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Major Weeds of Ecuador. II. Potato[1]

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Abstract

Potato is one of the main traditional crops in Ecuador, extensively grown in La Sierra, i.e. high-altitude ecosystem. Its production is an important staple for people of those areas and for export to neighboring Colombia. Yields are relatively low and not corresponding with the potential of the crop varieties. This low productivity is due to several biotic constraints among them weeds, which cover the crop canopy for long period of its cycle. The best way to conform a system for weed management is identifying main weed species present and their frequency/abundance. To this end a survey was carried out in 39 ha of different potato fields in two areas of northern Ecuador, San Gabriel in Carchi and Imbabura, and another area in the center, Cotopaxi. Weed cover was visually assessed using a scale where 1- up to 5% weed cover and 4-more than 50%. These values were processed to determine Absolute and Relative Frequencies, average weed cover and finally SI- index of infestation severity. Average weed cover were 2,3 for San Gabriel (Carchi) and 2,4 for Imbabura, while in Cotopaxi it was 1,7. In the survey 19 plant species from 9 families were found, only 3 of them native. *Persicaria nepalensis* showed the highest SI in fields of San Gabriel and Imbabura, followed by *Brassica napus, Galinsoga parviflora, Rumex obtusifolius* and *Taraxacum officinale* in San Gabriel, and *G. parviflora, Gnaphalium spicatum, R. obtusifolius, Lepidium bipinnatifidum* and *T. officinale* in Imbabura, while in Cotopaxi *Chenopodium album* showed the highest SI followed by *Fumaria officinalis, G. parviflora* and *Raphanus raphanistrum*. It is recommended to keep the crop weed free during the critical period of weed competition, and to test and validate rotatory hoe for inter row weeding. The effectiveness of herbicides for chemical control should also be determined in addition to risk assessment of the environmental impact of proposed compounds.

Keywords: *Weeds; Ecuador. II. Potato*

Introduction

Potato is one of the main traditional crops in Ecuador, in which 82 thousand producers of 90 cantons are involved, mainly in La Sierra (Mountain chain of Los Andes) [1]. It is the third most important transitory crop in Ecuador, grown at an altitude from 2000 - 3600 meters above mean sea level, with a production of 421,000 tons per year. The province of Carchi covers 35% of the national production, being the largest at the national level [2]. According to the data of INEC, in 2018 the area planted with potatoes nationwide was 23,974 ha, 49,5% of it grown in the province of Carchi [3]. It is mainly used for internal fresh consumption, but part of the production is also destined for export to Colombia [4]. Average yields are around 7 t/ha, but the potential of nearly all varieties are above 25 t/ha.

The crop has several constraints to its production, among them blight disease and some others caused by virus. However, weeds are also another biotic factor hindering high potato yields. Weed competition reduces yield and potato quality, affecting tuber size, weight, and quantity [5-7]. Late weed emergence may also reduce yields by interfering with harvest [5,6,8-10].

[1]Research carried out as part of the National Prometeo Project "Malezas principales en la agricultura de Ecuador", 2014 - 2015.

If weeds are not controlled at least within 4 to 6 weeks after potatoes emerge their competition reduce yields. According to Manorama [11], the potato crop develops canopy in about 4 weeks after crop emergence and weeds must be controlled by this time to gain a competitive advantage for the crop.

Taking into account the importance of weed management in potato it is of primary importance to identify main weed species present and their frequency/abundance. Hernández and Parra [12] published useful guides for weed control in potato of Ecuador, information that requires data update on the species with the highest incidence in the crop. This was the objective of the present work.

Materials and Methods

In two areas of northern Ecuador, San Gabriel in Carchi and Imbabura, and another area in the center, Cotopaxi, different fields cultivated with potatoes were chosen in order to determine the weed infestations and their composition. A total of 39 ha of potato were evaluated.

The northern zone is characterized by the predominance of black volcanic soils rich in organic matter (8 to 16% by volume). Air temperatures range between 11,8º and 12,1ºC, with rainfall between 900 and 950 mm.

Soils of Cotopaxi area predominantly clay loam inceptisols, air temperatures are between 8º and 17ºC, with rainfall from 250 mm up to 2000 mmm.

The main potato varieties were Chola and Superchola planted 160 cm between rows and 50 cm between plants. Land preparation included plowing consisting of breaking the surface layer in order to loosen the soil, incorporate plant residues and control weeds. This operation is conducted once or twice before planting tubers. In addition, cross harrowing to a depth of 10 cm with the aim of breaking up the soil clods, in order to obtain a loose shallow bed.

In some fields of Imbabura potato was intercropped with mashwa (*Tropaeolum tuberosum* Ruiz & Pav.), trailing plant of Andean origin, which produces elongated conical tubercles with a sharp apex.

Weeds were evaluated visually using a score system (See it below). Evaluation in each field was walking diagonally and stopping 6 - 8 times to evaluate the total weed cover and also cover of each species present. This walking method was followed whenever the slope of the elevation allowed it (less than 45%). When it was not possible, evaluation was conducted from the edges of the fields.

Scale-Cover

- 0: 0 weeds
- 1: 1 - 5%
- 2: 6 - 25%
- 3: 26 - 50%
- 4: More than 50%.

In order to determine Severity Infestation (SI), the data initially processed yielded: Absolute frequency (FA), i.e. the number of times each species was found in each site; Relative frequency (F) in in %, number of infested sites by one species divided by the total of sites evaluated in each field; ΣI- sum of the cover values; Im- average of cover values, i.e. ΣI/number of evaluated sites in each field. Finally, SI-Severity infestation obtained as F by Im.

Results and Discussion

In the evaluated fields, 19 plant species from 9 families were found (see below), where only 3 are of South American or Andean origin. Interesting would be to know how these species reached these areas very far from their habitat of origin. No doubt, man introduced them in these Andean areas. Usually plants out of their habitat are invasive and often more aggressive due to the lack of their natural enemies [13]:

- *Taraxacum officinale* G. H. Weber ex Wigg.- Asteraceae, European origin (EO)
- *Galinsoga parviflora* Cav.– Asteraceae, Andean origin
- *Gnaphalium spicatum* Lam.- Asteraceae, South American origin (SAO)
- *Senecio vulgaris* L.- Asteraceae, Afro-Euroasiatic origin (EAO)
- *Sonchus oleraceus* L., Asteraceae, EAO
- *Brassica napus* L., Brassicaceae, Asiatic origin (AO)
- *Lepidium bipinnatifidium* Desv.- Brassicaceae, SAO
- *Raphanus raphanistrum* L.- Brassicaceae, AO
- *Chenopodium album* L. Bosc. ex Moq.-Chenopodiaceae, EAO
- *Chenopodium murale* L., Chenopodiaceae, EO
- *Oxalis corniculata* L.- Oxalidaceae, AO
- *Fumaria officinalis* L. – Papaveraceae, EO
- *Veronica* pérsica Poir.- Plantaginaceae, EAO
- *Holcus lanatus* L., Poaceae, EO
- Lolium spp.- Poaceae, EAO
- *Persicaria nepalensis* (Meisn.) H. Gross- Polygonaceae, AO
- *Rumex acetosella* L. – Polygonaceae, EAO
- *Rumex obtusifolius* L.- Polygonaceae, EO
- *Urtica urens* L.- Urticaceae, EO.

Average weed cover were 2,3 for San Gabriel (Carchi) and 2,4 for Imbabura, which very easily exceed the average cover in the province of Cotopaxi, 1,7. Such differences have no other explanation than slightly better crop management in Cotopaxi, therefore, lower incidence of weeds. In the Northern area, manual hilling using hoe is done once or even three times, which helps to improve drainage, minimize

greening of tubers, and raising of soil temperatures. However, no further weeding as such is conducted. At this point, potato grows most of its cycle covered by weeds. Before the harvest, a few farmers apply paraquat to destroy present weeds and potato haulm.

Regarding weed composition, prevailing weed in San Gabriel was the so-called Corazón herido (wounded heart or *Persicaria nepalensis*) (Figure 1), its SI is soaring and widely exceeds the SI values of other abundant species, such as *Brassica napus, Galinsoga parviflora, Rumex obtusifolius* and *Taraxacum officinale*.

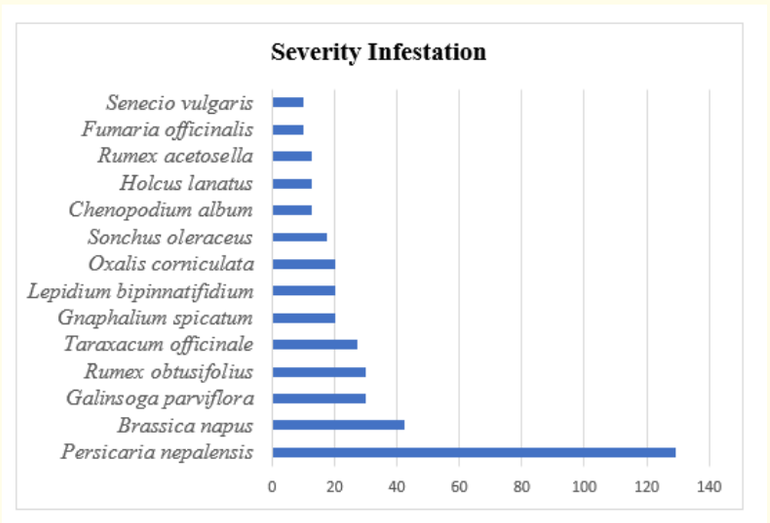

Figure 1: *Major weeds in potatoes of San Gabriel (Carchi).*

Weed infestation in the province of Imbabura presents very little variation with respect to what was seen for San Gabriel (Figure 2). *Persicaria nepalensis* is also the prevailing species accompanied by *Galinsoga parviflora, Gnaphalium spicatum, Rumex obtusifolius, Lepidium bipinnatifidum* and *Taraxacum officinale*.

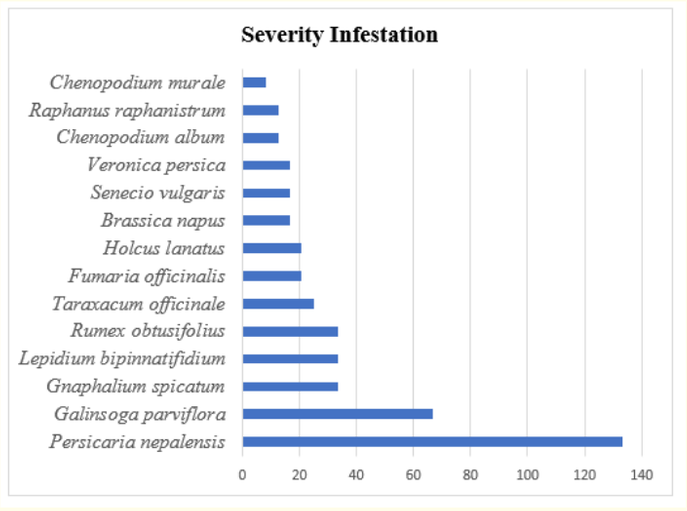

Figure 2: *Major weeds in potatoes of Imbabura.*

Despite being a traditional practice in many potato-producing areas, especially in Imbabura, it would be appropriate to verify to what extent mashwa favors the reduction of weeds within the potato crop.

Persicaria nepalensis was not found in the potato of the Cotopaxi province, where the covers of *Chenopodium album* (false quinoa) were the prevailing ones (Figure 3), followed by *Fumaria officinalis, Galinsoga parviflora* and *Raphanus raphanistrum*.

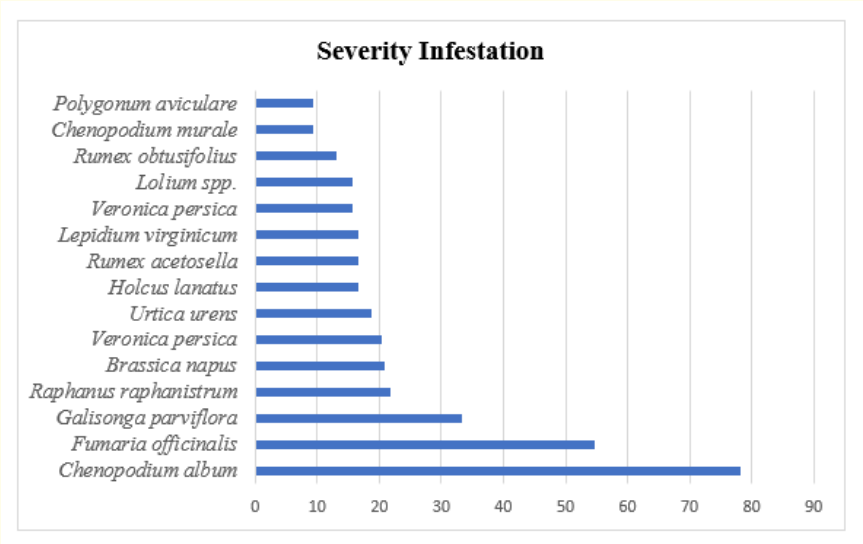

Figure 3: *Major weeds in potatoes of Cotopaxi.*

Previous information on weeds [4,12] indicate the presence of Kikuyu grass (*Pennisetum clandestinum* Hochst. ex Chiov.) in potato areas of the country. This weed was only seen outside the fields, which is a good indication that its control has improved.

However, farmers should understand the importance of weeding in early crop stage to avoid weed competition and avoiding yields reduction, and this can only be achieved with proper land preparation bringing about weed emergence for its removal before planting.

The fact that potatoes in several areas are covered with weeds for a large part of their vegetative cycle clearly indicates that the loss of yield and quality of the production obtained can be avoided by improvement of the system for weed management in potatoes.

Since the potato has a long cycle there, it is necessary to keep the crop weed free, at least during the so-called critical period. For the conditions of potato grown in Iran it is recommended to eliminate weeds from 19 - 24 days post-crop emergence up to 43 - 51 days [14]. In the case of potato grown in Huambo, Angola, the recommendation is to keep weed free the crop from 26 to 66 and from 20 to 61 days after emergence [15]. Both recommendations seem to be closest to the conditions of potato grown in Ecuador.

For the purpose of weed removal the use of rotatory hoes as a post emergence operation, burying weed seedlings in soil has been determined as effective [16,17]. The best for small holders in Ecuador would be to identify suitable manual rotatory hoes. In Ecuador most of weeding as well as potato harvest is carried out manually by a crew of 10 or more workers depending on the size of the field.

There is advice for the use of soil-acting herbicide, such as selective-to-potato metribuzin [4,12], an aspect that should be carefully validated in the field and making sure that there is no leaching of metribuzin or its metabolites (desaminometribuzin, desaminodiketometribuzin, and diketometribuzin) to groundwater. It is known that the second and the third metabolites are persistent and potentially able to contaminate groundwater [18]. The same concern is also applicable to other herbicides, approval of which should come once assessed their environmental impact.

Paraquat is not highly recommended for desiccation of potato haulm. Use of this chemical is restricted in several countries. In addition, the most used desiccant for potato haulm has been diquat, although less toxic than paraquat, again its use has been withdrawn in Europe due to toxicological concerns. Some other desiccants are under experimentation, such as pyraflufen-ethyl and carfentrazone-ethyl [19], which obviously should be tested and validated locally. In the case of potato in Ecuador weed cover at the time of harvest is high and there is a need to prevent weed interference with harvest, which causes potato tubers left in the field increasing their mechanical injury.

Conclusion

Obtained results suggest improvement of weed management in potato keeping the crop weed free during the critical period of weed competition, testing and validating manual hoeing for inter-row weeding, and/or chemical control using tested herbicides with previous risk assessment of their environmental impact.

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Volume 7 Issue 4 April 2021