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Economic importance of White Top (*Parthenium hysterophorous* L. [f]) under intense vegetable production in Trinidad

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A weed survey conducted to determine the incidence of *Parthenium hysterophorous* L. (f) in vegetable crops during the wet and dry seasons in Trinidad indicated that the plant is a predominant noxious weed. It has shown the ability to survive bipyridylium herbicide treatments, and biological and cultural control was insignificant in reducing the population of the weed. The weed reduced crop yield in tomato (*Lycopersicon esculentum* Mill.) cv. Calypso by 100% and crop quality in Cauliflower (*Brassica oleracea* var. *botrytis* L.) by 75-100% due to its competitive ability and allelopathic potential. The plant served as a suitable 'resting site' for the adult insect pest *Plutella xylostella* (L.) (Lepidoptera: Yponomenitidae) which attacks cruciferous crops.

Keywords: *Parthenium hysterophorous*; White top; Vegetables

Introduction

Parthenium (*Parthenium hysterophorous* L. (f) # PTNNY)[1] commonly called barley flower (Adams et al., 1972) and white-head or white-top (Hammerton, 1980) in the Caribbean is considered a noxious weed. The plant exhibits wide ecological amplitude, and invades and competes with all types of crops, especially vegetables, with substantial losses in yield (Gupta and Sharma, 1977).

The weed displays characteristics of profuse seedling ability, photothermal insensitivity, non-dormancy, high growth rate, and low photo-respiratory rate (Bridgemohan and Brathwaite, 1987). Hammerton (1980) reported that it has spread within the last few years to all Commonwealth Caribbean countries.

Brathwaite (1978) noted the frequent presence of the weed in the major vegetable growing areas of Trinidad, and reported that it was effectively controlled by dinitroanilines, e.g., butralin [4-(1,1-Dimethylethyl)-N-(1-methylpropyl)-2,6-dinitro-benzenamine] in eggplant (*Solanum melongena* L.), and by the amide herbicide, diphenamid [N,N-Dimethyl-2,2-diphenyl-acetamide] in cabbage (*Brassica oleracea* var. *capitata* L.).

1) Letters following this symbol are a WSSA approved computer code from *Important Weeds of the World*, 3rd. ed., 1983. Available from WSSA, 309, West Clark St., Campaign, IL 61820, USA

The weed is difficult to control physically. It has shown resistance to bipyridylium herbicides in Trinidad, and has become dominant on lands where these chemicals are used intensively (Brathwaite, 1978; Hammerton, 1980; Bridgemohan, 1987). The plant has the ability to survive carbohydrate depletion approach to control (Bridgemohan, 1987).

Parthenium is deemed a noxious weed in Australia (Haseler, 1976), and India (Gupta and Sharma, 1977). In India it causes severe skin allergies (Krishnamurthy et al., 1975) fever and asthma, and often death among the population (Mani et al., 1975). No cases of allergies or death have been reported in Trinidad (R.A.I. Brathwaite, Unpublished data, 1986).

In the Aranguez district, the major producer of the country's fresh vegetables, the weed was identified as early as 1956. However, it was not of any significance until the 1960's when the use of paraquat [1,1'- dimethyl-4-4'-bipyridinium ion] and diquat [6,7-dihydrodipyrido (1,2- a: 2,1-c) pyrazinedium ion]) became widespread.

The objective of this paper is to provide quantitative data on the levels of infestation of *Parthenium* in vegetable crops in the Aranguez district for both wet and dry seasons. Such information is essential for herbicide benefit analysis. The level of losses due to the presence of the weed in vegetable crops is also assessed in the paper.

Materials and methods

Two statistically designed surveys were conducted in the Aranguez District, where the soil type is River Estate Loam (pH 5-6). The first survey was made in the late wet season, October-December, 1986 and the second, in mid-dry season, February-March, 1987.

A random selection of the farms to be surveyed was made with the assistance of the local Agricultural Extension District Office. Apart from conducting counts of *Parthenium* in the crops, the farmers were interviewed with emphasis on the management of the crop, particularly the methods of weed control and their efficacy.

The survey and weed counts were conducted using a modification of the notional square system used by Phillipson (1974). A quadrat of $0.25m^2$ and 10 list counts for each farm were made. The weed number, height, physiological stage of growth, and basal area were recorded.

The data were summarized using seven quantitative measures as previously used and described by Ashby (1948), Misra (1973), Tiwari and Bisen (1981), and Thomas (1935), and modified by Bridgemohan (1987). Visual estimates (VE), Abundance (Ap), Density (DP), Percentage frequency (Fp), Relative dominance (RDi), Relative density (RDp), and Relative frequency (RFp) were determined. These were used to compute the Importance Value Index (IVI).

$$IVI = RDi + RDp + RFp$$

The IVI allowed for comparisons between seasons and years, and among crops. However, it does not necessarily represent losses in crop production caused by the weed as crops vary in their competitive ability. The level of losses due to the presence of the weed in various vegetable crops was assessed, and the economic importance of the weed determined.

Results and discussion

Incidence of *P. hysterophorous* in several crops

Irrespective of the visual estimate (VE) of parthenium infestations in the wet season (Table 1) and dry season (Table 2), the frequency (Fp) in both seasons was greater than 50%.

Table 1 Incidence of P. hysterophorous in the Aranguez District in various vegetables during the wet season (October - December 1986).

Crop	VE	Fp	IVI
Cauliflower [1]	50	90	417.1
Cauliflower [2]	10	70	262.5
Tomato [3]	25	100	274.1
Tomato [4]	50	90	430.0
Tomato [5]	75	100	562.5
Cabbage [6]	40	100	379.9
Cabbage [7]	50	100	974.7
Patchoi	40	100	382.2
Sweet pepper	25	50	265.4
Hot pepper	25	50	273.5
Spinach	30	90	358.0
Okra	100	100	880.0
Fallow field	100	100	910.0
Mean	48	87.5	489.9
S.E.±	7.85	5.2	72.17

1) 2 hand weedings and no herbicides; 2) 1 hand weeding and 1 herbicide application; 3) 2 hand weedings and 1 herbicide application; 4) 3 hand weedings and no herbicides; 5) 2 hand weedings and no herbicides; 6) 2 hand weedings; 7) 1 hand weeding

Table 2 Incidence of *P. hysterophorous* in the Aranguez District in various vegetables during the dry season (February - March 1987)

Crop	VE	Fp	IVI
Squash	90	100	674.9
Tomatoes	75	100	836.4
Cabbage	10	50	360.0
Spinach	25	100	365.6
Bodie bean	10	100	207.8
Cauliflower	10	50	215.8
Mean	36	83	443.4
S.E.±	2.45	2.07	6.5

There was no variation in the mean Importance Value Index (IVI) for parthenium for the wet (489.1) and dry (437.6) seasons. Also, variations between seasons were minimal under similar levels of weed management; cabbage in the wet season had an IVI of 379.9 and in dry season 360.0, cauliflower 262.5 (wet) and 215.8 (dry), and spinach 358.0 (wet) and 365.6)dry).

In the wet season (Table 1), there were variations within the same crops due to different levels of weed management, eg. cauliflower with two hand weedings and no herbicides had a higher IVI (417.1) than a crop of similar age with treatments of one hand weeding and pre-emergence herbicide (262.5). Similar trends for tomato and cabbage were observed at the same growth stage, but under different levels of weed management. The application of pre-emergence herbicides reduced the IVI for parthenium by 40 to 50% over one or two hand weedings.

Crops with shrub-type architecture, eg. hot and sweet peppers, had no competitive plant height advantage over leafy vegetable crops under similar levels of weed management. Both types of crops had an IVI below the mean recorded for the wet season.

In both wet and dry seasons, the IVI for leafy vegetable crops was lower than the mean IVI. This is due mainly to the close spacing used at planting, and the intensity and thoroughness of the hand weeding operations practised by the farmers.

A field prepared for planting, but subsequently abandoned, showed an IVI of 910 (wet season) and gives an indication of the weed's dominance. The high IVI (880) for okra in the wet season was due to the wide spacing as well as the absence of any weed management operations. The *Parthenium* seedlings were the same height as the crop (15-20 cm).

In the fields surveyed, adequate irrigation facilities were available to all farmers during the dry season. Adequate water supply was the main factor determining the lack of shift in *Parthenium* populations between seasons.

Incidence of *P. hysterophorous* during different seasons

There was no significant difference between visual estimates (VE) for *Parthenium* in the wet and dry seasons in the Aranguez District (Table 3), or for the major vegetable growing areas of Trinidad (Table 4). Visual estimates in the range of 25 to 60% can be considered as moderate infestations (Phillipson, 1974).

There were no changes in abundance (Ap) between seasons. *Cyperus rotundus* (L.) #CYPRO, "the world's worst weed" (Holm et al., 1977), is a serious weed in vegetable crops in India with an abundance of 2.7 to 9.6 (Tiwari and Bisen, 1981). The Ap for *Parthenium* in Aranguez fell well within this range in both seasons.

Wet season density (Dp) in Aranguez (5.77) did not differ significantly from that of other vegetable growing areas (7.46). Dexter et al (1981), reported that wild oats (*Avega fatua* (L.) #AVEFA) had an average of 2.0 to 2.5 plants per 0.25 m^2, and Thomas (1985) noted that green foxtail (*Setaria viridis* (L.) Beau #SETVI) had a density of 32 plants per m^2. These are serious weeds in cereals and oilseeds, respectively. The Dp for *Parthenium* emphasizes the predominance of this weed in Aranguez in both seasons.

Frequency (Fp) was over 80% in both seasons. Thomas (1985) indicated that weeds occurring in the frequency levels 76 to 100 are serious weeds that require some level of control. He found green foxtail and wild oats with frequency levels of 63.3 to 94% during his survey.

The RFp values for both seasons were over 60%. Chancellor (1971) observed that *Sinapsis arvenis* (L.) #SINAR, and *Chenopodium album* (L.) #CHEAL, had relative frequency levels of 60 and 44%, respectively, and both are widespread weeds in arable lands in Britain.

The IVI indicated that there were no shifts in *Parthenium* population between seasons (Table 3). Also there was no significant difference between IVI for Aranguez wet season and that for other vegetable growing areas of Trinidad (Table 4.) These findings indicate that *Parthenium* is a serious problem in all the major vegetable growing areas in Trinidad, especially in Aranguez, where the IVI is even greater for the dry season.

Crop loss assessment

Results from the surveys indicated that *Parthenium* caused significant losses to vegetable production in both seasons. Most farmers reported that the weed had no effect on the yield of solanaceous crops, if it was effectively controlled while the crop was in the early vegetative stage or prior to flower initiation. However, if weed control was poor, they observed yield reductions between 25 to 30% for the wet season, and 20 to 25% for the dry season.

All farmers found that the presence of the weed within or around the field can result in a reduction of the marketable yield of cabbage and cauliflower. The authors observed a 75 to 100% damage to marketable curds of cauliflower caused by the larvae of *Plutella xylostella* (L.) (Lepidoptera: yponomentidae). Apparently, the adult pest found *Parthenium* to be a suitable "resting site" (Mona Jones, Pers. Comm., 1987).

On nursery beds, failure to remove *Parthenium* seedlings at 3 to 5 day intervals on a regular schedule resulted in a 75 to 100% loss of healthy and vigorous vegetable transplants.

Table 3 Incidence of *P. hysterophorous* in the Aranguez District during wet and dry seasons of 1986-87

Parameters	Season	
	Wet (October-November)	Dry (February-April)
Visual Estimates (%) (VE)	47.69	36.66
Abundance (Ap)	5.77	5.25
Density (Dp)	5.24	3.99
Frequency (Fp)	87.69	83.3
Relative Dominance (RDi)	58.88	56.8
Relative Frequency (RDp)	415.61	340.0
Relative Frequency (F4RFp)	66.31	61.36
Importance Value Index (IVI)	489.99	443.43

Table 4 Incidence of *P. hysterophorous* for the major vegetable growing areas of Trinidad in 1986-1987

Parameters	Seasons			
	Wet (Oct. - Dec.)		Dry (Feb. - Apr.)	
	Mean	S.E.	Mean	S.E.
Visual Estimates (VE)	43.87	1.78	35.58	1.23
Abundance (Ap)	7.46	1.11	15.50	1.67
Density (Dp)	5.6	0.66	15.04	1.68
Frequency (Fp)	65.32	14.96	88.4	1.15
Relative Dominance (RDi)	53.02	9.04	44.4	1.81
Relative Density (RDp)	412.0	37.46	284.73	4.51
Relative Frequency (RFp)	58.43	5.9	59.48	1.03
Importance Value Index (IVI)	491.19	37.92	378.5	4.76

The authors noted the total loss of one tomato crop, (cv. Calypso) where the farmer had failed to remove the weed up to flower initiation stage. The weed had a V.E. of 100% and an IVI of 836.4 (Table 2). *Parthenium*, the only weed present in the field at the time of the survey, was 75 to 100 cm tall and flowering profusely. The farmer had applied paraquat at the pre-plant stage of the crop.

Failure to plant lettuce and celery on *Parthenium* free plots led to 50 to 60% mortality of the transplants. When early hand weeding at 10 to 14 day intervals was not done, mortality in excess of 75% was observed.

No significant reduction in yield was reported by farmers for vining crops, eg. pumpkin, squash, or cucumber and staked bodie bean withstood the weed competition. However, early hand weeding was essential for bush type cow peas to prevent yield reductions of 25 to 50%.

The reduction in crop yield and quality is probably due to the competitive ability and allelopathic potential of *Parthenium*. Rajendra and Rama Das (1981) noted that although the weed was a C3 plant, a low carbon dioxide compensation concentration and photorespiratory rate were observed. This was attributed to the activity of PEP carboxylase. The authors described the weed as having a luxurious growth and high survival potential. Sukhada and Jayachandra (1984) reported that *Parthenium* produced allelopathic compounds that influenced pollen germination and tube growth in solanaceous and bean crops where yield reductions between 27 to 73% were observed.

Conclusions

The survey provided quantitative data on the incidence of *Parthenium* infestation on vegetable crops for the main vegetable production area in Trinidad, the Aranguez District, over two seasons. It can be concluded that the weed is a more significant weed in the commonly grown vegetable crops in Aranguez than nutgrass. *Parthenium* is a predominant and pernicious plant in both wet and dry seasons.

From an earlier survey, the authors concluded that under systems of intensive vegetable production and where the use of bipyridyliums is widespread, the weed has shown the ability to survive herbicide treatments, except at the seedling stage, regardless of the season and crop or management practices. Also, biological and cultural control was insignificant in reducing parthenium populations. The weed can significantly reduce crop yields and quality due to its aggressive growth habit; competitiveness and allelopathic interference.

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