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Abundance and Geographical Distribution of Invasive Alien Weed Species in the Western Amhara Region, Ethiopia

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ABSTRACT

Plant invaders that are not yet found in the western Amhara Region start to emerge and wielding negative impacts. This study was conducted to assess the abundance and geographical distribution of invasive alien weed species **(**IAWS) in the western Amhara Region. 140 fields were surveyed at a regular interval of 5-10 km and the geographical coordinates of the sampling points were recorded using Garmin GPS receiver to map the extent of major IAWS infestations. IAWS types and their abundances were recorded from every sampling point. Frequency and average percent cover was calculated to quantify geographical distribution and abundance of IAWS, respectively. The result of the study depicted that fourteen IAWS were recorded in the Western Amhara Region growing in different habitats and agro-ecologies at varying levels of abundance along the road roadsides, grazing lands, and croplands. Among those IAWS *Argemone mexicana, Datura stramonium, Senna didymobotrya, and Tagetes minuta* were widely distributed in the study area with a frequency of 51.4%, 73%, 66%, and 51.4%, respectively however others had frequencies less than 25%. The result of the study also revealed that most of the IAWS had lower abundance levels except three species (*Argemone mexicana, Datura stramonium, and Senna didymobotrya*) which had *frequent* to *abundant* abundance levels. Therefore, early detection and eradication with appropriate management practices should be done to reduce the risk of IAWS on grazing and cropping land when present in small numbers. In addition, creating public awareness would also provide a synergistic effect to tackle IAWS.

Keywords: Abundance, Distribution, Invasive align weed species, Western Amhara Region.

INTRODUCTION

Invasive alien weed species (IAWS) are unwanted plants that are not native to a specific ecosystem and whose introduction threatens biodiversity and ecosystem services (McNeely et al., 2001). Apart from their threat to biodiversity and ecosystem services, invasive alien weed species have significant social, ecological, and economic impacts (Mussa et al., 2018). Invasions of invasive alien weeds hinder crop production through claiming agricultural lands and serving as a hiding place for crop pests, wild animals and contribute to the spreading of vector-borne diseases (Mussa et al., 2018). The livestock feed shortage is also further complicated by the introduction and expansion of unwanted bushes (Abate et al., 2010).

The globalization of trade, travel, and transport is greatly increasing the number of invasive alien weed species that are being moved around the world, as well as the rate at which they are moving (Burgiel et al., 2006). Invasive alien weeds that are not yet found in Western Amhara region starts to emerge and posing negative impacts on native biodiversity, agricultural lands, rangelands, national parks, waterways, lakes, rivers, power dams, roadsides, urban green spaces with great economy and social consequences(Jemal & Taye, 2015; Mengist, 2017). Among those invasive alien weeds *Argemone mexicana*, *Datura stramonium*, and *Echium plantagineum* are major concerns in the western Amhara Region (Jemal & Taye, 2015; Mengist, 2017). These species are spreading at an alarming rate from place to place by different mechanisms and exerting negative impacts on agricultural land and rangelands (Mengist, 2017). Therefore, accurate knowledge of the distribution and abundance of IAWS is needed to take proper protection measures and to prevent further introduction and spread into new areas that are not yet infested. However, there is a paucity of information about the abundance and distributions of invasive alien weed species in Ethiopia in general and the Western Amhara region in particular. Therefore, this study was conducted to assess the abundance and distribution of invasive alien weed species in the western Amhara region.

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MATERIALS AND METHODS

Abundance and geographical distribution assessment of IAWS were conducted in Western Amhara Region during 2017/18 and 2018/19 main cropping seasons. Visual observation of IAWS distribution and abundance was done along gravel and asphalt roads which were easily accessible by car using car odometer. The initial sampling point was determined at South Gondar Zone and then at every 5-10 km interval, IAWS occurrences, percent cover estimation, and abundance in 100 m^2 area were observed and noted on the data collection sheet. The abundance categories of the IAWS population were based on the percentage cover estimation indicated in Table 1 and percent cover estimation was determined depending on expert judgment (Fufa et al., 2017). Latitude and longitude coordinates of sampling points were recorded using handheld Garmin GPS receiver. Weed identification manuals and images were used to identify new IAWS in the study area. The frequency was calculated to quantify IAWS distribution and the average percent cover was calculated to quantify relative abundance (Nkoa et al., 2015) according to the following equations.

Distribution and abundance maps were developed only for the four most frequent IAWS in the study area.

$$\text{Frequency of species x} = \frac{\text{Number of fields containing species x}}{\text{Total number of fields surveyed}} \times 100$$

$$\text{Average \% cover of species x} = \frac{\sum(\text{\% covers of fields containing species x})}{\text{Number of fields containing species x}} \times 100$$

RESULTS

The composition of invasive alien weed species in western Amhara Region

The result of the study depicted that fourteen IAWS representing 8 families were recorded in Western Amhara Region. Most of the IAWS were found growing on roadsides and grazing lands (Table 2). This suggests that the introduction and distribution of invasive alien weed species were related to road construction and transportation. The biophysical survey depicted that *Argemone mexicana*, *Datura stramonium*, *Senna didymobotrya*, and *Tagtus minuta* were widely distributed in western Amhara region with the frequency of 51.4%, 73%, 66%, and 51.4%, respectively whereas others were found having a frequency of less than 25% (Table 2). The

Table 1: Abundance and coverage estimation category of weeds (Fufaet al.,2017).

Abundance category	Description
Absent	No recently emerged invasive alien weed is found
Present	Individuals plentiful, but coverage small
Rare	Individuals very numerous at least coverage 5 percent of the area
Occasional	Plant Covering 6-25 percent of the area
Frequent	Individuals few or many collectively, covering 26-50 percent of the area
Abundant	Plant covering 51-75 percent of the area
Very Abundant	Plant covering 76-100 percent of the area

Table 2: Invasive alien weed species frequency and average percent cover in western Amhara Region

S/N	Scientific name	Infested habitat	Family	Freq	Av% cov	Life cycle
1	*Cirsium vulgare*	RS,RL,CL	Asteraceae	22	14	Biennial
2	*Xanthium spinosum*	RS,RL	Asteraceae	18	5	Annual
3	*Xanthium strumarium*	RS,RI,CL,AF	Asteraceae	19	7	Annual
4	*Senna didymobotra*	RS,RL	Fabaceae	66	30	Perennial
5	*Opuntia stricta*	RS,RL	Cactaceae	16	4	Perennial
6	*Argemone Mexicana*	RS,RL	Papaveraceae	84	52	Annual
7	*Datura strumarium*	RS,RL,CL,AF	Solanaceae	73	38	Annual
8	*Tagtus minuta*	RS,RL,AF	Asteraceae	51	12	Annual
9	*Ageratum conyzoids*	RS,RL	Asteraceae	7	5	Annual
10	*Agave americana*	RS,RL	Asparagaceae	11	2	Perennial
11	*Phalaris paradoxa*	CL	Poaceae	6	4	Annual
12	*Cenchrus polystachios*	RL	Poaceae	30	8	Perennial
13	*Imperata cylindrical*	CL	Poaceae	8	3	Annual
14	*Echium plantagineum*	RS,RL	Boraginaceae	16	5	Annual

Infested Habitat: (RS= Roadside; RL= rangeland; CL= cropland; and AF; around forest); Freq=frequency; Av% cov= average percent cover

result of the study also revealed that most of the invasive alien weed species had minimum abundance except three species (*Argemone mexicana*, *Datura stramonium*, and *Senna didymobotrya*) which had frequent to abundant abundances in the western Amhara Region (Table 2). The following IAWS (*Argemone mexicana*, *Echium plantagineum*, *Senna didymobotrya*, and *Tagtus minuta*) that had the highest frequency and abundance in the study area were selected and presented in detail.

Argemone mexicana

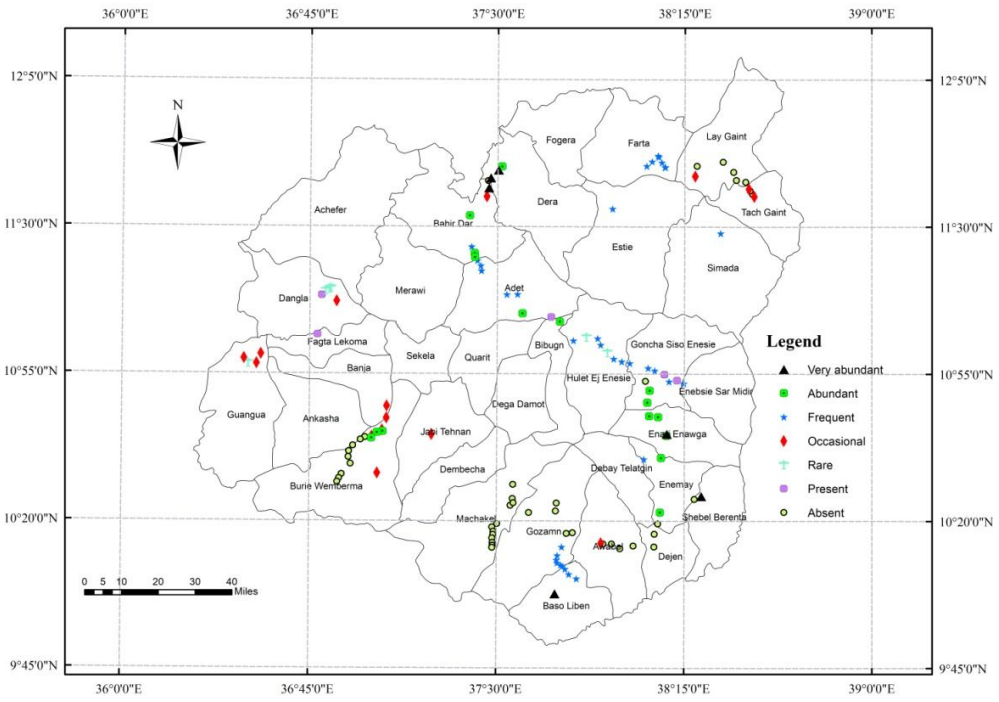
Argemone mexicana was widely distributed in the Western Amhara Region growing in different habitats and agro-ecologiesat varying levels of abundance (*very abundant* to *present*) along road roadsides, grazing lands, and croplands. It was found from the low altitude areas of shebelberenta district (1611 m.a.s.l) of West Gojjam Zone to high altitude areas of farta district (3202 m.a.s.l) in south Gondar zone (Fig. 1).Among 140 waypoints, *Argemone mexicana*was observed on 72 waypoints indicating its frequency was 51.4%. *Argemone mexicana*was observed *very abundant* in Bahir Dar Zuria, Basoliben, Shebelberenta, Dera, and EnargeEnawga districts whereas it was observed *frequent* to *present* abundance levels in some districts of Awi Zone, East Gojjam Zone, West Gojjam and South Gondar Zone (Fig. 1). It was observed abundant in Dera district of South Gonder Zone, West Gojjam Zone (Bahir Dar Zuria, Burie, and Adet) and in some districts of East Gojjam zone (Enarj Enawga, Bibugn, GonchaSisoEnesie, and Enemay).

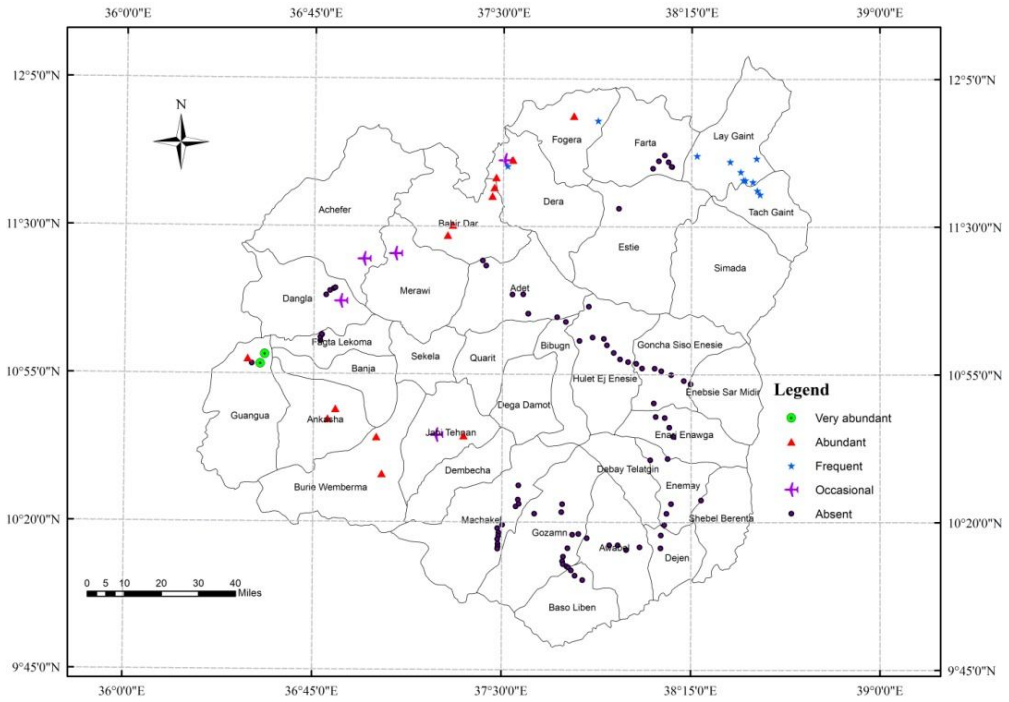
Senna didymobotrya

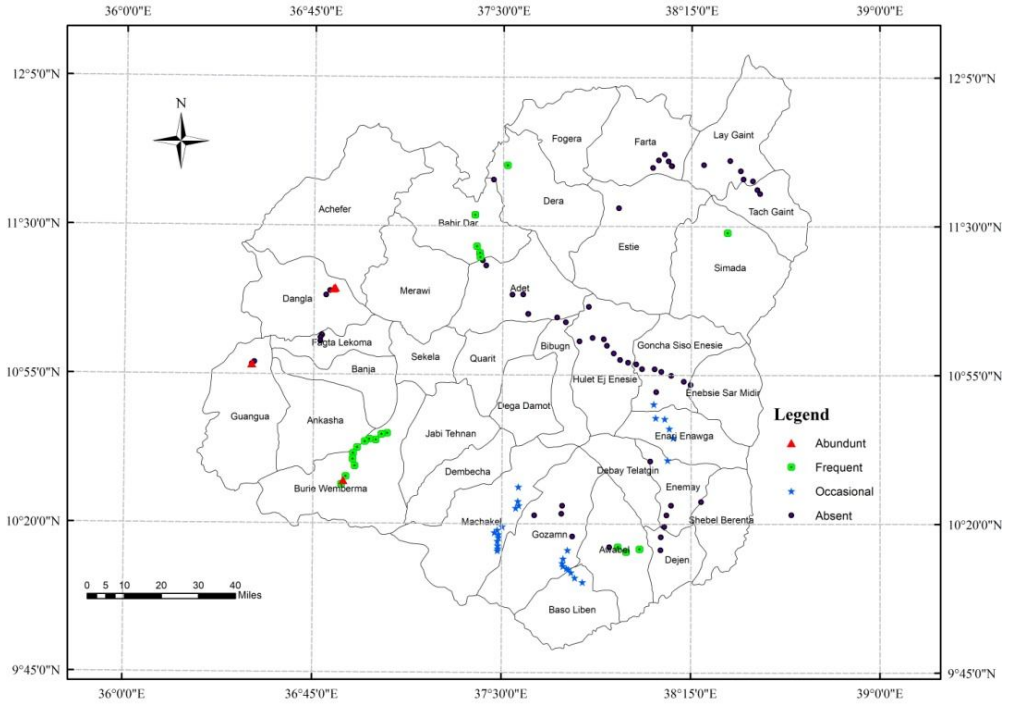
Senna didymobotrya was widely distributed in the Western Amhara region growing in different habitats (roadsides and rangelands), agro- ecologies, and different soil types at varying levels of abundance which indicates its adaptability to different climatic conditions. Among 140 waypoints *Senna didymobotrya* was observed on 92 waypoints in eleven districts of the study area indicating its frequency was 66% (Fig. 2). The biophysical survey also depicted that *Senna didymobotrya* was observed *frequent* in Lay Gaynt, Tach Gaynt, Fogera, and Dera districts whereas it was observed *abundant* in some districts of East Gojjam, West Gojjam and South Gonder Zone whereas it was noticed *very abundant* in some *kebeles* of Guangua district (Fig. 2).

Tagetesminuta

The biophysical survey portrayed that *Tagetes minuta* was widely distributed in the Western Amhara region growing on roadsides, grazing lands, and around forestlands at varying levels of abundance. Among 140 waypoints *Tagetes minuta* was observed on 72 waypoints in eight districts of the study area indicating its frequency was 51.4%. *Tagetes minuta* was found *abundant* in Dangla, Guangua and Wonberma districts whereas it was found *occasional* in some districts of East Gojjam Zone (Fig. 3). The biophysical survey also depicted that *Tagetes minuta* was found frequently in Wonberma, Bahirdar Zuria, Dera Hamusit, Simada, and Awabel districts (Fig. 3).



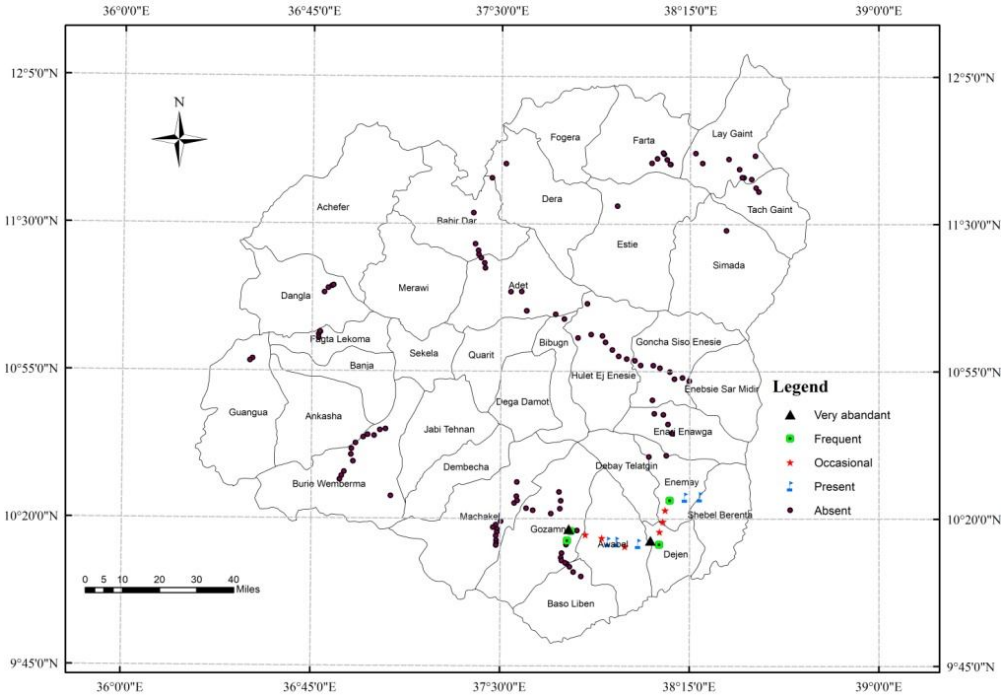




Echiumplantagineum

Echium plantagineum introduction and distribution was due to road construction (Dejen to DebreMarkos) byKagima road construction contractor. It was observed primarily at, Yetnorakebele, the seat of Kagima road construction contractor camp for the first time. Nowadays, its distribution is escalating at an alarming rate and invading roadsides and grazing lands in the study area along Dejen to DebreMarkos road. The biophysical survey depicted that *Echium plantagineum*was widely distributed in Dejen, Gozamen, Enemay, Aneded, and Awabel districts of West Gojjam zone growing along roadsides and in

grazing lands. Among 140 waypoints *Echium plantagineum* was observed on 23 waypoints in four districts of thestudy area indicating its frequency was 16 percent (Fig. 4). *Echium plantagineum*was found *very abundant* at the seat of Kagima road construction contractor, Yetnorakebele, and nearby kebeles such as Tikie and Zemeten. The biophysical survey also depicted that *Echiumplantagineum*was found *very abundant* at YewobieEnechifokebele of Aneded district. However, *Echium plantagineum was* found at varying levels of abundance (*frequent* to *present*) along Debre Markose to Dejen main road districts.



substantial amounts are eaten over prolonged periods (Culvenor, 1956).

Echium plantagineum is a very prolific seed producer; heavy infestations of *Echium plantagineum* can produce up to 10,000 seeds per meter squire (Piggin, 1978). Such levels of seed production are likely more than adequate for potential dominance under a wider range of environmental conditions. However, its invasiveness was restricted along the roadside, adjacent grazing land, and poorly tilled farmlands of East Gojjam Zone. This might be due to its heavier seeds which are less dispersible (Navie et al., 1998). *Echium*

DISCUSSION

Recent studies showed that new plant invaders that are not yet found in Ethiopia start to emerge and spreading to none invaded areas and exerting negative impacts (Jemal&Taye, 2015). Among which *Argemone mexicana, Senna didymobotrya*, and *Tagetes minuta* were found emerging weeds in the Western Amhara Region whereas *Echium plantagineum* was unknown in the country. However, it exerts negative impacts on animal production in the East Gojjam zone (Fig.4). It negatively affects animal production by replacing native vegetation particularly pastures and causes health problems on animals (Hulting et al., 2007). *Echium plantagineum* contains pyrrolizidinealkaloids, which cause chronic liver damage and animal mortality, especially if *plantagineum* was found dominant along roadsides due to its high colonization ability and its high seed production ability whereas it was also found invading adjacent grazing land and poorly tilled farmlands (Hansen and Clevenger, 2005). Invasion of adjacent grazing land and poorly tilled farmlands in East Gojjam Zone might be due to substantial seed production ability of *Echium plantagineum* (Hassen and Clevenger, 2005).

Argemone mexicana was first observed and reported in the Eastern part of Ethiopia (Tamado and Milberg, 2000). Afterward, it has been disseminated to all parts of the country and found widely distributed in the Western Amhara Region (Maru, 2017). This indicates that *Argemone mexicana* can grow well in various climatic conditions including frost and drought-prone areas. This result is in line with Maru (2017) who reported that *Argemone mexicana* was

found during the drought season of Ethiopia, 2016. It also found in frost-prone areas of East Gojjam zone, Choke Mountain (Maru, 2017). However, its abundance and distribution vary from place to place in the study area. This might be due to differences in a human intervention like trade, travel, and infrastructure development that fastens dispersal and the introduction of invasive alien weeds (Sharma et al., 2010). *Argemone mexicana* introduction and distribution mainly depended on road construction because it was found mostly along roads and land use types near the roadside. This result is in line with Namkeleja et al. (2014) who reported that the distribution of *Argemone mexicana* has been favored by land-use history. In most cases, *Argemone mexicana* was spotted along the roads, in gravel mining sites and residential areas. The abundance and distribution of *Argemone mexcana* decrease when we went far from roadsides whereas the number and distribution of native plant species increases and vice versa (Kefyalew, 2012). *Argemone mexicana* was also found abundant on heaped soil and grazing lands near roadsides whereas its abundance decreases when we went far from roads. This shows that the introduction and distribution of *Argemone mexicana* were due to road construction. This result is in line with Healy (1961) who reported that high densities of *Argemone mexicana* are likely to occur around the roadside, grazing lands and on transported soils for road construction.

Senna didymobotrya grows aggressively and displaces native vegetation along the roadside, grazing land, and abounded places around farmland in our study area. Its invasion is capable of forming dense impenetrable thickets that impede the growth and regeneration of native plants along the roadside, grassland, and near farmland in the Western Amhara Region. This result is consistent with Weber (2017) who reported that *Senna didymobotrya* was adapted to a wide range of habitats and occurs as a weed of grassland, woodland, riparian habitats, and disturbed habitats. Similarly, Tabuti (2007) also reported that *Senna didymobotrya* has been distributed throughout the tropical and subtropical countries in deciduous bush lands, along lakeshores, streams, rivers, in grassland and woodlands, from sea-level up to 2500 m altitude. It was found abundant on roadsides and communal lands where human intervention is minimal. However, its abundance was minimum near farmlands and around settlements.

Tagetes minuta was widely distributed in the Western Amhara Region growing along the roadside, grazing land, and around forest land at varying levels of abundance. This indicates that *Tagetes minuta* is a fast-growing annual weed that grows in moist and dry areas, from sea level to reasonable altitudes in the tropics and subtropics, and in soil pH ranging from 4.3 to 6.6 (Holm et al., 1997). It is capable of producing around 29,000 seeds per plant which enables it to invade pastures and orchards, as well as on abandoned cultivation and roadsides (Holm et al., 1997).This result is in line with Stadler et al. (1998) who reported that *Tagetes minuta* had been deliberately distributed across the tropics, subtropics and several temperate countries as an ornamental, medicinal, or perfume plant as well as accidentally as a weed.Similarly, Holm et al. (1997) also reported that *Tagetes minuta* is widely distributed across the tropics and subtropics and computing light, nutrients, and water with many economically important crops such as maize, rice, and beans. *Tagetes minuta* was not recorded in cropping land in the study area. However, reports somewhere else showed that the roots exude of *Tagetes minuta* delays germination and reduces the yield of crops grown in soil previously infested with the species (Meissner et al., 1986).

In conclusion, most of the invasive alien weed species recorded in the western Amhara Region were found growing in different agro-ecologies along roadside and grazing land with minimum frequency and abundance except some species. These invasive alien weed species can grow aggressively and displaces native vegetation along the roadside, grazing land and abounded places around farmland in Western Amhara Region. A human intervention like trade, travel, and infrastructure development fastens the dispersal and introduction of these invasive alien weed species in the study area. They are capable of producing a larger amount of seeds per plant, which enables them to invade farmland, grazing land, and roadside. The abundance and distribution of invasive alien weed species recorded in the western Amhara Region were found dominant along roadsides due to its high colonization ability and its high seed production ability whereas its abundance and distribution relatively decreases at adjacent landforms. It affects animal production by replacing native vegetation particularly pastures and causes health problems on animals. On the other hand, it affects crop production and human health. However, no attempt had been made by all concerned bodies including farming communities to manage further introduction and dissemination of IAWS in the Western Amhara Region. Therefore, early detection and eradication using appropriate management practices should be done when present in small numbers than when they are well established to reduce their risk.

A single technology in isolation will not give desired results. Thus, using an integrated package would provide a synergistic effect to tackle IAWS. Integrating screened chemicals with management practices of local inhabitants and biological methods will provide effective results. In addition to this, creating public awareness especially in farmers' area

about the effect of IAWS on agricultural productivity, the ecosystem, as well as dispersal mechanisms, management practices, infesting habitat and growing season, will help to manage those IAWS effectively at the right time and to prevent further introduction and spread into new areas that are not yet infested. Moreover, further studies should be done on the impact, management practices and population dynamics of those IAWS in the study area.

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REFERENCES

Abate, T., Ahmed, E., &Lisanework, N. (2010). Traditional rangeland resource utilization practices and pastoralists' perceptions on land degradation in southeast Ethiopia. *Tropical grasslands, 44,* 202-212.

Burgiel, S., Foote, G., Orellana, M., & Perrault, A. (2006). Invasive Alien Species and Trade: Integrating Prevention Measures and International Trade Rules. Washington, DC, USA: Center for International Environmental Law and Defenders of Wildlife.

Culvenor, C. C. J. (1956). The alkaloids of *Echium plantagineum* L. I. Echiumine and Echimidine. *Australian Journal of Chemistry, 9,* 512-520.

Fufa, A., Taye, T., &Hundessa, N. (2017). Distribution and abundance of emerging invasive weeds in the central-western part of Ethiopia. *African Journal of Agricultural Research, 12(13),* 1121-1127.

Hansen, M. J., & Clevenger, A. P. (2005).The influence of disturbance and habitat on the response of non-native plant species along transport corridors. *Biological Conservation, 105,* 271-280.

Healy, A. J. (1961). The interaction of native and adventive plant species in New Zealand. *Proceedings of the New Zealand Ecological Society, 8,* 39-43.

Holm, L. G., Doll, J., Holm, E., Pancho, J. V., &Herberger, J. P. (1997) World Weeds: Natural Histories and Distribution. New York: John Wiley and Sons Publishers. (FirstEd.).University of Wisconsin, Madison

Hulting, A. G., Krenz, J. E., & Parker, R. (2007). Paterson's curse, *Echium plantagineum* in the PacificNorthwest.URL:https://catalog.extension.oregonstate.edu/sites/catalog/files/project/pdf/pnw602.pdf.

Jemal, T.,&Taye, T. (2015). Abundance and Distribution of Invasive Alien Plant Species in IlluAbabora Zone of Oromia National Regional State, Ethiopia. *Journal of Agricultural Science and Food Technology, 1(7),* 94-100.

Kefyalew,A. (2012). Prevalence and effects of *Argemone mexicana* (Papaveraceae) on biodiversity in Ethiopia. *African Journal of Ecology, 50(2),* 160-166.

Maru, A. B. (2017). Effects and Dissemination of Argemone/Argemone Ochroleuca Sweet/in East Gojjam Administrative Zone, Amhara Regional State, Ethiopia.*Global Journal of Agricultural Research, 5(1),* 20-24.

McNeely, J. A., Mooney, H. A., Neville, L. E., Schei, P. J., &Waage, J. K., eds. (2001). *Global Strategy on Invasive Alien Species*. Cambridge, UK: IUCN in collaboration with the Global Invasive Species Program.

Meissner, R., Nel, P.C., &Beyers, E. A. (1986). Allelopathic influence of Tagetes- and Bidens-infested soils on seedling growth of certain crop species. *South African Journal of Plant and Soil, 3(4),* 176-180

Mengist, B. (2017). Distribution and Effect of PartheniumHysterophorus L. In East Gojam Zone, Amhara Region, Ethiopia. *Researcher,9(7),* 88-93.

Mussa, M., Teka, H., &Aliye, A. (2018). Socio-economic and environmental impacts of invasive plant species in selected districts of Bale Zone, Southeast Ethiopia. *African Journal of Agricultural Research, 13(14),* 673-681.

Namkeleja, H. S., Tarimo, M. T., &Ndakidemi, P. A. (2014). Spatial distribution of *Argemone mexicana* in Ngorongoro conservation area, in Tanzania. *American Journal of Research Communication, 2(4),* 266-278.

Navie, S. C., Panetta, F. D., McFadyen, R. E., & Adkins, S. W. (1998). The behavior of buried and surface-sown seeds of *Parthenium hysterophorus*. *Weed Research, 38(5),* 335-341.

Nkoa, R., Owen, M. D., & Swanton, C. J. (2015). Weed abundance, distribution, diversity, and community analyses. *Weed Science*, *63*(1), 64-90.

Piggin, C. M. (1978). Flowering and seed production of *Echium plantagineum* L. *Weed Research*, *18*(2), 83-87.

Sharma, G. P., Esler, K. J., &Blignaut, J. N. (2010). Determining the relationship between invasive alien species density and a country's socio-economic status. *South African Journal of Science. 106(3),* 1-6.

Stadler, J., Mungai, G., and Brandl, R. (1998) Weed invasion in East Africa: insights from herbarium records. *African Journal of Ecology, 36,* 15-22.

Tabuti, J.R.S. (2007). SennadidymobotryaPlant Resources of Tropical Africa / Resourcesvégétales

de l'Afrique Tropicale), Wageningen, Netherlands.URLhttps://uses.plantnetproject.org/en/Senna_didymobotrya_(PROTA).

TamadoTana& Milberg, P. (2000). Weed flora in arable fields of eastern Ethiopia with emphasis on the occurrence of Partheniumhysterophorus. *Weed Research*, *40*(6), 507-521.

Weber, E. (2017). Invasive plant species of the world: a reference guide to environmental weeds (2nd Ed.). Germany.