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Garden Pea used as a temporary crop to establish grass and legumes pastures: Effect on weed botanical composition

La arveja como cultivo temporal para el establecimiento de pasturas de gramíneas y leguminosas: Efecto en la composición botánica de las malezas

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Abstract

This research was carried out at IVITA's Research Center of the Universidad Nacional Mayor de San Marcos in the department of Junín, Peru. The main objective was to determine the effect of garden pea plants (*Pisum sativum*), seeded by broadcast to establish a temporary crop, on the abundance and botanical composition of weed species during the establishment of a pasture mixture of grasses and legumes in the Mantaro Valley. The following treatments were evaluated: T1, mixed pasture with manual weeding, without garden pea. T2, mixed pasture without weeding and garden pea. T3, mixed pasture with garden pea and without weeding. A Completely Randomized Block design with three replications was used for statistical analysis of the experiment. All plots were broadcasted with, 10 kg ha^{-1} of *Lolium multiflorum* Lam. 'Tama', 10 kg/ha of *Lolium boucheanum* K. 'Belinda', 5 kg/ha of *Medicago sativa* L. 'SW8210' and 3 kg/ha of *Trifolium pratense* L. 'Quiñequeli'. An additional 50 kg/ha^{-1} of *Pisum sativum* L. 'INIA 103 Remate' was broadcasted first on treatment T3. Weed botanical composition was evaluated on T2 and T3 treatments. The Asteraceae and Poaceae weed families recorded greater number of species while the Brassicaceae family recorded the greatest abundance, during pasture establisment in the Mantaro Valley. The most important species according to the Importance Value Index (IVI) were: *Brassica rapa* subsp. *campestris*, *Avena sativa* and *Medicago polymorpha*.

Key words: Weeds, garden pea, pasture.

Resumen

Esta investigación se condujo en el Centro de Investigación del IVITA Mantaro, de la Universidad Nacional Mayor de San Marcos, en el departamento de Junín, Perú. El objetivo principal fue evaluar el efecto de la arveja (*Pisum sativum*) sembrada al voleo como cultivo temporal, sobre la abundancia y composición botánica de las especies de malezas, durante el establecimiento de una pastura asociada (gramíneas con leguminosas), en el valle del Mantaro. Los tratamientos fueron: T1, establecimiento de la pastura con deshierbo manual, sin arveja; T2, establecimiento de la pastura sin deshierbo y sin arveja y T3, establecimiento de la pastura con arveja y sin deshierbo. Los tratamientos se dispusieron en un diseño de bloques completos al azar, con tres repeticiones. En cada una de las parcelas se sembraron al voleo, la pastura (gramíneas y leguminosas), en cantidades de 10 kg/ha de *Lolium multiflorum* Lam. 'Tama', 10 kg/ha de *Lolium* x *boucheanum* K. 'Belinda', 5 kg/ha de *Medicago sativa* L. 'SW8210' y 3 kg/ha de *Trifolium pratense* L. 'Quiñequeli'. En el tratamiento T3, previo a la siembra de la pastura, se sembró al voleo 50 kg/ha de *Pisum sativum* L. 'INIA 103 Remate'. Se evaluó la composición botánica de las malezas en los tratamientos T2 y T3. Las familias Asteraceae y Poaceae de malezas registraron el mayor número y variedad de especies, mientras que la familia Brassicaceae registró la más alta abundancia, durante el establecimiento de la pastura en el valle del Mantaro. Las especies más importantes, según el Índice de Valor de Importancia fueron: *Brassica rapa* subsp. *campestris*, *Avena sativa* y *Medicago polymorpha*.

Palabras clave: Malezas, arveja, pastura.

Introduction

In the Mantaro valley, 60 kg/ha of seed is used for sowing garden pea, and its cultivation involves cultural practices (sowing, weeding, tillage, hilling, pest management and control, etc.). As early varieties of garden pea with erect growth and high demand as vegetables are available, some studies showed the possibility of planting them as a temporary crop during pasture establishment (Ordóñez *et al.*, 1999; Ordóñez and Bojórquez, 2001). The role of garden pea is not limited to protecting pasture from adverse climatic factors and providing dry matter in total forage production, but also to provide ecological and economic

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services with the sale of green pods. Temporary crops have certain benefits such as: rapid growth and cover of the soil when forage grasses and legumes are in the early stages of development, weeds are supressed, soil erosion by water is reduced, fodder production is ensured and competition is minimized. forage crop (Ordoñez and Bojórquez, 2011). The establishment of pastures in the valley, takes an average of 120 days, during which a great diversity of weeds, emerge together with the components of the pastures. Apparently, forage mixtures planted in the Mantaro valley are characterized by a tolerance to competition produced by weeds and by having a subsequent recovery in vigour and dry matter production (Ordóñez and Bojórquez, 2011). In the central highlands there is no research on weed diversity nor on their effect on pasture establishment (Rojas et al., 2011, 2012, 2013a, 2014a)

Garden Pea and pastures are usually planted alone, and each has its own management technology. However, better soil utilization is garden pea sowing as a temporary crop (Ordóñez *et al.*, 1999; Ordóñez and Bojórquez, 2001), where light and soil moisture and nutrients are better utilized (Rojas et al., 2010). On the other hand, it is possible that garden pea could counteract the negative effect of weeds on the establishment of mixed pasture. At the IVITA Mantaro Research Center, herbicides are not used in pasture establishment and it is preferred to let mixed pastures to establish by themselves for approximately 120 days (Rojas et al., 2014a). Pastures are usually seeded on land where potatoes have been harvested and annual broadleaf weeds appear (Rojas et al., 2013b and 2013a). A viable alternative with probable biological and economic benefits could be the simultaneous sowing of mixed pastures with garden pea, as a temporary crop, where the garden pea would replace, at least in part the weeds, producing greater benefits. Temporary crops must have rapid growth and cover the soil when forage legumes are still in the early stages of development. They also suppress weeds by competition, reduce water soil erosion, ensure forage production, while producing minimal competition to forage crops (Ordoñez and Bojórquez, 2011).

Therefore, the following research question was formulated: What is the effect of broadcasted garden pea plants, as a temporary crop, on weed diversity, during the establishment of a mixed pasture (grasses with legumes) in the Mantaro Valley?, and as a null hypothesis: sowing pea as a temporary crop does not influence the diversity or botanical composition of weeds during the establishment of a mixed pasture (grasses with legumes) in the Mantaro valley. The main objective of this study was to determine the effect of a garden pea crop broadcast sown for the establishment of a temporary crop, on the abundance and botanical composition of weed species during the establishment of a mixed pasture.

Materials and methods

The study was carried out at the IVITA Mantaro Research Center of the Universidad Nacional Mayor de San Marcos, located in the Mantaro Valley, Province of Jauja, in the Junín Region, at 3320 masl, with an average annual precipitation of 750 mm, annual mean temperature 11 °C, on a sandy-clay loam soil poor in nitrogen, medium in phosphorus and high in potassium. The preparation of the soil was conventional, with two disc plow passes, two disk dredge passes, after which 3 m wide beds were constructed with a leveling blade. A mixture of four forage species was sowed, at the density recorded in Table 1. The sowing consisted in passing a rigid tip harrow to remove the soil, then garden pea seed cv. 'INIA 103 Remate' was broadcasted at 50 kg/ha, followed by a disc harrow pass to cover the seed. The pasture mixture was seeded at a density of 28 kg/ha· with the grasses accounting for 71 percent of the mixture and the legumes 29 percent. Treatments evaluated are shown in Table 2.

Table 1. Amount, species and cultivars present in the grass-legume mixed pasture sown in the Mantaro valley, Junín, 2012

Common name	Scientific Name	Cultivar	kg ha^{-1}
Italian rye grass	Lolium multiflorum	Tama	10
Hybrid rye grass	Lolium x boucheanum	Belinda	10
Alfalfa	Medicago sativa	SW8210	5
Red clover	Trifolium pratense	Quiñequeli	3

Table 2. Treatments evaluated in this study

Treatments	Description
T_1	Mixed pasture establishment with manual weeding without pea.
T_2	Mixed pasture establishment without weeding nor pea
T_3	Mixed pasture establishment, with pea, without weeding.

A completely randomized block design with three replications was used. At 120 days after sowing (das) weed diversity was evaluated in treatments T2 and T3, in four quadrants of 0.5 m x 0.5 m (0.25 m^2 in area), making one square meter per treatment. In such quadrants weeds were counted by species and number of individuals were registered. With this data the density and frequency were determined and, using their relative value, the Importance Value Index (IVI) was obtained (Matteucci and Colman, 1982; Mostacedo and Fredericksen, 2000).

The Importance Value Index is calculated as the sum from (i) the relative frequency; (ii) the relative density; and (iii) the relative dominance. The frequency is calculated as the number of plots where a specie is observed divided by the total number of survey plots. Relative frequency is calculated by dividing the frequency by the sum of the frequencies of all species, multiplied by 100 (to obtain a percentage). Density is calculated as the total number of individuals of a species. Relative density is calculated by dividing the density by the sum of the densities of all

species, multiplied by 100. Dominance is calculated as the total basal area of a species. Relative dominance is calculated by dividing the dominance by the sum of the dominance of all species, multiplied by 100.

The botanical composition of the mixed pasture was evaluated according to T'Mannetje and Haydock (1963) and Haydock and Shaw (1975), in four quadrants of 0.25 m^2, making one square meter in each treatment. (Ordoñez and Bojórquez, 2011).

For the taxonomic identifications of the weed diversity we used those determined by Rojas et al. (2010). For the taxonomic location, the classification system APG II and III which is considered, the most modern system for the classification of angiosperms according to phylogenetic criteria (APG, 2009).

Results and Discussion

A total of 11 weed species belonging to seven families were recorded (Table 3). The Asteraceae and Poaceae families accounted for 27.27 percent each of the total number of genera and species respectively (Table 4). The most representative families in terms of number of species were: Asteraceae and Poaceae, which together registered 54.55 percent. Of the remaining families, five were represented by a single species and constituted 45.45 percent (Table 4).

Data in Table 3 indicate that there was no greater effect on weed diversity due to garden pea sowing, since in T2 and T3 treatments, weed species were the same, with the exception of *Veronica persica* and *Bromus catharticus* that disappeared with the sowing of pea. However, data in Table 5 shows that in treatment 3, sowing of garden pea caused a significant reduction in plant density per m^2 of *Tagetes multiflora*, *Fuertesimalva limensis, Erodium cicutarium* and to a lesser extent of *Medicago polymorpha*, with no major effects on *Brassica rapa* subsp. campestris or *Avena sativa*.

Table 3. Diversity of weeds recorded at 120 days after seeding of the mixed pasture sown in the Mantaro Valley, Junín. February 2013.

Plant Family	Plant Species	T_1*	T_2	T_3
Brassicaceae	*Brassica rapa* subsp. *campestris*	-	x	x
Malvaceae	*Fuertesimalva limensis*	-	x	x
Fabaceae	*Medicago polymorpha*	-	x	x
Geraniaceae	*Erodium cicutarium*	-	x	x
Plantaginaceae	*Veronica persica*	-	x	-
Asteraceae	*Galinsoga parviflora*	-	x	x
	Tagetes multiflora	-	x	x
	Sonchus oleraceus	-	x	x
Poaceae	*Avena sativa*	-	x	x
	Bromus catharticus	-	x	-
	Pennisetum clandestinum	-	x	x

*T1 (mixed pasture establishment with manual weeding, without garden pea; T2 (mixed pasture establishment without weeding nor garden pea), and T3 (mixed pasture establishment with garden pea and without weeding.

Table 4. Families with the highest number of genera and species recorded during the establishment of the mixed pasture. Mantaro Valley, Junín. February 2013.

Plant Family	Genus	%	Plant Species	%
Asteraceae	3	27.27	3	27.27
Poaceae	3	27.27	3	27.27
Otras	5	45.45	5	45.45
Total	11	100	11	100

In treatment 2, (table 5) the species presenting Important Value Index (IVI) equal to or greater than 10 percent were five: *Brassica rapa subsp. campestris* with 33.8 percent, *Fuertesimalva limensis,* with 12.0 percent, *Avena sativa* with 11.2 percent, *Medicago polymorpha* with 10.9 percent, and *Erodium cicutarium* with 10.0 percent. Two species had higher density (>50 individuals/m): *Brassica rapa* subsp. campestris and *Avena sativa* with 209.3 and 40.7, respectively. In treatment 3, the species with higher IVI (>10%) were three: *Brassica rapa* subsp. campestris with 40.0 percent, *Avena sativa* with 14.1 percent and *Medicago polymorpha* with 11.4 percent. A single species recorded higher density (>50 individuals m^{-2}); this was *Brassica rapa* subsp. campestris with 202.67 plants m^{-2} (Table 5)). *Brassica rapa* subsp. campestris is an important weed in the Peruvian sierra, as it is found as an invasive species in many crops (Flores and Malpartida, 1987, Villagomez 1988, Monsalve and Cano, 2005*)*.

Tabla 5. Density and Importance Value Index of weed diversity during the establishment of the mixed pasture. Mantaro Valley, Junín. February 2013.

Species	T_2*		T_3	
	Plant Density plants m^{-2}	% IVI	Plant Density plants m^{-2}	% IVI
Brassica rapa subsp. *campestris*	209.3	33.8	202.7	40.0
Fuertesimalva limensis	37.3	12.0	19.3	9.6
Medicago polymorpha	28.7	10.9	22.0	11.4
Erodium cicutarium	21.3	10.0	12.0	9.8
Veronica persica	2.7	1.6	0.0	0.0
Galinsoga parviflora	3.3	2.9	2.7	3.1
Tagetes multiflora	36.7	9.5	13.3	6.1
Sonchus oleraceus	0.7	1.3	1.3	2.8
Avena sativa	40.7	11.2	39.3	14.1
Bromus catharticus	2.7	2.8	0.0	0.0
Pennisetum clandestinum	12.0	4.0	3.3	3.2
Total	395.3	100.0	316.0	100.0

IVI = Ímportance Value Index
T2 (mixed pasture establishment without weeding nor garden pea); T3 (mixed pasture establishment with garden pea and without weeding).

Brassica rapa subsp. campestris, *Fuertesimalva limensis* and *Tagetes multiflora*, are the most important ecological weeds in the establishment of pastures grown in the Mantaro valley (Rojas et al., 2011, 2012, 2013b, 2014a, 2014b). The interaction "cultivated grass-weeds", during the 120 days after sowing, does not seem to affect the population and final production of the forage (Ordóñez and Bojórquez, 2011; Rojas et al., 2014a, Bojórquez et al., 2015).

Brassica rapa subsp. campestris recorded the highest Importance Value Index values in Treatments 2 and 3 with 33.8 and 40.0 percent respectively. *Brassica rapa* subsp. campestris produces biocidal compounds such as glucosinolates, which by hydrolysis give rise to substances such as isothiocyanates. Both products have been considered as products toxic to pest and diseases (Brown and Morra 1997, Kirkegaard and Sarwar, 1998). The amount of glucosinolates is greater during flowering and serve to keep weeds at bay.

Conclusions

The Asteraceae and Poaceae families recorded more species, while the Brassicacea family showed higher abundance during the mixed pasture establishment in the Mantaro valley. The most important species according to the Importance Value Index were: *Brassica rapa* subsp. campestris, *Avena sativa* and *Medicago polymorpha*. It is hypotesized *that Brassica rapa* could act as a weed control agent during mixed pasture establishment.

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