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Popular Article

A Study on Autoecology and Ecophysiology of Chile Piquin (*Capsicum annuum* Aviculare Dierb), a Wild Chilli of High Medicinal and Commercial Value in Northeast Mexico

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Abstract

A study has been undertaken on history, autoecology and ecophysiology of chile piquin (*Capscicum annuum* var. aviculare (Dierb). Studies were undertaken on morphology of the plant, root system, pollen viability, phenology, effects of water stress on growth and productivity. Morphological values were higher except dry weight in chile piquin compared to that in mouse's eye. It possess profuse fasciculate root system occupying a greater part of soil extending to deeper depth. The percentage of pollen viability ranged from 51 to 90%, average was being 72.7%. All pigment contents were lower than that of Mouse's eye indicatingthat chile piquin is more efficient in potential photosynthetic capacity compared to that in Mouse's eye. It was observed clearly that the water potential of Mouse's eye was highly fluctuating at different dates of collection, but in the case of chile piquin, it was more or less stable indicating higher level of tolerance to water stress. It indicated that the former has high capacity of extracting soil moisture even from lower soil layers. Both P, K and Fe content were higher in fruits whereas leaves contained highest content of Mg and Cu; Zn content highest in flowers. Number of leaves was higher in the treatment where application of 150 cc water was done at every two days interval, but the number decreased abruptly with increasing water stress. Growth attributes like leaves, fruits, branch numbers as well as plant height, dry weights of these had also been found to decrease with the degree of water stress.

1. Introduction

Chile piquin (*Capsicum annuum* Aviculare Dierb) is wild chilli of high commercial and medicinal value and harvested by farmers from its wild habitat in forest and mountainvalley in northeast Mexico. Owing to difficulty in germination, it is not cultivated but transplanted in home gardens. It has high demand both in the national and international markets for its pungency and taste, medicinal values but it is costly. Little research has been undertaken on this wild chilli. This article gives a brief review of various aspects of this wild chilli.

The Chile piquin, a wild chili represents a natural resource and typical culture of northeast Mexico. This plant species is a component of the shrubs of Northeast of Mexico and is perennial. It grows in the semi-arid and tropical region of Mexico. Ithas high commercialvalue as condiment, medicine and also a source of income of the inhabitants of the region (Medina Martinez, 2007).This grows in the Tamaulipanthornscrub forests of mesquites, oaks etc. Mostly they grown in shade under the trees to avoid heat stress.

It is estimated that the 15% of the rural population of northeast Mexico is dedicated to the collection of chile piquin from its wild habitat during the months of September to December, and during this period, 60% of the income obtained by the communities is through the collection and sale of the abundant product present during this period. The rest of 40% of the income is obtained from other agricultural activities. This activity is carried out mostly by women and children in this process (Medina Martinez et al., 2007; Medina Martinez, 2010).The local consumers have special preference for the variety of the regional chilepiquin in comparison with serrano and jalapeno pepper, although having the same characteristics (Rodriguez et al., 2004).

The price of the product is influenced by the demand of the market. The greater offers of the product by the producers tends to reduce the price (Medina Martinez, 2007). At the same time, the greater part of the production is available in the natural vegetation of northeast Mexico, depends mainly on the rainfall and the prevailing temperature (not more than 35 °C), so that

the pollens are not dehydrated and the minimum temperature (not lower than 15 °C) for normal physiological processes. The collection was found to decrease owing to the decrease in rainfall and high temperatures (up to 42 °C) (Rodriguez et al., 2004; Medina Martinez et al., 2006).With respect to the commercialization of this product, it is sold commonly in fresh forms. Besides, some alternatives may be to store in dry forms in packets, preparing sauce, in brine, or in the form of powders, which pretends to give higher prices, and there by, preserve the resource in natural forms (Medina Martinez, 2010).

One of the main problem they face is the difficulty to obtain labour at the peak period of harvest during the first phase. An average of seven harvest/picking is undertaken during this phase. The first phase is the month of May and June, when the prices of chilli piquin is higher in the market. Other problems of management is the damage by virus. The biology faculty, UANL, Mexico has made good progress in the development of technology on the harvest of chilli piquin in natural condition in forests of mesquites and oaks up to the production in the green house. They made an extensive survey on the mode of harvest by the local farmers from wild condition for sustainable production. This article thus focuses on the basic information with some tested findings to understand this crop.

2. Taxonomy

• Scientific name: *Capsicum annuum*var. *aviculare* Linnaeus cv. 'Chile Piquin'
• Family:Solanaceae
• Order: Solanales
• Bot. Synonyms: *Capsicum annuum* var. glabriusculum. *Capsicum annuum* L. var. minimum (Miller) Heiser, *Capsicum annuum* L. var. minus (Finger huth) Shinners*, Capsicum baccatum* auct. non L.*, Capsicum frutescens* sensu Standl.
• In Northeast of Mexico, it has various common names such "Chile del campo", "Chile del monte", among others.
• Popular names: Chile Piquin, Chile Piquin, Chile Pequin, Piquin, Amashito, Mashito, amash, chile de monte, Pequin pepper, Bird pepper, peperoncino degli uccelli (El Rincon del chile
• Pequin (or Piquin) pepper (pronunciation: pee/puh-KEEN) is a hot chile pepper cultivar commonly used as a spice. Taxonomically, it is classified within variety glabriusculum of the species *Capsicum annuum*.

3. Botany

Chile Piquin has a compact habit growing typically 0.3-0.6 m tall, with bright green, ovate leaves and small fruits that rarely exceed 2 cm in length. The chile piquin plant has a bushy habit with a strong stem and horizontal branches presented in alternate manner on main stem. The horizontal branch extends laterally on all sides of the main stem and produce secondary, tertiary, quaternary branches in dichotomous manner depending on the availability of the space. Stem is round, strong, green with longitudinal streaks which may vary in different habitat. Leaf deep green, thin, pliable, spear shaped. Mid rib is thin with 5 to 6 lateral veins with reticulate venations. The upper leaf is deeper in green tan on the lower surface. It possess profuse fasciculate root system. Starting from the base of the stem, few thick roots grow downwards in an inclined manner which in turn produce profuse secondary, tertiary finer roots occupying a greater part of soil extending to deeper depth (Figure 1). Flowers are small with 5 white petals, united and five sepals, joined. Fruit small, round or elliptical depending on ecotype. Fruit contains many seeds that are flat with hard seed coats. Like other chillies, the fruits are green in the beginning, while ripening they turn to brilliant red at maturity. Flavour is described as citrusy, smoky (if dried with wood smoke), and nutty. Ripe fruits are used in the preparation of hot sauce, soups and vinegars.

4. Adaptation

Ii is originally of tropical regions and grows on hot climate starting from sea level up to 30 m. Cultivated family garden and associated with tropical perennial forest.The distribution and production of chilepiquin extends in low valley from the south of USA up to Peru.

5. Medicinal Properties

The medicinal properties are attributed to cure of skin problems and bodies with scars, grains. It has use to stop bleeding using toasted fruit.This plant excite flatulence, stimulate appetite, provoke urine, and help in digestion.

6. Cultivation Practices

• The chile piquin (*Capsicum annuum* aviculare Dierb "piquin") is an herbaceous, perennial plant harvested from their wild habitat or cultivated for small red chillies starting from summer, spring up to winter autumn.
• Soil should be moist and well drained for good growth. Irrigation is given with maximum of 1.5" (3.81 cm) supplied each week during spring and summer. The plants should be irrigated in the morning for assuring good growth of foliage.
• The plant requires a place partially shiny with fertile well drained soil.It should be taken into account that it bears more fruits which receive six or more hours of direct sun light daily.
• The plants of chile piquin is fertilized with fertilizer soluble in water @ 5-10-10 (NPK) at the time of sowing. Apply second fertilization when the plants start flowering. Specialists should be consulted for correct application of nutrients.
• The fruits are harvested when they are one inch (2.54 cm) on length and possess a dark maroon colour. Utilize chillies when fresh or dried for its future use.

• The plants are pruned after the harvest of chilli to control its size and form. One third part of plant growth is removed with sterile garden scissors. Remove the foliage affected with disease, damaged or dead to maintain healthy plants.
• It prefers to grow under shade of a tree on rocky substrate. The population decreases in open habitat exposed direct to sun.
• It is advisable to spread one layer of two inches (5.08 cm) of organic matter which help around the plant to conserve the soil moisture. This also helps to conserve soil moisture and control the growth of weeds.
• The hand should be washed with water and soap before manipulation of chilli. This will protect plants to control disease.

7. Production of Seeds

• All the species of genus of *Capsicum*, are self-pollinated. The genus *Capsicum*, include more than 30 different species, therefore do not require pollination for reproduction caused by insects like bees, flies etc. But the majority of the species of *Capsicum* may be cross-pollination by insects.
• Seeds should be collected only from the healthy fruits, although not matured may be kept until matured. Although immature fruits can be kept to mature in ideal temperature.
• The entire matured fruits with thin skin can be dried, while it can be cut into halves and seeds can be dried later.The drying of fruits can be done over heater or hot climates in environmental temperature or in the sun, but if the climate is very hot, care should be taken, so that the seeds may not rot. The temperature for drying should not exceed 50°C.A good ventilation and humidity should be maintained below 45%. The dry seeds can be kept in hermetic bags in dry placesand fresh in room at 10 °C.
• The seed germinates even after 27 years gave 50% germination if is kept in optimum conditions.

8. Methodology and Findings on Biology and Physiology

8.1. Morphological characters

Data on morphological variables mentioned in the Table 1. 20 leaves each of chile piquin and mouse's eye, another well adapted plant of this regionwere taken. Data on fresh weight (g), leaf length (cm),petiole length (cm), total length (cm), dry weight (g), and water content (g) were taken and the average was calculated.It was observed that the values of morphological values were higher except dry weight in chile piquin compared to that in mouse's eye.

8.2. Pollen viability

We collected flowers from 11 A.M. to 12 A.M. This study was undertaken to determine the effect of the prevailing environmental temperatures (23°C, 28°C, 30°C and 32°C) on pollen viability percentage of four species of woody trees, at the time of collection. We adopted two techniques- staining with 1% safranin and 3% iodine in KI, the latter was found to be better than the first one. The fresh anthers were separated, squashed and stained with 3% iodine in potassium iodide for 10 minutes and then counted the number of pollen grains stained as viable at 40× under light microscope, each with 10 replications. The percentage of pollen viability ranged from 51 to 90%, average was being 72.7% (Table 2).

8.3. Determination of chlorophyll and carotenoids

Four samples of leaf tissue (1.0 g of fresh weight) of each plant species were used for analysis. The chlorophyll a and b and carotenoids were extracted in 80% (v.v.) aqueous acetone and vacuum filtered through a Whatman No.1 filter paper. Pigment measurements were determined spectrophotometrically using a Perkin-Elmer Spectrophotometer (Model Lamda 18). Absorbance of chlorophyll a, and b and carotenoid extracts were determined at wavelengths of 669, 645 and 470 nm respectively. Carotenoid (mg g^{-1} dry weight) of pigments were calculated by equations of Lichteenthale Wellbaum, 1983.

A comparative analysis of pigments (Chla, Chl b, carotenoids, Chl(a+b), Chl(a/b), Chl(a/b)) revealed that the pigment contents varied in different dates of collection in both chile piquin (*Capsicum annuum* var aviculare) and Mouse's eye, another native plant showing the influence of environments on pigment production. It is also observed that all pigment contents were lower than that of Mouse's eye indicating that chile piquin is

Table 2: Pollen viability of chile piquin

No. of observations	% Viability	No. of observations	% Viability
1.	67	6.	67
2.	51	7.	75
3.	69	8.	85
4.	78	9.	76
5.	90	10.	69

Table 1: Morphological parameters

Species	Dates	Fresh weight (g)	Leaf length (cm)	Leaf breadth (cm)	Petiole length (cm)	Total length (cm)	Leaf arear (mm^2)	Dry weight (g)	Water content (g)
Chile piquin	14th May, 2014	0.12032	4.892	2.8	1.5284	6.4204	9.3926	0.02792	0.0924
Mouse's eye	14th May, 2014	0.09948	3.692	1.856	0.68	1.89248	5.4116	0.03648	0.063

more efficient in potential photosynthetic capacity compared to that in Mouse's eye (Table 3). It is also observed that the amount chlorophyll obtained from chile piquin at 2nd May was lower than that observed at 14thMay indicating the influence climatic condition on thechlorophyll content.

Table 3: Chlorophyll and carotenoids content

Species	Dates	Chla (mg g^{-1})	Chlb (mg g^{-1}))	Car (mg g^{-1}))	Chl (a+b)	Chl (a/b)	Chl (a+b)/ Car Mg g^{-1}
Chile piquin	2nd May	1.416	0.4398	0.3159	1.8561	3.1247	5.9016
Chile piquin	14th May	1.8784	0.5363	0.3949	2.4147	3.6904	6.3296
Mouse's eye	14th May	1.0429	0.2992	0.2468	1.3421	3.5423	5.3758

8.4. Water potential (Mpa)

Water potential is determined at 2 pm at intervals of more or less 15 days starting from May to September. The water potential (Mpa) of chile piquin and Mouse's eye determined at 2 pm at intervals of more or less 15 days in 10 dates starting from 8th May upto 23rd September revealed that water potential varied at different dates of collection depending on the environments and soil moisture. In the case of chilepiquin, it ranged from -1.47Mpato -3.05 Mpa, while in the case of Mouse's eye,itvaried from -1.57 Mpato -4.14 Mpa (Table 4). This indicates clearly that chile piquin is more tolerant to drought compared to that of mouse's eye. Chile piquin was well adapted to xeric condition while (mouse's eye) showed fluctuation indicating its susceptibility to water stress. 1st September sampling Mouse's eye showed drastic drop of water potential, while Chile piquin showed good recovery. Itwas observed clearly that the water potential of Mouse's eye was highly fluctuating at different dates of collection, but in the case of chile piquin, it was more or less stable indicating higher level of tolerance to water stress. On 23rd September with the receipt of rain fall,chile piquin recovered fast.

Table 4: Comparative status of water potential (Mpa)

Plants	8th May	14th May	28th May	16th Jun	30th Jun	15th Jul	4th Aug	19th Aug	1st Sep	23rd Sep
Capsicum annuum	-1.6	-1.482	-1.482	-2.21	-1.98	-1.64	-1.53	-1.95	-3.05	-1.47
Bernardia myricifolia		-2.63	-2.05	-4.07	-3.16	-3.6	-2.14	-4.14		-1.57

8.5. Soil moisture contents

We took soil moisture contents in the localities both for chilepiquin and Mouse's eye and shown in the Table 5. The soil moisture contents was determined at different dates in 5 replications at five different depths starting from 0-10 cm, upto

Table 5: Soil moisture contentsat different depths of soil and dates

Species	Dates	Soil depth (cm)				
		0-10	10-20	20-30	30-40	40-50
Chile piquin	14th May, 14	34.55	10.72	10.59	7.36	9.96
Chile piquin	28th May, 14	30.85	26.86	24.17	25.79	25.13
Chile piquin	16th Jun,14	17.26	12.99	14.03	15.73	18.96
Chile piquin	30th Jun, 14	15.19	13.91	12.79	16.74	18.94
Chile piquin	15th Jul, 14	16.65	15.54	12.58	12.95	18.58
Chile piquin	4th Aug, 14	18.98	14.23	13.18	12.50	12.41
Chile piquin	19th Aug, 14	15.63	14.51	15.27	14.82	14.20
Chile piquin	1st Sep, 14	11.37	11.46	14.54	13.47	16.28
Chile piquin	23rd Sep, 14	39.41	30.34	28.68	27.29	32.77
Mouse's eye	14th May, 14	12.54	6.86	5.33	7.36	7.137
Mouse's eye	28th May, 14	30.33	21.56	23.53	22.34	21.08
Mouse's eye	16th Jun,14	12.04	14.01	13.52	15.14	17.39
Mouse's eye	30th Jun, 14	16.47	14.26	14.81	16.44	17.86
Mouse's eye	15th Jul, 14	15.22	16.32	15.51	14.63	14.02
Mouse's eye	4th Aug, 14	20.69	16.91	14.25	15.20	14.24
Mouse's eye	19th Aug, 14	13.38	11.83	13.83	16.59	17.23
Mouse's eye	1st Sep, 14	13.20	11.75	29.15	14.45	26.14
Mouse's eye	23rd Sep, 14	29.53	24.37	26.48	31.58	26.24

Figure 1: Growth stages of chilepiquin in polythin bags and field and root system (fasciculated)

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Figure 1: Growth stages of chilepiquin in polythin bags and field and root system (fasciculated)