, thrips, caterpillars, whitefly, leafhoppers, cutworms, flea beetle
11.	Etoxazol	Spider			1	Spider mites
12.	Fenazaquin	Matador			2	Spider mites
13.	Fenpropathrin	Smash			1	Caterpillars
14.	Hexaflumuron	Consult 10 SC			2	Caterpillars
15.	Imidacloprid	Septer			1	Thrips & whitefly
16.	Lambda-cyhalothrin	Karate 5			2	Caterpillars, whitefly, leafhoppers
17.	Monocrotophos	Monocron 60			2	Aphids
18.	Spinosad	Tracer Super 240 SC			1	Thrips
19.	Teflubenzuron	Molit 15 EC			1.5	Caterpillars

Remarks:
RK = Registered in Kenya, K1 = fully registered in Kenya, K2 = provisional registered in Kenya, K3 = temporarily registered in Kenya, - Not given, 1 = most effective, 2 = very effective, 3 = effective by farm protection experts

Table 6. List of recommended fungicides for registration

No	Active ingredient	Trade name	RK	Code	Efficacy	Target Pests
1.	Azoxystrobin	Amistar 250 SC	K1	3494	1	Rust
2.	Azoxystrobin 250g/l	Ortiva SC	K1	3246	1.7	DM, Botrytis, rust, PM
3.	Benalaxyl+Mancozeb	Galben 8-65 WP	K3	3253	1	DM, Botrytis
4.	Benomyl	Benlate		3033	1.5	DM, PM, Botrytis
5.	Benomyl	Benomilo 50 WP		3422	1.6	PM, Botrytis, Fusarium, soil borne diseases
6.	Benomyl 50% WP	Benomyl		3317	1.8	Botrytis, Phytophthora, Pythium, Rhizoctonia
7.	Bitertanol	Baycor 300 EC	K1	3031	1.3	PM
8.	boscalid+keroxym-methyl	Collis		3434		PM
9.	Buprimate	Nimrod 25 EC	K1	3297	1.3	PM
10.	Captan	Captan 83 -(80/50,500)	K1, K3	3035	1	Botrytis, black spot
11.	Captan	Merpan 83 WP	K1	3286	1.5	Botrytis, Fusarium, soil borne diseases, dieback
12.	Carbendazim	Bavistin 50 DF	K3	3105	1.7	DM, PM, Fusarium, Botrytis, soil borne diseases, Rhizoctonia, root rot
13.	Carbendazim	Goldazim 500 SC	K3	3309	2.	PM, Botrytis
14.	Chloropryfos	Merpan 4 EC		3070	1	PM
15.	Chlorothalonil	Bravo 500 SC	K3	3142	1.7	DM, Botrytis, black spot
16.	Chlorothalonil	Daconil 75 WP	K1	3037	1.7	DM, Botrytis
17.	Chlorothalonil	Ranco 75 WP	K1	3429	1.8	DM, Botrytis
18.	Chlorothalonil	Ranconil 500 SC	K1		1.8	DM, Botrytis
19.	Chlorothalonil + Metalaxyl	Foliogold 537.5 SC	K3	3397	1.5	Botrytis, DM
20.	Copper hydroxide	Kocide 101	K1	3042	1.8	DM, Botrytis, Crown gall (CBD & rust in Coffe in Kenya)
21.	Cymoxanil + Propineb	Milraz 76 WP	K1	3045	1	DM, PM
22.	Cyprodinil + Fludioxonil	Switch 62.5 WG	K1	3289	1.5	Botrytis
23.	Dazomet	Basamid G	K1	3072	2	Crown gall, nematodes, soil born fungi
24.	Difenoconazole	Score 250 EC	K3	3123	1.1	PM, Botrytis, Alternaria
25.	Dimethomorph + Mancozeb	Acrobat MZ	K1	3062	1.7	DM
26.	Dithianon	Delan 500 SC	K1	3206	1	DM
27.	Dodemorf acetate	Meltatox 40 EC		3043	1.1	PM
28.	Famoxate + Cymoxanil	Equation Pro DF	K1	3221	1.2	DM

29.	Fenamidone +Fosetyl-Aluminium	Verita WP		3473	-	DM
30.	Fenarimol	Rubigan 12 EC	K3	3059	1.7	PM
31.	Fenhexamid	Teldor WG 50	K1	3241	1	Botrytis
32.	Flusilazole	Nustar 40 EC	K2	3047	1	PM
33.	Folpet	Folpan 50WP	K3	3295	2	DM
34.	Fosethyl –Aluminuim	Fosotonic 80 WP	K1	3414	2	DM, Botrytis
35.	Fosetyl-Aluminium	Aliette 80 WP	K1	3085	1.5	DM, Pythium, Phytophthora
36.	Fosetyl-Aluminium	Fast WP		3100 Eth	1	Phytophthora, Pythium
37.	Hexaconazole	Anvil 5 SC	K1	3064	2	PM
38.	Iminoctadine	Bellkute 30% FL	K1	3325	2	PM
39.	Iprodion	Rovral Aquaflo 500	K2	3078	1.2	Botrytis, Alternaria
40.	Iprodione	Ippone 500 SC	K3	3476	2	Botrytis
41.	Iprodione	Iprodione 50% SC		3106 Eth	1.3	Botrytis, Alternaria
42.	Iprodione	Rovral 250 flow	K1	3054	1.8	Botrytis
43.	Kresoxim-Methyl	Ardent 50 SC	K3		2	PM
44.	Kresoxim-Methyl	Stroby 50 WG	K2	3090	1.8	PM, Botrytis
45.	Mancozeb	Mancozeb 80 WP		3259	1.5	DM, Botrytis, black spot, rust
46.	Mancozeb	Sancozeb 80% WP	K1	3120	1.3	DM, Alternaria, crown gall, Erwinia
47.	Mancozeb 80%	Dithane M-45	K1	3038	2	DM, Botrytis, Alternaria
48.	Manganese+Zineb	Mancozan		3188	2	Alternaria
49.	Metalaxyl +Mancozeb	Ridomil Gold MZ 68 WP	K1	3116	1	Pythium
50.	Metalaxyl +Mancozeb	Ridomil Gold MZ WG	K1	3264	1.1	DM, black spot
51.	Metalaxyl 25%	Ridomil MZ		3051		Phytophthora, Pythium
52.	Metalaxyl-M 8% + Mancozeb 64%	Victory 72 WP	K1 2006		1.5	DM, Phytophthora, Pythium
53.	Metham sodium	Metham sodium	K3	3346		Soil sterilization
54.	Methram complex	Polyram DF	K2	3050	2	DM, Alternaria
55.	Mono & Dipotassium phosphate	Agri-Fos 400 AS	K1-2006	3531	1	DM
56.	Myclobutanil	Systhane 12 EC		3130	2	PM
57.	Oxycarboxin	Plantvax 20 EC	K1	3048	3	Rust
58.	Penconazole	Topas 10 EC	K3	3217	2	PM

59.	Pentachloronitrobenzene +Etridiazole	Terrachlor Super X EC	K3	3055	1	Phytophthora, Pythium, Rhizoctonia, Fusarium blights, soil borne diseases
60.	Polyoxin B	Milpan 10 WP	K3	3261	1	DM, PM
61.	Polyoxin AL	Polar 50 SG	K3	3049	1.7	PM, Botrytis
62.	Propamocarb	Dorado		3099 Eth	1.3	DM
63.	Propamocarb + Fosetyl	Previcur Energy SL 840	K1	3455	2	DM
64.	Propamocarb –HCL	Previcur N	K1	3075	1.3	DM, Botrytis, Phytophthora, Pythium
65.	Propiconazole	Bumper 25 EC	K1		2	PM, rust
66.	Propiconazole	Tilt 250 EC	K1	3216	1	Rust in *Hypericum*
67.	Propineb	Antracol 70 WP	K1	3023	1.5	DM, Botrytis, Rhizoctonia
68.	Propineb + Iprovalicarb	Melody duo 69		3454	-	DM, Botrytis
69.	Propamocarb hydrochloride	Proplant 722 SL	K3	3296	1.5	DM
70.	Pyrimethanil	Scala 40 SC	K1	3122	1.3	Botrytis
71.	Quaternary (Didecyl-dimethyl Ammonium chloride)	Sporekill	K1	3224	1	PM, Botrytis
72.	Spiroxamine	Impulse EC 500	K1	3311	2	PM
73.	Sulphur	Kumulus DF	K1	3273	3	PM
74.	Sulphur	Sulphur dust		3158	1.7	PM
75.	Sulphur	Thiovit Jet 80 WP	K1	3081	1.7	PM, Botrytis, DM
76.	Tebuconazole	Orius 250 EW	K1	3511	1	Rust
77.	Tebuconazole	Folicur 250 EC	K1	3182		PM
78.	Tetraconazole	Domark 40 EW	K3	3307	2	PM
79.	Tetraconazole	Domark 50 EW		3307	1	PM
80.	Thiabendazole	Tecto 500 SC	K3	3357	1.3	Botrytis, PM
81.	Thiophanate-Methyl	Topsin M	K3	3162	1.5	Botrytis, PM, Fusarium blights, soil borne diseases, Rhizoctonia
82.	Thiram 80%	Thiram 80 WP	K3	3056		Botrytis
83.	Thiram 98%	TMTD 98% Satec		11058 Holland		Botrytis
84.	Tolclofos methyl	Rizolex 50 WP	K2	3052	1	Fusarium, soil borne diseases, Rhizoctonia, crown gall
85.	Tolylfluanide	Euparen M		3207	2	Botrytis

86.	Tolylfluanide	Euparen 50 WP	K2	3039		Rhizoctonia
87.	Triadimefon	Bayleton 25 WP	K1	3032	1.5	PM
88.	Trifloxystrobin	Flint WG 50	K1	3306	1.3	PM, rust
89.	Triforine	Saprol 20 EC	K1	3057	1.3	PM, rust

Remarks:
RK = Registered in Kenya, K1 = fully registered in Kenya, K2 = provisional registered in Kenya, K3 = temporarily registered in Kenya, - Not given, 1 = most effective, 2 = very effective, 3 = effective by farm protection experts

Table 7. List of rejected fungicides

No.	Active ingredient	Trade name	RK	Code	Efficacy scale	Target disease
1.	Chlorothalonil	Brankon		-	1.5	DM, black spot
2.	Difenoconazole	Defence		-	2	Botrytis, rust
3.	Fluazinain 38.5%	Shielane		-	-	Botrytis
4.	Imazalil	Fecundal		-	-	PM
5.	Mancozeb	Helcozeb		-	2	DM
6.	Mancozeb	Manzidan WP		-	1.8	DM, Alternaria
7.	Metalaxyl M	Ridomil Gold 480 EC		-	1	Pythium, Phytophthora
8.	Methyl bromide	Methyl bromide - band	K1	3044	1	Crown gall
9.	Mono & dipotassium phosphate	Agrifos 600		-	1	DM
10.	Penconazole	Ofir 2000 EC		-	2	PM
11.	Propamocarb -HCL	Dotan SC		-	1	Phytophthora, Pythium
12.	Propamocarb -HCL	Dynone SC		-	1	Phytophthora, Pythium
13.	Pyrifenox	Dorado 200 EC		-	1.5	PM, DM
14.	Tolifluazinid 50.5%	Guparen		-	-	Botrytis
15.	Triforine	Heliogofrit		-	1	PM

Remarks: RK = Registered in Kenya, K1 = fully registered in Kenya, K2 = provisional registered in Kenya, K3 = temporarily registered in Kenya, - Not given, 1 = most effective, 2 = very effective, 3 = effective

Table 8 List of herbicides, stickers, post handling agents, pH-reducing agent and hormones recommended for registration

No.	Active ingredient	Trade name	Code	RK	Efficacy scale	Type
Herbicides						
1.	Glyphosate	Round up	3077	K1	-	Herbicide
2.	Oxidiazon	Ronstar	3053		-	Herbicide
Sticker						
1.	Fatty acids, glycol ethers	Biofilm	3106	K3	2	Sticker
2.	Wetting/spreading	Supafilm	3128	K3	1	Sticker
Post harvest handling agents						
1.	Silver thiosulfate 0.8	STS	-		1	Post harvest handling agent
2.	-	Tamilage tablets	-		-	Post harvest handling agent (in cold room use)
3.	Thiobendazole 75, HQS-Hydroxi Quinolin 35, Ammonium chloride 40	Tog 3	-		1	Post harvest handling agent
Hormones						
1	Ethylene	Atryl	-		1	Hormone
2	4-indol-3-yl-butric	BB5 (Bladbuff 5)	3174		1	Hormone
3.	Giberellic acid	CCC	7938 Holland		1	Hormone
4.	4-indol-3-yl-butric acid	Chryzostop green	9160 Holland		1	Hormone (rooting powder)
5.	-	Diazidamon	-		1	Hormone
6.	Giberellic acid	Giberellic acid	3484		-	Hormone
7.	Indol acetic acid (0.3%, 0.6% & 0.8%)	Homoril 3, 6 & 8	-		-	Hormone
8.	Giberellic acid	Tivag	3234		-	Hormone
9.	Gebberelin	GA3 Berelex	3185		-	Hormone
10.	Gebberelin A4+A7	GA3 Valioso	11053 Holland		-	Hormone
11.	Gebberelin Vitamin	Gerasol	-		-	Anti stress agent
12.	Paclabutazol	Cultar	-		-	Growth control
pH-reducing agent						
1.	-	Blotbuff	-		-	pH-reducing agent

Remarks:

RK = Registered in Kenya, K1 = fully registered in Kenya, K2 = provisional registered in Kenya, K3 = temporarily registered in Kenya. - Not given, 1 = most effective, 2 = very effective, 3 = effective by farm protection experts

Perception of flower growers

Most of the farms emphasized the problem of getting pesticides on time. They attribute this to the delay in transportation and quarantine process. Moreover, due to the limited number of pesticide suppliers in the country almost all of the farms import pesticides by themselves in small quantities with increased costs. In addition, pesticide importation was reported to be time consuming and costly adding extra burden to flower growers. Lack of coordination in inspection process was also reported as a problem. It was also reported by some farms that some pests developed already resistance to certain pesticides, e.g. red spider mites to an insecticide called Tedion around Wonji. Some of the farms suggested that at least 10 pesticides should be registered for each pest and used alternatively, especially for spider mites and downy mildew to avoid resistance development. Registration of biological agents like *Phytoseilus* sp for spider mites, *Diglyphus* spp. for leaf minor, *Aphidius* spp. for aphids and *Trichoderma* spp. for *Fusarium*, *Pythium* and *Phytophthora*, *Steinrema* spp. (entomopathogenic nematodes) against sciaride fly were suggested as an important step for integrated pest control in flower production by growers, but its importation can not be decided at this moment due to lack of regulation in place. Growers currently are demanding assistance and guidance from research institutions with regard to pest control, training on safety, disposal and other related issues. Growers also encountered problems of pesticides lables in foreign languages other than English such as Hebrew that cannot be understood by local workers. Cases of toxicity of pesticides during application were experienced by some farms. It was reported that dehydration occurred to workers who spray pesticides. Many growers share the absence of strict regulation on disposal of unused pesticides and containers to safeguard the environment.

Discussions

Some pests were found associated with flowers as cosmopolitan species, while others were supposed to be introduced into the country together with planting materials. Spider mites, aphids, white flies, termites, and caterpillars of different species might be indigenous to Ethiopia. However, diseases, like *Agrobacterium* might be introduced together with different planting materials coming from other countries like Kenya and South Africa (Morris 2006). This could be due to lack of strict implementation of quarantine regulations. Therefore, implementing the existing quarantine regulations is a must in order to restrict the introduction of exotic pests into the country.

The Ethiopian government has given special emphasis to large-scale flower farms due to its contribution to the economic development of the country. Hence, special arrangement was made for importation of pesticides, planting materials and other inputs like fertilizers, hormones and greenhouse facilities without following formal procedures. Thus, each flower farm imports pesticides and other inputs by its own since most of the inputs are not registered in the country. Different flower farms used different types of chemicals to control the same pest. But, this resulted in introduction of several different pesticides that may lead to an increase in volume of obsolete pesticides, create problems in getting the required amount within short period, and adds extra work among other things.

Currently, the government requires replacing the special arrangement with the normal quarantine regulation and other crop protection decrees for the use of pesticides and other chemicals in the country. The regulation and decree allows only locally registered pesticides and chemicals to be imported and commercialized (Pesticide registration decree 1990). Local efficacy data is one of the preconditions for registration. Since the research institutions lack greenhouse facilities to undertake efficacy trials secondary data were used to recommend pesticides that are already in use by flower growers for registration.

Therefore, 77 insecticides, acaricides and nematicides, 89 fungicides, 2 herbicides, 2 stickers, 12 hormones, 3 post harvest handling chemicals and 1 pH-reducer are recommended for registration to be used in flower production in Ethiopia. It is assumed that sufficient number of pesticides was selected in order to avoid build up of resistance of pests to a pesticide and give options against the cost of pesticides. About 34 pesticides i.e. 19 insecticides /acaricides and 15 fungicides were rejected because they were not found in the MPS lists and/or registered in Kenya and/or were not effective enough to control target pests. MPS is an international certification organization established

in 1994 in Holland. It assesses and certifies flower companies in respect to environmentally friendly cultivation of flowers; reduce the use of pesticides, fertilizers, and energy. The environmental risks considered in the MPS are toxicity to mammals, birds, long-term effects, aquatic life, soil life and natural enemies of pests, persistence, decomposition and bio-accumulation, mobility in air and water and regional and nursery specific conditions. According to MPS, pesticides are marked as red (Re), amber (Am) green (Gr) and white (Wh) based on an average of all risks. A Product with black (Bl) color means that the active ingredient/product may not be used under MPS. In 2000, MPS broadened its standards beyond environmental certification by developing additional components to improve participants' social performance including MPS-GAP (good agricultural practice). MPS-GAP was developed for international supermarket chains that are concerned about how their product is produced. Farms must meet requirements to supply to participating supermarkets. On the other hand, the Kenya Registration Booklet consist pest control products registered for use in Kenya. It was published by the Pest Control Products Board (PCPB) of Kenya. The document is divided in to three parts: a) list of fully registered pest control products for a period of three years from date of registration and may be renewed for a period not exceeding two years at a time (K1), b) list of products under provisional registration, pending evaluation to full registration (K2), c) list of products under temporary registration and puts some additional scientific technical information to be provided before the product is evaluated to full registration status or for emergency control of infestations that are seriously detrimental to crops (K3). The three criteria were not used for hormones and post handling agents because they were reported to be used in small quantities and were not assumed to be as hazardous as pesticides (Bohmont, 1981).

There is a need by flower growers to have input suppliers in the country, one of the major inputs being pesticides. Chemical companies are expected to import and supply the registered pesticides. Hence, the required amount of pesticides can be obtained within a short period of time. This may decrease the problem of accumulation of obsolete pesticides; reduce the cost involved in transport and storage by flower growers, and allows implementation of pesticide regulation in the country. There is no appropriate training for pesticide sprayers in flower farms. Pesticide sprayers do not follow safety regulation while spraying. Cases of poisoning by pesticides were reported by flower growers. Hence, training should be given on safety precautions, handling and use of pesticides for pesticide sprayers. Calendar based heavy use of pesticides should also be replaced with alternative methods i.e., reliance on use of chemicals alone should be changed by use of all control and management options (integrated pest management) including biological control.

Acknowledgements

The authors would like to thank managers and plant protection experts of flower farms for their positive response to our questions. Thanks go to the EIAR management for financing and facilitating different workshops. We also thank all stakeholders (MOARD, Chemical companies and flower growers) for their contribution.

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