RELATIONS BETWEEN THORNS AND SHOOTING OF VEGETATIVE AND FLOWER BUDS IN *Crataegus pubescens* (H.B.K.) Steud.

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ABSTRACT

The results were obtained on some types of *Crataegus* germplasm collection either on trees grown from seeds (single tree data) or from selected wild trees, reproduced by grafting to seedling stock (5 to 8 trees per type). Collateral shoots, emerging at the thorn base, were shorter, thinner, and mostly vegetative in nature (89.67 %). The lateral shoots, appearing in the thorn-free zone, of the extension growth, were larger and more frequently terminated with inflorescences (29.96 %). Fifty percent of collateral buds remained dormant, while all lateral buds bursted. The collateral shoots were in 78.4 % equal or shorter than 10 mm, while 86.9 % of lateral shoots were longer than 10 mm. It seems, that the thorns controlled the shooting of collateral buds, the size of emerging shoots and the formation of flowering shoots. The degree of such action was modified by the particular selection. Thus, the thorns might modify the tree productivity by slowing down the process of collateral shoots differentiation and by reducing, temporarily or permanently, the number of buds shot per node by half.

ADDITIONAL KEY WORDS: hawthorn, nodes, lateral bud, collateral buds, flowering.

RELACIONES ENTRE LAS ESPINAS Y LA BROTACIÓN DE YEMAS VEGETATIVAS Y FLORALES EN *Crataegus pubescens* (H. B. K.) Steud.

RESUMEN

Este estudio se realizó en algunos tipos de la colección de germoplasma de *Crataegus* en árboles generados de semilla (resultado de un árbol) o de árboles silvestres seleccionados y reproducidos por injertación sobre patrones francos (5 a 8 árboles por tipo). Los vástagos colaterales, que salieron en la base de la espina, fueron más cortos, más delgados y en estado libre de espinas, sobre los tallos de crecimiento largo, fueron más largos y terminaban con inflorescencias con una frecuencia mayor (29.96 %). Cincuenta por ciento de yemas colaterales permanecieron dormidas, mientras que todas las yemas laterales brotaron. Los vástagos colaterales fueron en 78.4 % iguales o más cortos de 10 mm, mientras que 86.9 % de vástagos laterales fueron más largos de 10 mm. Los datos sugieren, que las espinas controlan la brotación de yemas colaterales, el tamaño de vástagos emergentes y la floración de vástagos generativos. Las espinas, entonces, pueden modificar la productividad del árbol por desacelerar el proceso de diferenciación de yemas en vástagos colaterales y al reducir, temporáneo o permanente, el número de yemas brotadas por nudo en 50 %.

PALABRAS CLAVE ADICIONALES: tejocote, nudos, yemas laterales, floración.

INTRODUCTION

Crataegus pubescens (H.B.K.) Steud. is one of the many species of fruit trees of México (Borys 1994; Borys and Nieto-Angel, 1994). Some cultigens of *Crataegus* free of thorns are commercially grown on 5,000 ha. Almost 60 papers were presented on species biology, ecological values, management practices and industrial use in Mexico (Anonymous, 1991). One special feature is the presence of selections free and heavily armed with thorns (Nieto-Ángel *et al*., 1991).

It is widely accepted that thorns form a defensive, physical barrier to wild and domesticated ruminants, nevertheless it has been shown that, these animals may be the principal cause of disappearance of *Crataegus* stands (Linhart and Whelan, 1980). Three horticultural types of *Crataegus* can be distinguished on the basis of the thorns presence: a) those with continued formation of thorns, each node giving a thorn, b) those with annual zonal formation of thorns, that is, a zone presenting a thorn in each node and a zone of nodes free of thorns, c) those with all nodes completely free of thorns (Borys and Leszczyñska-Borys, 1993). The

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thorn appears from the axillary bud, on a shoot representing annual increment of growth (Delbrouck, 1875).

The thorny rootstocks had no influence upon grafting results (Nicolás-Cruz and Borys, 1984). Thorns of the scion may be one of the causes of lower, local, cambium activity, which resulted in uneven radial growth of the stem (Borys, 1991). Initial field observations indicated that thorns may have inhibitory influence upon shooting of collateral buds and the number of flowering shoots (Borys and Leszczyñska-Borys, 1993). Comparing the thorny group of *Crataegus* with the thorn free group, it was found, that the first one was less productive (Nieto Angel *et al*., 1991). The probable reason lays in the number of buds per node. In *Crataegus* armed with thorns, two accompanying buds per node are present. In thorn free selections accompanying buds are absent. The term "collateral" refers to buds or shoots located at the base on one or both sides of the thorn; "lateral" to buds or shoots located in the zone where thorns were not formed. Often, one or both collateral buds are failing to shoot or show a weak, vegetative growth resulting in a barren spur (Borys and Leszczyñska-Borys, 1993). The lateral buds are present on extension growth and on thorny short twigs. Those on the thorny short twigs usually remain dormant for one to few years; they may never shoot. The aim of the present paper is to report the results of the observations upon the thorn's influence on: a) the size of shoots emerging from collateral thorns or lateral buds from nodes free of thorns, b) the percent of vegetative and flowering shoots, c) the shooting of buds.

MATERIAL AND METHODS

Some selections that form part of the *Crataegus* germplasm collection at the Universidad Autónoma Chapingo were evaluated. Single tree of each selection (Plot J 41), established from seeds or vegetatively propagated (Plot J 42) by grafting the scions to four or more *Crataegus* seedlings were sampled. The samples included trees thorn free and showing zonal presentation of thorns (Figure 1, 2). The grafting wood was taken from an old or young but heavily fruiting, wild tree (terminal extension growth). These were observed for the effects of thorns upon sprouting of collateral buds and the size of vegetative or flowering shoots. Similar observations were conducted on twigs of *Crataegus* trees, a) heavily armed with thorns (each node one thorn), b) types showing zones free of thorns and zones heavily armed, and c) types completely free of thorns (cultigens). The data reported refer to types showing zonal formation of thorns and types free of thorns. Observations were made from the southern and northern part of the crown distinguishing, the spring and summer flushes of growth. Under Mexican conditions, trees grown in well watered or in deep soils may give two, sometimes three flushes of terminal extension growth. The zones of concentration of buds, present below the terminal buds or appearing between the spring and summer flushes, were excluded from observation. Also, were excluded from the count the lateral buds appearing on thorny short twigs.

Normally, one node produces one thorn. A thorn is understood to be a thorny, short twig (shoot) or a true thorn (Phipps, 1983). The term lateral bud is used to refer to a bud present on twigs' zones free of thorns (whole year growth or a zone of one season growth).

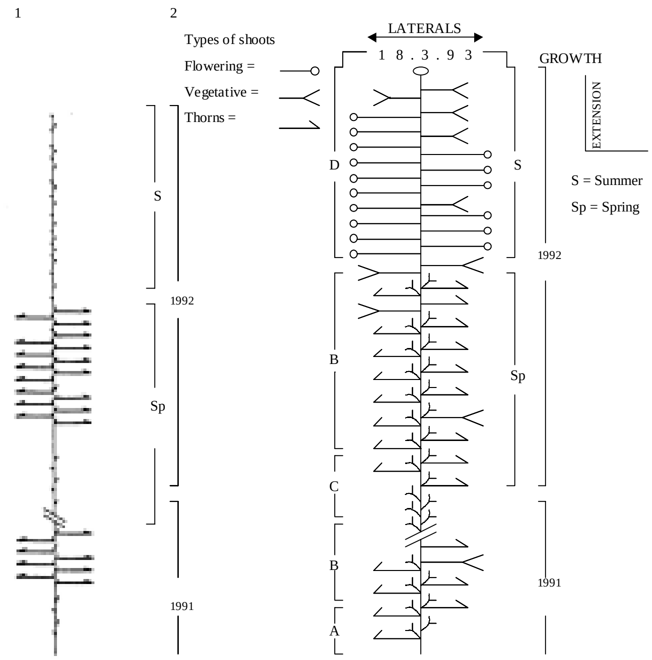

FIGURE 1. Schematic representation of shoots development in *Crataegus* type H4-1, with zonal formation of thorns and, two flushes per year of extensión growth. In thorn free nodes either vegetative or flowering laterals developed; in thorny nodes only vegetative shoots of very reduced size appeared. The laterals developed in the spring of 1993. Zone. A: latent buds; B: thorn covered, with shoots of reduced size; C: thorn free with laterals of reduced size; D: thorn free, with flowering laterals of normal size; (1) situation in the winter 1992, (2) in the spring of 1993.

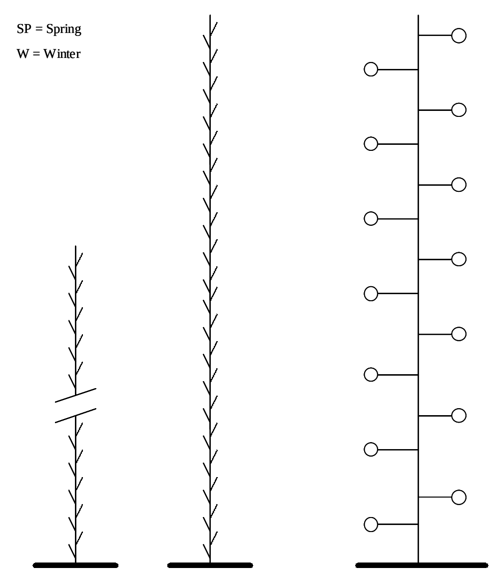

FIGURE 2. Schematic, typical growth reaction in *Crataegus* type free of thorns (TH). In the spring of 1991 the twigs were prunned giving large shoots. In the spring of 1992 all lateral buds giving flowering shoots.

RESULTS AND DISCUSSION

The lateral buds of thorny twigs, in some types of *Crataegus*, may burst, with resulting slow growth for two-three years. All laterals of extension growth usually are bursting (Figures 1, 2, 3, 4, 5, 6, 7, 8, 9, 10). Comparing the number of buds shoot, the size of shoots and the number and percentages of collateral and lateral buds transformed from vegetative to flowering shoots (Table 1, 2, 3, 4, 5) the overall inhibitory or delaying effect of thorns is clearly evident. The thorn might be inhibitory, because some or all collateral buds do not develop or may develop thorns and, delaying, because some or all do develop the following years into vegetative or flowering shoots. The shoots of initial size below 10 mm remain short and thin (Table 6), unproductive. Those larger than 10 mm will give a high percentage of fruiting shoots (5 to 20 cm large).

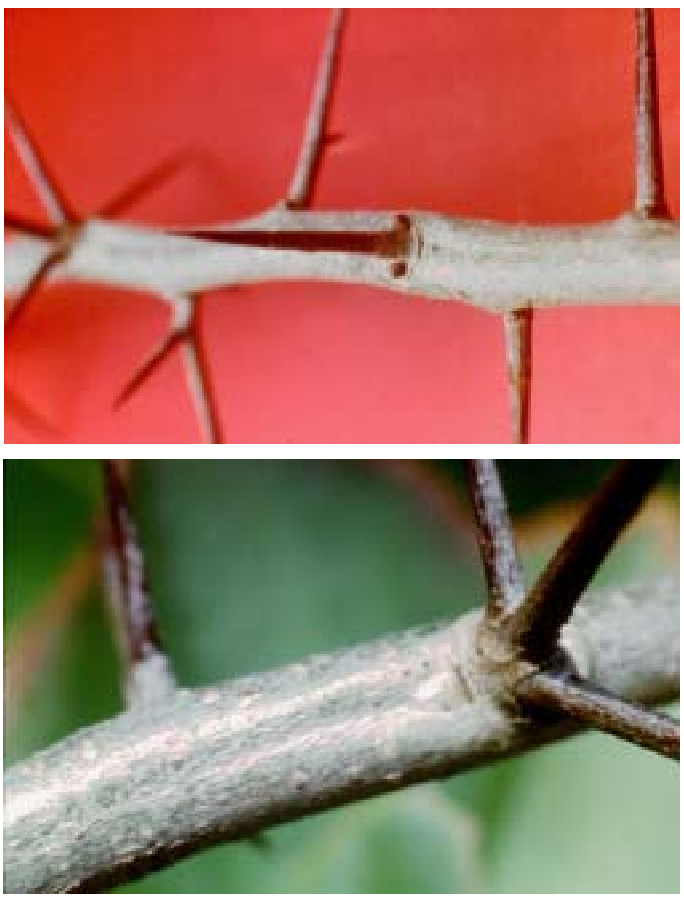

FIGURE 3. The thorn affected the radial growth of *Crataegus* twig. Below the thorn a hollow formed due to uneven growth girth. Two collateral buds accompanied the thorn. The hollow was deep and gradually fading with the distance from the thorn. This suggested that the hollow formation depended directly from the thorn. Both collateral buds remained dormant. The phenomenon of hollows formations was observed in various hawthorn types in the collection.

FIGURE 4. The spring extensión growth terminated with very restricted internodal growth and a concentration of underdeveloped *Crataegus* buds. These nodes were not counted. Afterwards, the apical bud gave summer flush of extension growth.

The results presented in Figures 1, 2, 9 and Table 3, 5 indicate that, where the thorns do not form, the flowering shoots are present and, where the thorns appear, vegetative shoots prevail and the appearance of flowering shoots is prevented or delayed by some years, totally or partially. This general response of buds to the presence or absence of thorns is modified by the selection of *Crataegus* (Table 3, 4) and, probably, by the season's conditions under which the shoot grows or forms (Allsopp, 1965; Delbrouck, 1875). The spring shoots (Table 4), from thorn-free nodes gave equal number of flowering and vegetative shoots, whereas the thorny nodes gave a higher number of vegetative shoots. Summer season growth was superior in vegetative shoots. Again, this response was modified by selection.

The lateral buds of the selection free of thorns, may result in 100 % of laterals terminated with inflorescences (Figure 9).

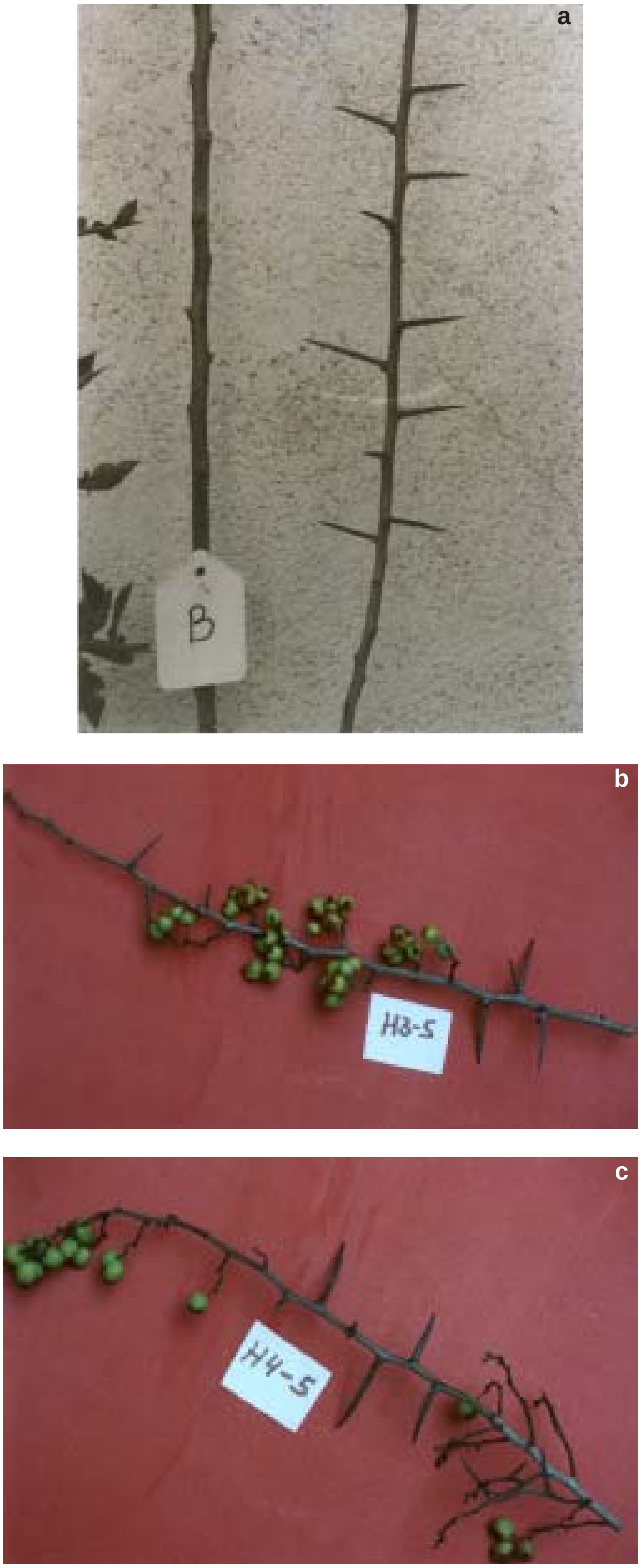

FIGURE 5. ***Crataegus*** **trees of thorny types formed zones free of thorns and heavily armed with thorns (a) giving short, fruiting shoots in the zone free of thorns (b, c). This behavior may last for some years, until thorns collateral buds will produce flowering shoots.**

FIGURE 6. This "thorn pointed" ***Crataegus*** **twig, with two bursting collateral buds, could be classified as true thorn. Close-up examination showed the presence of underdeveloped lateral buds.**

FIGURE 7. The "thorn pointed" ***Crataegus*** **shoot was accompanied by two collateral dormant buds at its base. Three well developed axial buds were present with leaves of residual size. The pointed, apical part was in process of dying back.**

FIGURE 8. ***Crataegus*** **short shoots developed upon compound "three thorns pointed twigs" - Two horizontal and one vertical" as a result of bursting of lateral buds. These shoots needed four years to develop. Each muy produce terminal infloresce in one-two years.**

FIGURA 9. Types of hawthorns free of thorns gave at each node one short shoot terminated with inflorescence.

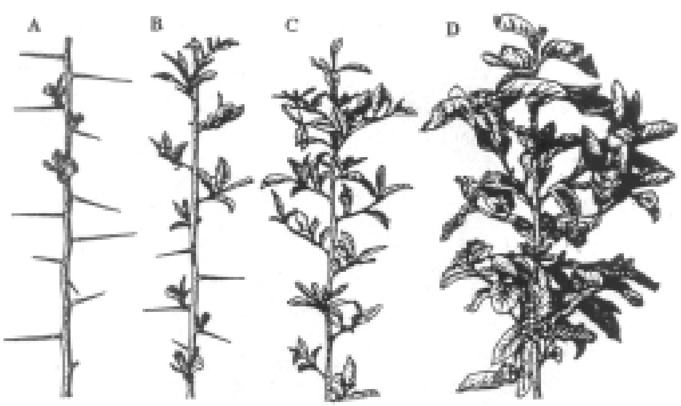

Figura 10. Shooting of collateral (A, B) and lateral buds (C) and the relative length of shoots in the presence (A, B) and absence (C) of thorns in a wild type *Crataegus* compared to shooting and size of lateral shoots of cultivated type free of thorns (D). All the lateral shoots of cultivated type terminated with inflorescences. A, B, C = basal, medial, apical part of a shoot, respectively.

TABLE 1. Total of observations upon the shooting of collateral or lateral buds and the appearance of flower or vegetative shoots of *Crataegus.*

Attributes	Cases	Observed (%)
1. Collateral buds bursting	232	50.00
Collateral buds resting	232	50.00
2. Lateral buds bursting	431	100.00
Lateral buds resting	0	0.00
3. Collateral shoots of > 10 mm of size	89	21.60
Collateral shoots of ≤10 mm of size	323	78.40
4. Lateral shoots of > 10 mm of size	378	86.90
Lateral shoots of ≤ 10 mm of size	57	13.10
5. Collateral shoots with inflorescences	25	10.33
Vegetative collaterals	217	89.67
6. Lateral shoots with inflorescences	207	29.96
Vegetative laterals	484	70.04

TABLE 2. Length of shoots appearing in the zone armed with and free of thorn of *Crataegus*.

Shoot zone	Shoot length (mm)	Influence of selection F Ratio
Thorns absent	37.10	11.42
Thorns present	6.34	12.46

TABLE 3. Number of grown buds giving flowering of vegetative shoots from nodes with and without thorns of *Crataegus.*

Plot	Selection	Buds from nodes			
		With thorns		Without thorns	
		Flowering shoots	Vegetative shoots	Flowering shoots	Vegetative shoots
J41	F4-1	0.0	9.6	3.9	16.3
	H2-17	0.0	1.8	4.7	5.3
	H2-19	0.9	2.3	6.1	5.4
	H2-11	2.0	10.3	1.0	2.3
	H2-13	0.0	8.7	6.3	10.6
	H2-15	2.5	6.0	1.5	1.5
	H2-25	0.0	1.8	3.3	5.5
	H3-3-27	3.0	4.0	6.8	5.6
	H6	2.7	6.0	3.7	7.3
J42	4-3	0.0	0.6	3.8	26.0
	H9-1	0.0	0.0	3.5	10.0
Average		1.0	4.7	4.1	8.7
Ratio of Vegetative/Flowering shoot				4.7	2.12

TABLE 4. Number of buds from nodes without thorns on spring or summer growth giving flowering or vegetative shoot of *Crataegus.*

Plot	Selection	Nodes without thorns: Flowering shoot	Vegetative shoot	Flowering shoot	Vegetative shoot
		Spring Growth			
J42	7/21	1.8	1.4	4.2	4.6
	9/1	12.0	4.5	0.5	2.0
J41	H4/1	0.3	7.3	0.0	10.0
	H2/11	0.3	1.0	5.5	7.0
Average		3.6	3.6	2.6	5.6
		Summer Growth			
J42	7/21	0.0	4.0	0.0	2.6
	9/1	2.0	10.5	0.0	2.6
J41	H4/1|	9.0	8.8	0.0	0.0
	H2/11	0.5	3.0	0.5	10.5
Average		2.6	6.6	0.1	3.8

TABLE 5. Frequency of thorns influence upon the number of flowering or vegetative shoots and number of nodes per shoot of *Crataegus*.

Attributes	Thorns Presence	Mean	Frequency of thorns influence: Ranking Lower	Higher	Ties	P^z
Flowering shoots	-	3.98^y				
	+	0.48	40	3	9	0.0001
Vegetative shoots	-	9.30				
	+	4.17	34	13	5	0.0007
Shoots present	-	13.09				
	+	4.23	42	8	2	0.0001
Nodes	-	15.40				
	+	5.30	43	6	3	0.0001

[y]Wilcoxon matched pairs signed rank test and probability level.
All means comparisons were significant; F from $P \leq 0.05$ to 0.0001
The total number of observation = 52. This includes eleven selections (one-tree) 3-7 shoots were sampled per tree.

TABLE 6. Modifying influence of selection upon the size of *Crataegus* shoots.

	Size of: Extention growth (cm)	Thorns (cm)	Lateral shoot in zones free of thorns (cm)	Collateral shoot in presence of a thorn (cm)
Overall mean	54.9	3.8	3.8	0.6
Minimum	26.0	1.0	0.2	0.0
Maximum	148.0	7.5	14.5	3.2
Selection influence				
F Ratio	6.16***	46.7***	11.73***	14.9***
Chi-square ($P \leq$)	0.001	0.001	0.001	0.001

***; significant with a $P \leq 0.001$.

Coefficient lateral/collateral shoots and potential productivity

One way to measure the potential productivity is to count the number of lateral and collateral buds which develop into fruiting shoots or to estimate the number flowering shoots and compare it with vegetative ones. The other is to measure the number of shoots which may have a high probability of attaining generative size. In the case of *Crataegus* the ones that have a higher probability to generate flowers, and fruits, have the lateral shoots as compared to collateral shoots (Figure 1 compared with Figure 2).

The lateral shoots are formed from axillary buds (lateral buds) whereas the collateral shoots appear from buds, located at the basis of each thorn. Thus, per node free of thorn one lateral bud and/or shoot appears per thorn-free node while, per node armed with a thorn two collateral buds are present, which may or may not shoot. Sometimes three thorns develop per node. Thus, all three buds, one axillary and two collateral, are transformed into a thorn. Also, in the case of *Crataegus* types with zonal formation of thorns or thorn-free zone the length of each zone varies, thus the number of buds may alter. In spite of the reason, the number of lateral shoots dominate over collaterals (Table 7). The most striking attribute is the superiority of laterals to give inflorescences as compared to collaterals (Table 7). Also noteworthy, although less striking, is the manifestation of vegetative shoots, especially those of the larger size (more than 10 mm length).

TABLE 7. Coefficients for the related characters (number/number) of *Crataegus*.

Attributes	Value
1. Laterals with inflorescences / Collaterals with inflorescences	8.28
2. Vegetative laterals / Vegetative collaterals	2.23
3. Collaterals of > 10 mm size / Laterals of > 10 mm size	0.24
4. Collaterals of d≤10 mm size / Laterals of d≤ 10 mm size	5.67
5. Shoots produced in the zone without thorns / with thorns	1.86

The exceptionally high potential of lateral buds to produce flowering shoots (Table 7, Fig. 2) is of importance to the practice of management of *Crataegus* fruit trees plantations, and as ornamental trees and for the selection of types of horticultural desire. The tree types with collateral shoots should have very special, open crown architecture, with long scaffolds. Some selections do have such characteristics (Borys and Leszczyñska-Borys; 1994; Borys, 1996).

Thorn's and shooting of vegetative and/or generative shoots from colllateral buds.

Flowering shoots of *C. azarolus* give terminal inflorescences (Gardner *et al*., 1952). This is also true in the case of the *Crataegus* studied. At present, our data indicate that the presence of thorns or thorny shoots in *Crataegus* do: (a) delay or reduce the shooting of collateral buds, (b) reduce the rate of growth of arising vegetative shoots, (c) influence the percent of vegetative or generative shoots. All the mentioned effects (a,b,c) are modified by the selection.

The presented data, originated from macroscopic field evaluation, was supported by microscopic studies. Juárez *et al*. (1995) found that the rate of formation of generative structures is faster in *Crataegus* type free of thorns as compared to the armed type. Again, the collateral buds remained vegetative.

Thus, thorns influence the potential productivity of trees by delaying the time of differentiation (Juárez *et al*., 1995) and/or by reducing the number of collateral buds differentiated into flower shoots (Figure 1, 11, 12). Tracing back the growth periods of some of the genotypes of *Crataegus* for up to three years, it was found, that in some cases the collaterals needed at least two to three years to reach the generative stage of development, and the laterals of the thorny shoot rarely entered the generative stage in 10 years. Thus, this explains the lower productivity of thorny group of types of *Crataegus* observed by Nieto-Ángel *et al*. (1991). The laterals of a long or short shoots extension growth of a thorn-free type or shoots of thorn free zone, are ready to bear fruits the next season (Figure 1, 2, 13).

The thorny types of *Crataegus* may show higher productivity on the basis of number of inflorescences or infrutescences per node as compared to thorn free types once all the collaterals enter the productive age. This was observed in some selections.

It was stated that the presence of thorns or thorny short shoots negatively influences the formation of vegetative and flowering shoots (presently reported results) or the process of differentiation of meristems (Juárez *et al.,* 1995). Thus, removing thorns should result in accelerated shooting or development of shoots from collateral buds. Cutting off of the existing old or just appearing thorns, gave no positive response. Such results are of no surprise, because the thorn is being formed at the very early stage of growth of axillary bud (Delbrouck, 1875). Such practical procedure was applied already to late to obtain a positive response. The thorn growth may have influenced the development of meristems of collateral buds. The visual changes observed have resulted from much earlier events.

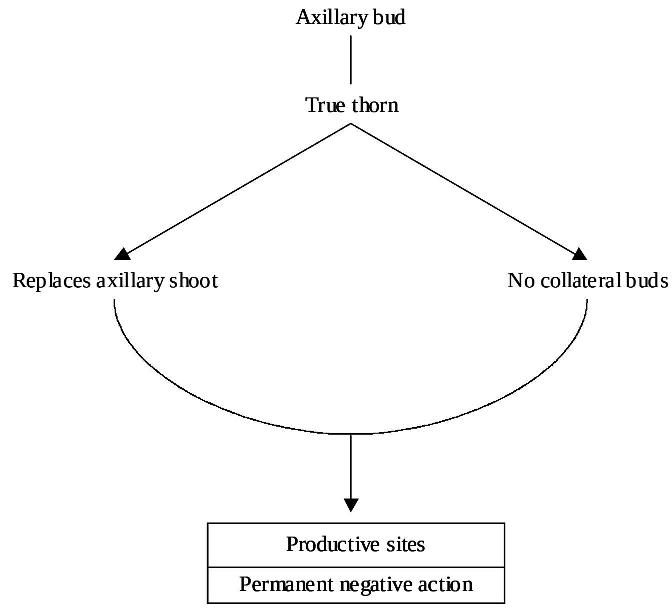

FIGURE 11. Possible situation if an axillary bud in *Crataegus* is transformed into a true thorn. This results in lowering of number of productive sites (flowering shoots).

Thorny shoots and shooting of their lateral buds

Observations indicate that the collateral and lateral buds of thorny shoots remain dormant or show a very slow development (Figure 1, 10, 14). Some of them may enter the generative stage in 10 years. Their foliation - number and size of leaves, is always reduced and depends upon the solar radiation available to trees, scaffold branches, and crown architecture. Similar observations upon the presence, development of lateral buds and leaf size on thorns of the *Rutaceae* are listed by Uphof (1935).

The morphological distinction between the true thorn and the thorny shoot is clear. The true thorn has no buds (Phipps, 1983) and should form neither lateral buds nor leaves, including rudimental ones. Functional distinction should also be mentioned. The true thorn is alive for one, rarely two years. Each thorny shoot, simple or branched, starts to die from thorny apex. The dieback continues up to the first living lateral bud or, in its absence, until location of the collaterals (Figure 5). It is interesting to note that the presence of buds stops the advances of necrosis no matter the degree of bud's development (Figure 5). Details of these and similar phenomena, the discussion of relations, are listed by Borys and Leszczyñska-Borys (1993). The necrosis of the thorn slows down the differentiation of their meristems into flower buds (Juárez *et al.,* 1995). The rate of development of buds, deepens the dormancy of lateral and collateral buds. Perhaps the most interesting result of thorn dieback is the formation of hollows above or below the point of attachment of the thorn or thorny shoot to the twig (Borys, 1991). This, possibly, is related to diminished formation of conducting

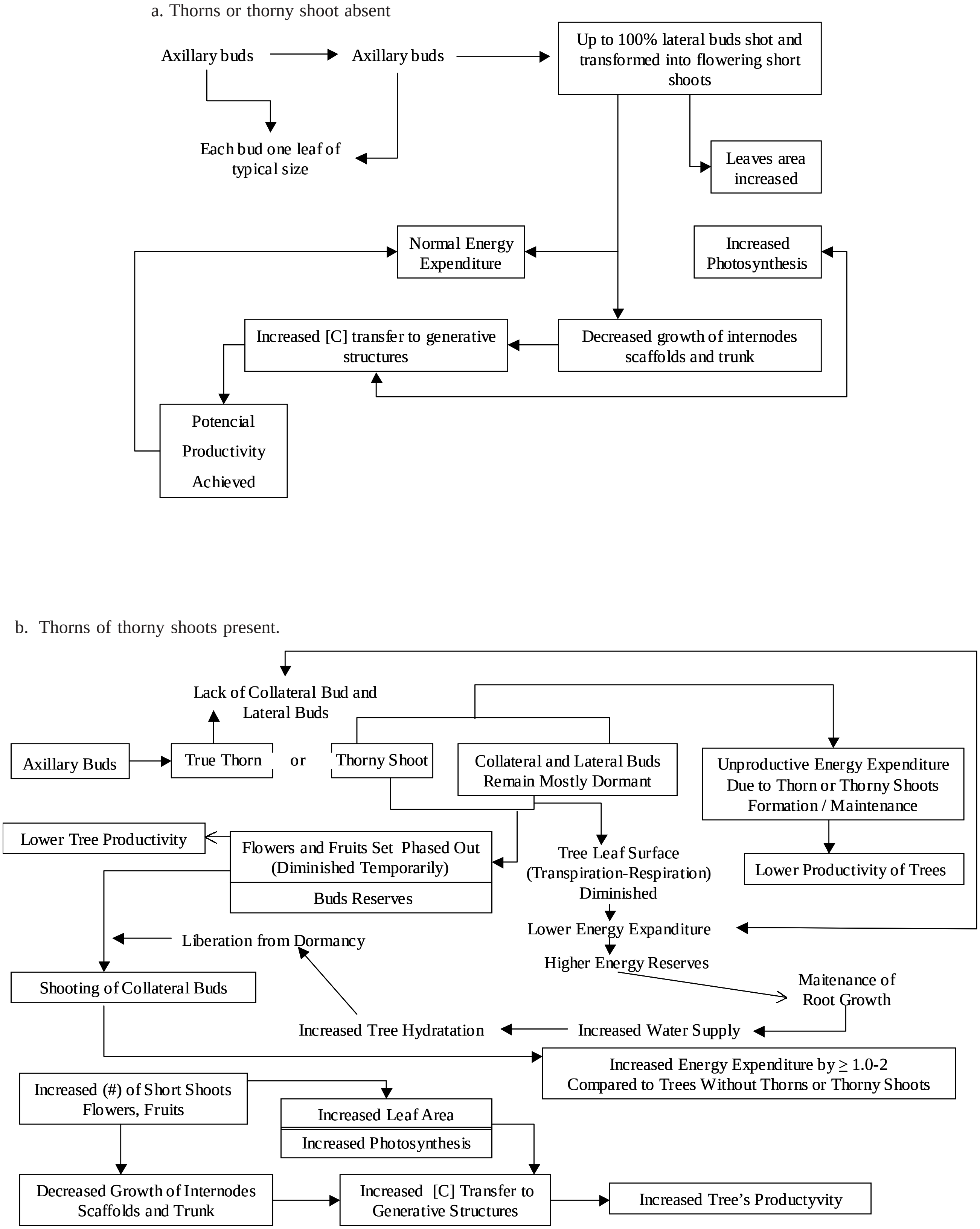

FIGURA 12. The fate of axillary bud in the zone free of thorns or in trees of *Crataegus* free of thorns (a) and, when the axillary bud is transformed into a thorn with resulting actuation of the thorn upon the collateral buds (b).

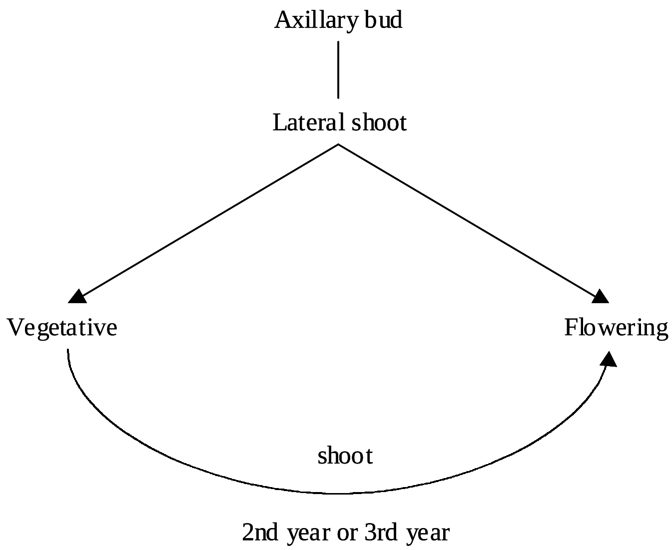

FIGURE 13. Possible situation of an axillary bud in *Crataegus* thorn-free type or in the zone free of thorns.

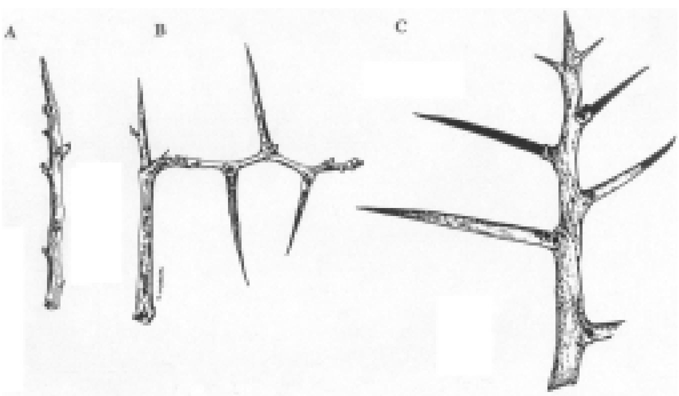

FIGURE 14. Thorny short twigs present in three wild types of *Crataegus*: (A) simple, covered with vegetative lateral buds; (B) simple, converted into armed compound short shoot, with collateral buds at each base of a true thorn remaining dormant and terminated with a vegetative bud; (C) thorny short shoot heavily armed with strong thorns with collateal buds dormant. Note the dieback of each thorn proceeding until the first living bud. The lateral and collateral buds may be converted next years into flowering shoots.

tissues, a probable reason of slow or very slow development of buds located on thorny shoot (thorny twig).

The data presented point to the following: first, all the lateral buds of any type of extension growth of the thorn-free selection or thorny selections, presenting thorn-free zones, may be transformed into flowering (fruiting) shoots. Second, only a part of buds collateral to thorns may be transformed into vegetative and/or flowering shoots and this occurs with a delay. Third, only very few lateral buds of thorny shoots (short shoots terminated with thorns) may be transformed into vegetative and/or flowering ones and, this presents itself after some years of latency. The evaluated selections belong to: (a) group of annual bearing, (b) every second year, (c) with irregular fructification and with very few selections barren for all eight years. The first group dominates. It is interesting to note the dominance of thorny species inside the genus. The thorns are permanently present throughout the whole life cycle of a tree. The thorns, at least in the group of *Crataegus* types appearing in zones, modify the development of collateral buds. All these attributes of *Crataegus* may constitute tactical means of a general strategy of the genus to secure formation of seeds. The annual fructification depends upon species, year, region (Boboreko, 1974) or genotype (Nieto-Ángel *et al*., 1991). The biological aim is to secure seeds production in minimum quantity under extreme natural growth conditions and/or to secure the tree's survival.

It should be accepted that thorns constitute one of the productivity factors of *Crataegus.* It seems, that the thorns control the growth of collateral buds and shoots, the flowering, the fruiting and time of entrance into the flowering stage of such shoots.

The thorns diminish the number of flowers and fruits, and reduce the transpiration surface of the entire tree (number of inflorescences, rudimental leaf surface). Thus, the thorns are engaged in the control of energy expenditure in *Crataegus* and, probably in xerophytic, thorny flora growing under the continued spring stress (high temperature, low relative air humidity, reduced water supply). The thorny species are the floristic component of xerophytic flora (Strassburger, 1980). It would be of interest to see if the effect of thorns, found in *Crataegus*, is also present in other thorny species. No comments were found upon such effects in the paper of Uphof (1935).

Changing the shooting time of collateral buds, outphasing it, probably may secure tree survival, diminish accumulated energy expenditure and the use of water in the critical spring time. These suggestions await experimental proof. The proper expenditure of energy by the tree components is the strategy, achieved by ways of using the tactical options available. That such a partial option is used by the *Crataegus* tree is reflected in the influence of thorns upon the phasing out of shooting of collateral buds, the slowing down of the growth of shoots and the differentiation of vegetative shoots into flowering (fruiting) shoots.

Models of thorn actuation upon the axilary and collateral buds or shoots

There are types of *Crataegus* forming a thorn at each node - true or thorny shoot, simple or ramified, short or large (Figure 14). The thorny short twigs, with collateral or lateral buds may develop shoots, slowly, during the years, which eventually may give flowering and fruiting shoots. The potential to generate inflorescences by lateral buds on thorny short twigs is very low. One or both collateral buds may develop flowering shoots already in the third year after bursting.

The presented measurements, photographs and drawings, form the documentary basis of thorns (thorny shoots) actuation upon the development of collateral buds of *Crataegus* trees (Figure 11, 12, 13). The models are self explanatory and are based upon the reported data. The models are, in part, supported by microscopic study of generation of flower buds (Juárez *et al.,* 1994).

CONCLUDING REMARKS

Crataegus trees are one of many fruit genera presenting thorns. These constitute morphological attributes which damage physically the fruit quality and lower the income of workers involved in grafting, planting, pruning and harvesting. These are the basic reasons of looking for thorn free mutants. The thorns, in many species, express the juvenile stage of development. Most of *Crataegus* species remain thorny throughout the whole life span. The thorns seem to influence the productivity of *Crataegus* representatives. With the case study presented, we wish to point out new aspects for further critical studies on the relations among morphological components of apparent static - thorns and, functional importance -development of vegetative and flowering shoots. The knowledge of these relations is of practical significance for *Crataegus* because it affects its productivity and it may be of importance to other thorny fruit species and for the selection of types of higher productivity.

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