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Article

Effect of weeds on the yield of chiltepín pepper

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Abstract

Chiltepín pepper (*Capsicum annuum* var. *glabriusculum*) is characterized by being a wild plant appreciated in several regions of Mexico as a condiment and for its intense spiciness. It is a species with small, variable-sized fruits, and as a crop, it can be affected by interference from other undesirable plant species. The research aimed to determine the competitive capacity of weeds on chiltepín fruit yields in terms of weight, number, length, and diameter. A trial was established in 2024 under greenhouse conditions in Tlajomulco de Zúñiga, Jalisco, where the chiltepín pepper crop was maintained with interference from three plant species: *Cyperus rotundus* (coco-grass), *Cynodon nlemfuensis* (African bermudagrass), *Medicago sativa* (cultivated species of alfalfa), emerging weeds and a clean control. The results showed that the treatment with emergent weeds exhibited a total loss of fruit yield (99.97%), followed by *C. nlemfuensis*, whose greater competitive capacity reduced the yield in weight (88%) and the number of peppers (93%). Treatment with *C. rotundus* was the one that most affected fruit size, with a 14% reduction in length and a 9.5% reduction in width. Treatment with *M. sativa* showed interference with fruit weight and number only after the 5th cut, compared with the clean control.

Palabras clave:

Cynodon nlemfuensis, *Cynodon nlemfuensis*, *Medicago sativa*, fruits, production.

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Introduction

The wild pepper *Capsicum annuum* var. *glabriusculum* (Dunal) Heiser and Pickersgill is called in Mexico by different names depending on the region, some of them being amashito, max, piquín, chiltepín (Latournerie-Moreno *et al*., 2020), quipín, piquincito, and quipincito (Martínez *et al*., 2012). This spice is important for its culinary use, for being an economic resource, and for its well-known medicinal tradition, constituting a cultural symbol in Mexico (Bañuelos *et al*., 2008), and whose gene pool is being lost (Castellón-Martínez *et al*., 2012).

The chiltepín pepper is generally known for its round shape in some regions; however, it can also have an elongated fruit shape (Rodríguez-del Bosque, 2005). Morphological variability and variability in the fruit length/diameter ratio have been reported (Alcalá-Rico *et al*., 2023), which supports the characterization of genotypes whose gene reservoir may have potential use for the genetic improvement of this resource. The fruit, bright orange-red or red at maturity, can be globose and measures 6 to 8.5 mm in diameter, or it can also have an ellipsoid or ovoid shape and be 9-13 mm long (Barboza *et al*., 2022).

It is considered a non-domesticated species, and almost all of it comes from wild harvests (Araiza-Lizarde *et al*., 2010; Ramírez-Meraz *et al*., 2015; González-Cortés *et al*., 2015), although it has also been subjected to cultivation (Semarnat, 2009; Márquez-Quiroz *et al*., 2013; Megchún-García *et al*., 2024).

Like some crops, yield can be affected by the interference of weed plants and in the region of Tlajomulco de Zúñiga, Jalisco, invasive plants have been reported, such as *Cynodon nlemfuensis*, whose species is a serious problem due to its difficulty of management and control (López-Muraira, 2008) and *Cyperus rotundus*, which stands out for being considered one of the worst weeds in the world (Holm *et al*., 1977); therefore, the objective was to evaluate the effect of the interference of *Cynodon nlemfuensis*, *Cyperus rotundus*, *Medicago sativa*, and emerging weeds on fruit yield in number, weight, and size under greenhouse conditions because this species is appreciated regionally for its flavor and spiciness and established non-commercially in small plots for its value as a condiment.

Materials and method

The research was conducted in a greenhouse of the Technological Institute of Tlajomulco, Jalisco, located at 20.44239° north latitude and 103.42047° west longitude, with an altitude of 1 556 m. Climatic conditions were recorded with a digital thermo-hygrometer (ThermoPro TP359®), with temperatures ranging from 15.6 °C to 47.5 °C (average of 31.55 °C) and relative humidity from 10% to 71% (average of 40.5%).

The soil preparation began with the complete weeding of the area, with the aim of making the furrows uniform. Management was based on an integrated and intensive nutritional program. The organic base was mature compost and fortnightly applications of worm leachate, with a C/N ratio of 2.07 and high potassium; it was enriched with humic/fulvic acids, glutamic acid, alginic acid, and beneficial microorganisms (*Trichoderma* spp. and *Bacillus* spp.). The cumulative dose was 650 ml of leachate per plant (applied at 10% concentration, 0.5 L per plant/event). To cover peaks in demand, this base was complemented with strategic microdoses of NPK fertilizers and calcium nitrate, the formulations of which were adjusted to the growth phases.

Chiltepín pepper seedlings were acquired and planted in a double-row triangular pattern, with a distance of 40 cm between plants. The average height of the seedlings at the time of transplantation was 13.4 cm. Phenological development was as follows: the first flower buds appeared 10 days after transplanting (dat), with the first flower open at 12 dat. Flowering occurred consistently between 18 and 31 dat. Finally, the start of fruit filling was observed at 38 dat.

The design used was completely randomized with five treatments and 23 replications, having a total of 115 chiltepín plants for the entire trial. The nine harvest cuts were carried out on different dates after transplanting: cut 1 (103 dat), cut 2 (109 dat), cut 3 (121 dat), cut 4 (131 dat), cut 5 (141 dat), cut 6 (152 dat), cut 7 (161 dat), cut 8 (173 dat) and cut 9 (183 dat).

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To ensure the interference effect of the weed on the chiltepín, 10 days prior to transplanting the crop, seedlings of coco-grass (T1) (*Cyperus rotundus*) were transplanted at a distance of 10 cm between plants, African bermudagrass runners (T2) (*Cynodon nlemfuensis*) also at a distance of 10 cm apart, seeds of alfalfa variety CUF 101 (T3) (*Medicago sativa*) were sown at a sowing density of 18 kg ha^{-1}, and as emerging weeds from seed, the natural establishment of the local weed complex (T4) was allowed; finally, the clean control treatment (T5) consisted of manual weeding to keep the chiltepín crop free of weeds and competition throughout the cycle.

In the general management, weeding activities were carried out to remove unwanted species in each of the different treatments, except T4, since no weeding was carried out in this case. The variables to be evaluated were:

Yield in weight

For each fruit harvested, fresh weight in grams was recorded with an A&D GR-120 precision analytical balance.

Number of peppers per cut

The number of fruits harvested per plant/cut was quantified.

Pepper size

For this parameter, the length and diameter (mm) of each fruit were measured using an Urrea digital vernier caliper.

For the statistical analysis of the data, the Minitab 2019 statistical package was used, applying an analysis of variance (Anova) to the variables evaluated, followed by Tukey's multiple comparison test, using a 95% confidence level.

Results and discussion

As a result of the experimental design, 7 676 fruits were harvested, yielding a total of 1 404.57 g for the nine cuts and in the total of the treatments. Treatment four showed the presence of 18 weed species distributed in 10 botanical families, with a total population of 1 690 individuals (Table 1).

Table 1. Weed species found in treatment four and the number of individuals per species.

Scientific name	Family	No. of individuals
Panicum adhaerens Forssk.	Poaceae	585
Portulaca oleracea L.	Portulacaceae	206
Eragrostis sp.	Poaceae	193
Gnaphalium americanum Mill.	Asteraceae	180
Euphorbia hirta L.	Euphorbiaceae	177
Perityle microglossa Benth.	Asteraceae	85
Oxalis corniculata L.	Oxalidaceae	67
Chenopodium album L.	Amaranthaceae	45
Apium leptophyllum (Pers.) F. Muell.	Apiaceae	41
Galinsoga parviflora Cav.	Asteraceae	31
Nama dichotomum (Ruiz & Pavón) Choisy	Hydrophyllaceae	27
Lepidium virginicum L.	Brassicaceae	19
Solanum americanum Mill.	Solanaceae	16

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Scientific name	Family	No. of individuals
Oenothera tetraptera Cav.	Onagraceae	5
Amaranthus palmeri S. Watson	Amaranthaceae	5
Euphorbia prostrata Aiton	Euphorbiaceae	3
Amaranthus spinosus L.	Amaranthaceae	3
Sonchus oleraceus L.	Asteraceae	2
Total 18 species		**1 690**

The species *Panicum adhaerens* had the highest density, with 585 individuals, followed by *Portulaca oleracea* with 206 individuals, which covered 51.5% of the total weed population. The interference with the emerging weed (T4) reduced the yield parameter by 99.97% with respect to the number of fruits, which can be considered as a total loss, and considering the problem of weeds in the pepper crop, as in many other crops, it has a significant impact on yields; thus, it has been reported that weeds caused an average reduction of 76% in sunflower (Esperbent, 2015), of 52% in corn (Soltani *et al*., 2016) and of 78% in soybeans (Silva *et al*., 2008).

Yield in weight and number of fruits of the treatments

Regarding fruit weight, the total yield of the clean control was 37% higher than that of alfalfa (T3), with an average fruit weight of 0.158 g (Table 2). Higher weights are reported in wild populations of piquín peppers, with average values of 0.211 g (Ramírez, 2018). In the cultivation of different pepper varieties, it has been reported that humus or organic fertilizers influence the yield in terms of weight (Abreu, 2018; Luna-Ortega, 2025).

Table 2. Average weight and number of chiltepín fruits (23 plants/treatment).

Cut	Coco-grass		African bermudagrass		Alfalfa		Weeds		Clean control	
	Weight (g)	No. fruits	Weight (g)	No. fruits	Weight (g)	No. fruits	Weight (g)	No. fruits	Weight (g)	No. fruits
1	0.08 ab	23	0.105 a	24	0.072 ab	14	0	0	0.025 c	10
2	0.122 b	41	0.08 c	18	0.178 a	54	0	0	0.114 b	20
3	0.048 b	15	0.082 b	30	0.174 a	135	0.026 c	2	0.174 b	102
4	0.019 b	6	0.061 b	17	0.174 a	257	0.018 c	2	0.177 a	144
5	0.051 b	12	0.082 b	27	0.168 a	200	0.017 c	3	0.165 a	324
6	0.109 b	45	0.078 c	18	0.157 a	403	0.006 d	2	0.171 a	527
7	0.148 c	131	0.055 d	8	0.189 b	395	0	0	0.206 a	587
8	0.152 c	152	0.051 d	9	0.183 b	742	0.004 e	2	0.204 a	1175
9	0.147 c	238	0.138 c	110	0.172 b	534	0 d	0	0.186 a	1133

Different letters in the same column indicate significant differences, Tukey= 0.05. At 103 dat (cut 1); 109 dat (cut 2); 121 dat (cut 3); 131 dat (cut 4); 141 dat (cut 5); 152 dat (cut 6); 161 dat (cut 7); 173 dat (cut 8); 183 dat (cut 9).

The number of peppers in the alfalfa treatment (T3) for the first, second, third and fourth cuts is higher than that of clean control, with 28%, 62%, 24% and 43%, respectively, since it has been reported that *Medicago sativa* contributes nitrogen to the soil (Ballesta and Lloveras, 2010). Subsequently, the clean control overcomes the alfalfa treatment (T3) in the remaining cuts. Finally, the clean control obtained 32% more fruits than the alfalfa treatment. The interference with African bermudagrass (T2) is also reflected in the number of fruits since, in the entire trial, only 261 peppers were produced, and compared to the clean control, the yield decreased by 93%.

The interference of coco-grass (T1) in the number of fruits is 88% lower than that of the clean control (T5) and agrees with studies that have shown that the interference of *Cyperus rotundus* can reduce yields by up to 44% in tomatoes and 32% in bell peppers (Morales-Payan *et al*., 1997) and corn grain weight (Silva *et al*., 2015).

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Fruit length and diameter

In relation to these parameters, T5 (clean control) produced wider and longer peppers compared to T1, T2 and T3. The coco-grass treatment was the most affected, with a reduction of 14% and 9.5% in fruit length and width, respectively, followed by treatment T2 (African bermudagrass) with a reduction of 9.5% and 2.6% in fruit length and width, respectively. Finally, treatment T3 (alfalfa) was the least affected in these parameters, with reductions of 1% and 1.5% in fruit length and width, respectively, compared to the clean control (Table 3), probably due to the *Rhizobium* nodules contained in *Medicago sativa* and their contribution of nitrogen to the soil (Campillo *et al*., 2003).

Table 3. Length and width of chiltepín fruits.

Cut	Coco-grass		African bermudagrass		Alfalfa		Weeds		Clean control	
	Length (mm)	Width (mm)	Length (mm)	Width (mm)	Length (mm)	Width (mm)	Length (mm)	Width (mm)	Length (mm)	Width (mm)
1	6.59 a	6.75 a	7.42 a	7.05 a	6.71 a	6.73 a	0	0	6.51 a	6.73 a
2	6.43 c	6.55 ab	6.58 b	6.17 b	6.86 a	7.02 a	0	0	7.1 a	7.18 a
3	5.7 d	5.99 c	6.15 c	6.01 c	6.75 b	6.63 b	7.22	10.2	6.91 a	6.92 a
4	5.11 d	5.47 c	5.95 c	5.82 b	6.88 a	6.81 a	7.03	7.61	6.8 a	6.92 a
5	5.35 c	5.96 b	6.14 b	5.95 b	6.46 a	6.43 a	0	0	6.41 ab	6.66 a
6	6.01 b	5.95 b	6.88 ab	6.7 a	6.63 a	6.49 a	6.38	0	6.64 a	6.62 a
7	6.34 c	6.12 b	7.98 a	6.53 a	7.9 a	6.53 a	0	0	7.6 b	6.47 a
8	6.75 c	5.92 b	8.12 a	6.41 a	7.55 b	6.41 a	0	5.37	7.98 a	6.47 a
9	6.29 d	6.12 b	6.57 c	6.44 a	7.07 b	6.58 a	0	0	7.48 a	6.59 a

Different letters in the same column indicate significant differences, Tukey= 0.05. At 103 dat (cut 1); 109 dat (cut 2); 121 dat (cut 3); 131 dat (cut 4); 141 dat (cut 5); 152 dat (cut 6); 161 dat (cut 7); 173 dat (cut 8); 183 dat (cut 9).

This may be related to critical periods of weed competition, a crucial concept in crop management, representing the period during which unwanted plants most significantly impact yield (Blanco *et al*., 2014). In the specific case of peppers, it has been determined that the critical period of competition is between eight weeks after transplantation (Galal *et al*., 2020). This period varies with the species cultivated, and in the case of eggplants, it can reduce yield by up to 66% and the formation of top-quality fruits by 96% (Aramendiz-Tatis *et al*., 2010).

Conclusions

Treatment T4 (weeds) showed the greatest interfering effect on the crop yield of chiltepín (*Capsicum annuum* var. *glabriusculum*), causing the total loss of fruit production.

The treatment with coco-grass (T1) caused adverse effects on chiltepín fruit weight, with an 88% reduction in yield; likewise, it produced the smallest fruits, with an average length of 5.11 mm, which significantly impacted fruit length and width. The *Cynodon nlemfuensis* (T2) grass was the weed species that most negatively affected the chiltepín pepper, impacting the yield in terms of weight and the number of fruits obtained, with a 96.4% reduction compared to the clean control.

On the other hand, the impacts on fruit length and width were minor, at 2.5% and 5.7%, respectively, compared to the clean control. The alfalfa treatment (T3) showed interference with the chiltepín crop only after the 5th cut and yielded more peppers during the first four cuts than the clean control. However, the yield in terms of total weight was affected by 37% compared to the clean control.

Moreover, fruit length and width were not affected. The effects of the different treatments on the growth and yield of chiltepín peppers revealed significant results that underscore the importance of proper weed management in agricultural production. This is especially true for species such as *Cynodon nlemfuensis* and *Cyperus rotundus*, which individually showed negative impacts on the development and production of chiltepín peppers.

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