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PRACTICAL AND ECONOMIC EFFICACY OF *AMBROSIA ARTEMISIIFOLIA* L. SURVEILLANCE IN COMPLIANCE WITH THE INTERNATIONAL STANDARDS

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Abstract: *Ambrosia artemisiifolia* distribution in the Ukraine for the 1973–2013 period was analyzed. The infested areas were consequently grouped into 6 categories. Intense infestation in the region was the reason for the analysis and the categorization. A practical approach to the *A. artemisiifolia* surveillance system which complied with the International Standards for Phytosanitary Measures concerning "a pest free area", "pest free places of production", "pest free production sites" and "an area of low pest prevalence" was recommended. This action should drive the policy-making process to underpin national legislation regarding invasive species. The opportunity also presents itself for improved communications with growers and stakeholders because of the more transparent and cost effective system of *A. artemisiifolia* surveillance offered. There would be a chance to slow down the *A. artemisiifolia* invasion even though this invasive species has already occupied 3.6 million hectares.

Key words: common ragweed, distribution, infested area, International Standard for Phytosanitary Measures (ISPM), invasive alien species, surveillance

INTRODUCTION

Globalization increases trade, travel, and transport and is leading to an invasive alien species distribution posing a threat to the environment as well as a financial and health threat (Hulme 2009). One pre-condition for successful participation in a global market is adaptation of the phytosanitary international standards. Such standards would prevent the spread of harmful organisms, enhance the capacity of national quarantine and plant protection services, and unify the relevant methods and procedures, including those for pest surveillance (Burgiel *et al.* 2006).

All countries have a responsibility to collect and record data on quarantine pest occurrence to support phytosanitary certification and to provide technical justification on phytosanitary measures (ISPM – International Standards for Phytosanitary Measures; ISPM 1). Currently the pest survey in the Ukraine follows the general instruction on growing-season inspections and detection. However, there is no actual delimitation of the boundaries of an area assumed to be infested by or free from a pest. The extent of the infestation is also not considered. The concepts of "pest free areas" (ISPM 4), "pest free places of production", "pest free production sites" (ISPM 10) as well as "areas of low pest prevalence" (ISPMs 22, 29) are still not in use. There are annual verifications of infested sites by State Plant Quarantine Inspection instead of the complete procedure of identification, verification, subsequent maintenance, and use of pest free area. Restrictive controls on commodity movements and overestimated needs of certification and post-harvest treatments would be considered disadvantages.

Nevertheless, such strict regulations cannot stop the spread of organisms with a high potential for establishment and further spread like *Ambrosia artemisiifolia* L. (common ragweed). Today, *A. artemisiifolia* has spread to 26 out of 27 regions of the Ukraine (Review on quarantine pests, diseases, and weeds distribution in the Ukraine, 2013) posing threats as a severe agricultural weed, allergic agent, and successful ecosystem invader (Mar'uschkina 1986).

Nearly a century ago, *A. artemisiifolia* was first detected in the Ukraine (Protopopova 1973; Mar'uschkina and Podberezko 2008). It was officially listed in the flora of the Ukraine, in 1950 (Bullock *et al.* 2010). By 2010, the presence of the weed had been confirmed on a total area of 3.6 million hectares – the biggest infested area so far (Review on quarantine pests, diseases, and weeds distribution in the Ukraine, 2013). Quarantine zones within all regions were enclosed within the boundaries of the regions in

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spite of the differences in areas infested (ranging in 2010 from 0.002 hectares in Volyn and Ivano-Frankivsk regions up to 1,338.5 hectares in the Zaporizhia region). Such an approach led to similar strict phytosanitary regulations for all plant producers from 26 regions, even though they may have a field/enterprise still situated within a weed-free area.

This paper describes a practical approach to the implementation of the *A. artemisiifolia* surveillance system in the Ukraine, The approach is meant to comply with the International Standards for Phytosanitary Measures (ISPMs), thus supporting a more effective monitoring system, revision of distribution records, and justifying the need for determining a weed-free area.

MATERIALS AND METHODS

The data on *A. artemisiifolia* distribution records (the State Plant Quarantine Inspection of the Ukraine, 1973–2013), cadastral maps (State Cadastral Agency, 2011), research work (Institute of Plant Protection, 2005–2011), and publications were used for our analysis.

It should be noted, that the term "region" was applied to 27 administrative divisions of the Ukraine: 24 oblasts, one autonomous republic and two cities with special status.

The following six categories were used to characterize the intensity of the area of a region's *A. artemisiifolia* infestation:

Group I 0 hectares of infested area in the region
Group II 0.1–1,000.0 hectares of infested area in the region
Group III 1,000.1–10,000.0 hectares of infested area in the region
Group IV 10,000.1–100,000.0 hectares of infested area in the region
Group V 100,000.1–1,000,000.0 hectares of infested area in the region
Group VI < 1,000,000.1 hectares of infested area in the region

The percent of the infested area within a region was calculated using the following formula:

$$IA = \frac{IA_T}{A_R} \times 100$$

where:
IA – percent of infested area,
IA_T – total square of infested area,
A_R – total square area of a region (not including land under buildings, industries and water resources).

Strengths, weaknesses, opportunities, and threats analysis (SWOT) (Chapman 2007) was performed to identify the internal and external factors that are favourable and unfavourable to implementation of the proposed phytosanitary regulations of *A. artemisiifolia* in the Ukraine.

RESULTS

The distribution timeline of *A. artemisiifolia* since 1973, has revealed differences in the spread of this invasive species within 3 temperate-climate ecotones and habitat types in the Ukraine (from north to south): Polissia, Forest steppe, and Steppe zones. The highest level of distribution was recorded in the Steppe zone, where common ragweed spread over 96% of the administrative districts, 48% of cities/towns/villages, 59% of agricultural enterprises, and 2% of smallholdings. These indexes for Polissia and Forest steppe zones were 1.3–17 times less (Fig. 1).

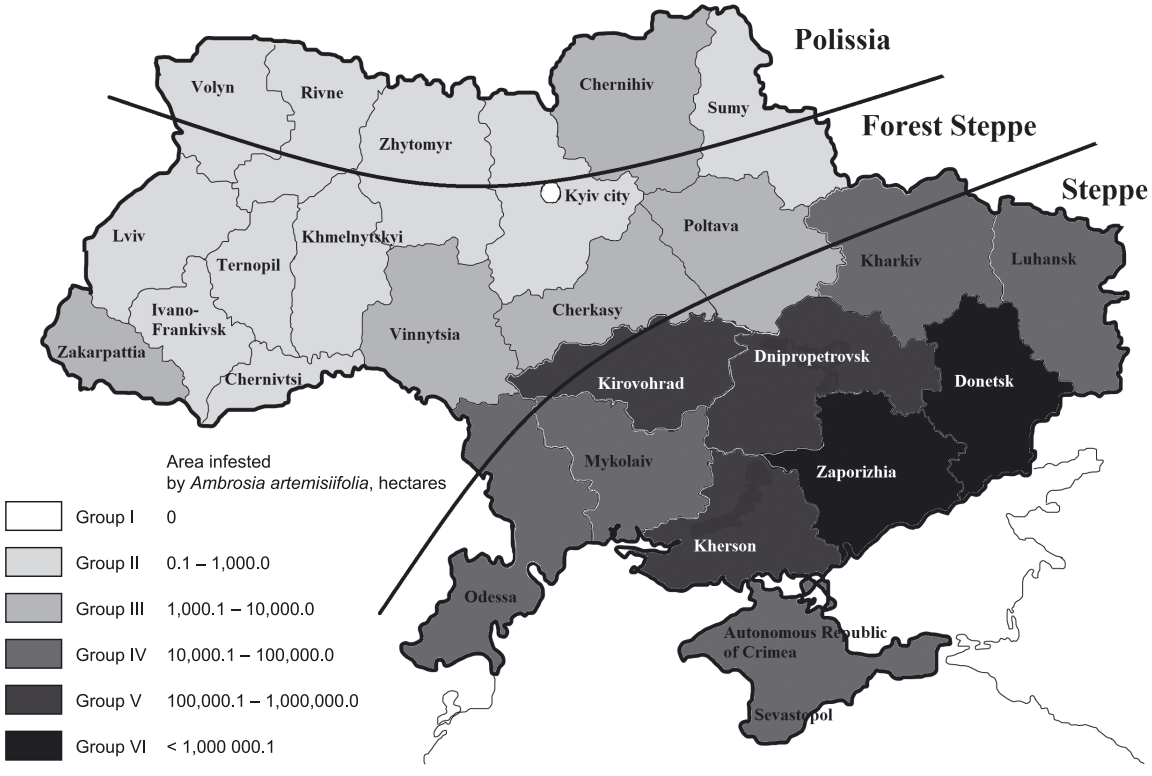

Fig. 1. Distribution rate of *A. artemisiifolia* in different regions and zones of the Ukraine (State Phytosanitary Inspection, January 2010)

Analysis permitted grouping the regions into 6 main categories according to the intensity of the area of a region infested with *A. artemisiifolia*. The most infested Donetsk and Zaporizhia regions fell into Group VI. In this group there were 1,087.8 and 1,338.5 thousand hectares of infested land, which constituted 43 and 53% of the total area of the region, respectively (this does not include land under buildings, industries and water resources; State Land Cadastre, the Ukraine) (Table 1).

Group V included the Kherson, Kirovohrad, and Dnipropetrovsk regions. In this group, the infested area ranged from 290.7 to 425.0 thousand hectares (12–14% of the total area of the region).

Table 1. Grouping of the regions based on the intensity of the area of the region infested with *A. artemisiifolia* (the Ukraine, 2010)

No.	Region	Total area of the region (thousand hectares**)	Weed-infested area, thousand hectares*			
			the total	agricultural enterprises	smallholdings	others
	Group I (0 hectares infested)					
1	Kyiv City	66.0	0.0	0.0	0.0	0.0
	The total	66.0	0.0	0.0	0.0	0.0
	Group II (0.1–1,000.0 hectares infested)					
1	Volyn	1,839.5	0.002	0.0	0.0	0.02
2	Ivano-Frankivsk	1,344.1	0.002	0.002	0.0	0.0
3	Sevastopol City	82.3	0.004	0.002	0.0	0.002
4	Ternopil	1,336.8	0.01	0.01	0.0	0.02
5	Rivne	2,850.6	0.06	0.03	0.0	0.03
6	Zhytomyr	2,815.8	0.05	0.01	0.0	0.04
7	Khmelnytskyi	1,976.2	0.10	0.09	0.0	0.01
8	Lviv	2,100.3	0.20	0.16	0.0001	0.05
9	Chernivtsi	777.1	0.50	0.50	0.04	0.003
10	Kyiv	2,556.5	0.60	0.09	0.03	0.50
11	Sumy	2,262.0	0.70	0.0	0.0	0.70
	The total	19,941.2	2.23	0.890	0.07	1.38
	Group III (1,000.1–10,000.0 hectares infested)					
1	Chernihiv	2,977.7	1.3	1.0	0.00002	0.3
2	Vinnytsia	2,547.8	1.7	1.6	0.04	0.1
3	Cherkasy	1,907.8	2.2	1.7	0.04	0.5
4	Zakarpattia	1,231.5	6.2	0.5	0.30	5.4
5	Poltava	2,599.8	7.6	6.2	0.30	1.1
	The total	11,264.6	19.0	11.0	0.68	7.4
	Group IV (10,000.1–100,000.0 hectares infested)					
1	Odessa	3,019.4	11.0	10.0	1.0	0.0
2	Autonomous Republic of Crimea	2,370.3	16.5	16.1	0.1	0.3
3	Kharkiv	3,018.9	17.7	14.3	1.0	2.3
4	Luhansk	2,581.6	21.0	18.3	0.0	2.7
5	Mykolaiv	2,292.2	77.9	4.3	0.0	73.6
	The total	13,282.4	144.1	63.0	2.1	78.9
	Group V (100,000.1–1,000,000.0 hectares infested)					
1	Kherson	2,478.5	290.7	280.2	1.6	8.9
2	Kirovohrad	2,347.3	306.2	295.6	9.1	1.5
3	Dnipropetrovsk	2,952.9	425.0	399.3	25.7	0.0
	The total	7,778.7	1,021.9	975.1	36.4	10.4
	Group VI (< 1,000,000.1 hectares infested)					
1	Donetsk	2,536.2	1,087.80	994.70	40.60	52.40
2	Zaporizhia	2,509.5	1,338.50	1,180.20	32.60	125.70
	The total	5,045.7	2,426.30	2,174.90	73.20	178.10
The gross total		57,312.6	3,613.53	3,224.89	112.45	276.18

*State Plant Quarantine Inspection data, 01.01.2010

**total area of the region not counting land under buildings, industries, water resources, State Land Cadastre, the Ukraine

Group IV covered the Odessa, Kharkiv, Luhansk, and Mykolaiv regions as well as Autonomous Republic of Crimea. In this group there were 11.0–77.9 thousand hectares invaded by common ragweed (0.4–3.4% of the total area of this region).

Group III included the Chernihiv, Vinnytsia, Cherkasy, Zakarpattia, and Poltava regions. In this group there were 1.3–7.6 thousand hectares infested with *A. artemisiifolia,* which was equal to 0.04–0.29% of the total area of this region.

Group II contained 11 regions. The infested area ranged from 2 (the Volyn and Ivano-Frankivsk regions) up to 700 hectares (the Sumy region), which did not exceed 0.03% of the total area of the region.

Group I was the Kyiv City region, which was the only one free from *A. artemisiifolia.*

Following the general requirements for the establishment of pest free areas (ISPM 4), delimitation of "a weed free area" is suggested only for the regions where this invasive species either is absent (Group I) or occurs on a small number of plots (on less than 1% of the total area), where it could be easily eradicated (Groups II–III) (Table 2).

It is suggested that the establishment of "areas of low weed prevalence" be only for the regions where an infested area does not exceed 5% of a territory (Group II–IV). This would allow for the application of phytosanitary measures sufficient enough to control weed distribution which is under a specified low level (ISPMs 22, 29).

Meanwhile delimitation of "weed free places of production" would be appropriate in the regions with no more than 13% of infested land (Group III–V). In such areas, it could still be possible to find places or collections of fields operated as a single production unit, to be free from *A. artemisiifolia* over a relevant period of time. Where a defined portion of a place of production can be managed as a separate unit within a place of production, it would be possible to maintain that site as weed free. In such circumstances, the place of production would be considered to contain a "weed free production site" (ISPM 10).

Whenever the risk posed by *A. artemisiifolia* is identified as unacceptable, the quarantine zone must be delimited. A quarantine zone can comprise a whole region if more than 50% of its area is infested – like Group VI. But even in such regions a few "weed free places of production" or "weed free production sites" can still be established as half of Group VI territory free from invasive species.

DISCUSSION

Since its first detection in the beginning of the last century, there has been a lot of effort to eradicate *A. artemisiifolia* from the Ukraine territory. But it is mainly after common ragweed became widespread within all regions of the country and recognized as having a destructive impact on biodiversity, economics and human health, that it received substantial attention from the government and the public (Burda and Tokhar 1988). Although this awareness has resulted in a big campaign for mechanical weed and chemical eradication, there is still a lack of phytosanitary strategies to mitigate the spread of *A. artemisiifolia* into areas not yet invaded (Sotnikov *et al.* 2006).

There is one management tool not yet implemented in the Ukraine but successfully applied in other countries for better operational and eradication plans. It is the determination of land status as, for example, "weed free areas", "weed free places of production", "weed free production sites" as well as "areas of low weed preva-

Table 2. Determination of the land status in compliance with the state of *A. artemisiifolia* distribution

Group	Area infested by *A. artemisiifolia* [ha]	*A. artemisiifolia* status	Possible land status
I	0	absent	weed free area
II	0.1–1,000.0	– present at a low prevalence on a small number of plots, – under eradication	– weed free areas, – areas of low weed prevalence
III	1,000.1–10,000.0	– present at a low prevalence on a small number of plots including agricultural land, – under official control	– weed free areas, – areas of low weed prevalence, – weed free places of production, – weed free production sites, – quarantine zones
IV	10,000.1–100,000.0	– present in different parts of regions including agricultural land, – under official control	– areas of low weed prevalence, – weed free places of production, – weed free production sites, – quarantine zones
V	100,000.1–1,000,000.0	– high density in different parts of regions including agricultural land, – under official control	– weed free places of production – weed free production sites – quarantine zones
VI	< 1,000,000.1	– wide distribution in the region, – under official control	– very few weed free places of production, – very few weed free production sites, – quarantine zones

lence". Requirements for the establishment of these areas stated in ISPMs were extrapolated for the regions in the Ukraine with a different history of *A. artemisiifolia* distribution. Adoption of this approach to infested land status determination will lead to significant changes in national phytosanitary regulations. Currently, the regulations are equal for all infested regions, despite the status of *A. artemisiifolia* being different within each of them.

This can be illustrated by commercial wheat phytosanitary regulation while rail transporting such a commodity within the territory of the Ukraine. Because 26 out of 27 regions of the Ukraine are infested by *A. artemisiifolia,* all of them are considered as quarantine zones delimited by administrative borders of the region (in contrast to actual quarantine zone borders for each particular plot) (The Law of the Ukraine on Plant Quarantine 2006). Such an attitude takes the majority of the phytosanitary control out of the wheat field and into the storage and transportation facilities which must be routinely inspected for phytosanitary certification.

Rail transportation of commercial wheat within 26 regions infested with *A. artemisiifolia* must be accompanied by a quarantine certificate issued according to standard procedure. The following components of the procedure include: field inspection made by grower; control field inspection made by a quarantine inspector; commodity inspection at storage facilities, and sampling for a single wheat lot to be downloaded into one bulk grain hopper wagon (60 tons); bulk grain hopper wagon inspection; laboratory analysis of samples collected for pests, weeds, and pathogen fungus detection and identification; quarantine certificate issuance (for each transportation unit – a bulk grain hopper wagon, in our case), with a total fee per one quarantine certificate of 200.81 UA Hryvna (= 18.9 Euro) (Table 3).

The adoption of an *A. artemisiifolia* infested land status determination, in compliance with ISPMs, will put the majority of the phytosanitary control back into the field. Expenses of the phytosanitary certification would be cut 75% (for "an area of low *A. artemisiifolia* prevalence", "weed free places of production" or "a weed free production site"), and 100% (for "an *A. artemisiifolia* free area") (Table 3).

Below, the SWOT analysis shows an assessment of the capacity of State Phytosanitary Inspection of the Ukraine in relation to the implementation of the proposed phytosanitary regulations:

Strengths:
- established algorithm for areas with special weed status delimitation,
- improved procedure for phytosanitary certification,
- reasonable level of engagement with growers and stakeholders because of a more cost efficient certification system,
- better support for access to the international market and trade.

Weaknesses:
- staff numbers significantly less than what is needed,
- strict maintenance responsibility and verification of delimited areas with special weed status,
- lack of a national budget outlay for eradication programs in sensitive locations (*e.g.* near water and forest),
- lack of specific, helpful national legislation.

Opportunities:
- strengthening of the phytosanitary inspection capacity,
- strengthening of phytosanitary and economic safety,
- availability of new technologies for surveillance,
- improving the data reporting systems,
- improving communication channels.

Threats:
- significant gap between current staffing and human resources needed to deliver functions,
- lack of awareness regarding the urgent need for a national program on *A. artemisiifolia,* among the policy makers,
- funding deficiencies.

It is proven, that the establishment of certified pest free areas is a "public good" which benefits the producers. For example, "the pest free area" concerning the Queensland fruit fly (*Bactrocera tryoni* Froggatt) in South Australia, Victoria, and New South Wales benefits producers through a price premium on export and interstate produce, reduced pesticide costs and pest damage, and reduced costs of post-harvest treatments (White *et al*. 2012).

Although delimitation of a "pest free area" sometimes restricts trade pathways or brings down export capacities in the first place, it makes a good start for a more successful eradication program leading finally to an abolishing of the restriction. In Egypt such an implementation has helped to decrease brown rot infestation rates after 14 years of maintenance of areas certified as free from *Ralstonia solanacearum* (Smith). Brown rot infestation rates in Egypt went from 17.0% to 1.7%. With this success, potato exports to the EU have finally started to rise (Kabeil *et al*. 2008).

We find that implementation of "a pest free area", "pest free places of production", "pest free production sites", and "an area of low pest prevalence" can guide and strengthen phytosanitary regulations on *A. artemisiifolia* in the Ukraine. Delimitation of special status areas will depend on the intensity in the area of infestation in the region and will be appropriate in regions with no more than 13% of infested land.

The implementation of the proposed phytosanitary regulations for *A. artemisiifolia* will drive the policy-making process in the Ukraine to underpin national legislation regarding invasive species. This should then result in an increase in the effectiveness of phytosanitary measures against invasive species. There is an opportunity to improve communication with the growers and stakeholders because of a more transparent and cost effective system of *A. artemisiifolia* surveillance and control. There would then be a chance to slow down the invasion of *A. artemisiifolia,* even if this invasive species has already occupied 3,6 million hectares.

Table 3. Estimated cost for phytosanitary certification of wheat transported within the country by rail transport (amount per certificate)

Phytosanitary certification component		User fees, UA Hryvna*					
		national phytosanitary certification within all regions containing *A. artemisiifolia* quarantine zones**	phytosanitary certification in compliance with ISPMs				
			for an *A. artemisiifolia* quarantine zone	for an area of low *A. artemisiifolia* prevalence if a commodity will be transported to it		for an *A. artemisiifolia* free place of production or production sites	for an *A. artemisiifolia* free area
				A. artemisiifolia quarantine zone	*A. artemisiifolia* free area		
Field inspection made by grower		free of charge	free of charge	free of charge	free of charge	free of charge	free of charge
A control field inspection made by quarantine inspector		free of charge	free of charge	free of charge	free of charge	free of charge	free of charge
Commodity inspection at storage facilities and sampling for a single wheat lot to be downloaded into one bulk grain hopper wagon (60 tons)		51.00	51.00	51.00	51.00	51.00	–
Bulk grain hopper wagon inspection		20.93	20.93	–	20.93	–	–
Laboratory analysis for pest detection & identification		30.93	30.93	–	30.93	–	–
Laboratory analysis for weed detection & identification		27.27	27.27	–	27.27	–	–
Laboratory analysis for pathogen fungus detection & identification		31.88	31.88	–	31.88	–	–
Quarantine certificate Issuance		38.80	38.80	–	38.80	–	–
Total fee		200.81	200.81	51.00	200.81	51.00	–
Differences between UA and ISPMs scheme	±, UA Hryvna	–	0.00	–149.81	0.00	–149.81	–200.81
	±, %	–	0	–75	0	–75	–100

*1 Euro = 10.65 UA Hryvna; 1 USA Dollar = 7.99 UA Hryvna

**fee applicable per lot of wheat transported by one transport unit; in this case – by one wagon (60 tons)

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REFERENCES

Bullock J.M., Chapman D., Schafer S., Roy D., Haynes T., Beal S., Wheeler B., Dickie I., Phang Z., Tinch R., Čivić K., Delbaere B., Jones-Walters L., Hilbert A., Schrauwen A., Girardello M., Prank M., Sofiev M., Niemelä S., Räisänen P., Lees B., Skinner M., Finch S., Brough C. 2010. Assessing and controlling the spread and the effects of common ragweed in Europe. Final report: ENV.B2/ETU/2010/0037. https://circabc.europa.eu/sd/d/d1ad57e8-327c-4fdd-b908-dadd5b859eff/Final_Final_Report.pdf [Accessed: March, 2013]

Burda P.I., Tokhar V.K. 1988. Загроза біологічного забруднення північноамериканськими видами. [The threat of biological pollution by North American species in Ukraine]. Ukrainian Botanical Journal 55: 127–130 (In Ukrainian).

Burgiel S., Foote G., Orellana M., Perrault A. 2006. Invasive Alien Species and Trade: Integrating Prevention Measures and International Trade Rules. Center for International Environmental Law, Defenders of Wildlife, The Nature Conservancy, Global Invasive Species Initiative. http://cleantrade.typepad.com/clean_trade/files/invasives_trade_paper_0106.pdf [Accessed: March, 2013].

Chapman A. 2013. SWOT analysis [online]. www.businessballs.com/swotanalysisfreetemplate.htm [Accessed: March, 2013].

Hulme P.E. 2009. Trade, transport and trouble: managing invasive species pathways in an era of globalization. J. Appl. Ecol. 46 (1): 10–18.

ISPM 1. 2006. Phytosanitary principles for the protection of plants and the application of phytosanitary measures in international trade [online]. Rome, IPPC, FAO. www.ippc.int/index.php?id=ispms&no_cache=1&L=0 [Accessed: March, 2013].

ISPM 4. 1995. Requirements for the establishment of pest free areas [online]. Rome, IPPC, FAO. www.ippc.int/index.php?id=ispms&no_cache= 1&L=0 [Accessed: March, 2013].

ISPM 10. 1999. Requirements for the establishment of pest free places of production and pest free production sites [online]. Rome, IPPC, FAO. www.ippc.int/index.php?id=ispms&no_cache=1&L=0 [Accessed: March, 2013].

ISPM 22. 2005. Requirements for the establishment of areas of low pest prevalence [online]. Rome, IPPC, FAO. www.ippc.int/index.php?id= ispms&no_cache=1&L=0 [Accessed: March, 2013].

ISPM 29. 2007. Recognition of pest free areas and areas of low pest prevalence [online]. Rome, IPPC, FAO. www.ippc.int/index.php?id= ispms&no_cache=1&L=0 [Accessed: March, 2013].

Kabeil S.S., Lashin S.M., El-Masry M.H., El-Saadani M.A., Abd-Elgawad M.M., Aboul-Einean A.M. 2008. Potato Brown Rot Disease in Egypt: Current Status and Prospects. American-Eurasian J. Agric. & Environ. Sci. 4 (1): 44–54.

Mar'uschkina V.Y. 1986. Амброзия полыннолистная и основы биологической борьбы с ней [Common ragweed and its biological control.]. Naukova dumka, Kyiv, Ukraina, 117 pp. (In Russian).

Mar'uschkina V., Podberezko I. 2008. Моніторинг амброзії полинолистої: екологічні аспекти [Ecological aspects of common ragweed surveillance]. Quarantine and Plant Protection 5: 18–25 (In Ukrainian).

Protopopova V.V. 1973. Адвентивні рослини Лісостепу і Степу України [Adventive plant species in Forest steppe and Steppe zones of Ukraine] Naukova dumka, Kyiv, Ukraina, 191 pp. (In Ukrainian).

Sotnikov V.V., Zuza V.S., Bahtiarova E.T. 2006. Амброзія полинолиста – небезпечна карантинна рослина [Common ragweed – dangerous quarantine plant]. Kharkiv, Ukraina, 64 pp. (In Ukrainian).

Review on quarantine pests, diseases and weeds distribution in Ukraine. 2013. State Plant Quarantine Inspection of Ukraine. http://golovderzhkarantyn.gov.ua/index.php?option=com_content&task=view&id=144&Itemid=1 (In Russian). [Accessed: March, 2013].

[The Law of Ukraine on Plant Quarantine]. Закон України „Про карантин рослин" 2006. Kyiv, Ukraina, 36 pp. (In Ukrainian).

White B., Sadler R., Florec V., Dominiak B. 2012. Economics of Surveillance: a Bioeconomic Assessment of Queensland Fruit Fly. http://ageconsearch.umn.edu/bitstream/125741/2/White_etal_Economics_of_Surveillance_AARES.pdf [Accessed: March, 2013].