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par
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Répression mécanique de la petite herbe à poux (*Ambrosia artemisiifolia* L.) en milieu urbain et péri-urbain.

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RÉSUMÉ

L'herbe à poux est une importante source de pollen aéroallergène et la principale cause de la rhinite allergique dans l'Est du Canada. Vue l'importante infestation à laquelle fait actuellement face le sud-ouest du Québec, et en particulier le long des abords routiers, il devenait nécessaire d'évaluer différentes méthodes de contrôles mécaniques pour apporter un élément de réponse à la persistance de l'herbe à poux le long des routes. Des traitements mécaniques effectués en bordure d'une autoroute et d'un terrain vacant ont été évalués durant l'été 1990. Les traitements suivants ont été effectués, soit le fauchage à 2 cm, 5 cm et 8 cm de hauteur de coupe ainsi qu'un traitement d'écrasement. Chaque traitement de fauchage, répété à deux reprises dans la saison, a eu lieu le 5 juillet et le 22 août; le 1er août et le 22 août; le 9 août et le 5 septembre. Le traitement d'écrasement a eu lieu le 26 juillet. De façon générale, les traitements à 2 cm ont été les plus efficaces pour réduire à la fois la production de pollen et celle d'achaines. La combinaison du traitement à 2 cm, le 1er août et le 22 août, a diminué significativement le nombre d'inflorescences au cours de la saison de croissance. L'écrasement s'est avéré totalement inefficace, de même que les traitements à 8 cm de hauteur de coupe. L'efficacité des méthodes actuellement utilisées dans les municipalités a été très variable. Quatre des sept méthodes évaluées ont réduit significativement le nombre d'inflorescences mâles. Une tonte le long des abords routiers n'est pas suffisante pour contrôler l'herbe à poux. Dans les parcs, la tonte régulière de la pelouse à 5 cm a diminué la

longueur cumulative des inflorescences mâles de 90%, mais 65% des plants a formé des graines. La hauteur de coupe moyenne effectuée par un tracteur faucheur a été d'environ 10 cm. Pour assurer un meilleur contrôle de l'herbe à poux avec la machinerie déjà existante, il faudrait tondre les abords routiers à deux reprises en début et fin août, à une hauteur inférieure à 5 cm du sol.

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INTRODUCTION GÉNÉRALE

Dans le cadre de la maîtrise en Sciences de l'Environnement de l'Université du Québec à Trois-Rivières, mon projet de recherche traite de la répression mécanique de la petite herbe à poux *Ambrosia artemisiifolia* L. en milieu urbain et péri-urbain. Ce projet a été préparé en collaboration avec Suzanne Fortin du Département de santé communautaire de Lanaudière, Daniel Cloutier de la Ferme Expérimentale d'Agriculture Canada à L'Assomption et Gilles Vincent du Jardin Botanique de Montréal.

Problématique générale

La petite herbe à poux est une plante annuelle qui abonde dans les champs cultivés, les terres incultes et les terrains vagues ainsi que le long des chemins et des clôtures (Bassett et Crompton, 1975). En agriculture, elle est considérée comme une mauvaise herbe très persistante en fin de saison, mais elle n'occasionne pas de problèmes importants, parce qu'elle est facilement contrôlée par les herbicides (Sweet et al., 1978; Vézina et al., 1990). L'herbe à poux est considérée nuisible en Amérique du Nord et au Québec, parce qu'elle est la plus importante cause de la rhinite allergique saisonnière communément appelée rhume des foins (Bassett et Frankton, 1971). En effet, de la mi-août à la mi-septembre, environ 10% de la population québécoise est affectée par le pollen de l'herbe à poux (Vincent, 1988).

Une étude réalisée en 1989 dans la municipalité régionale de comté de Joliette a permis de localiser précisément les zones infestées par l'herbe à poux (Schneeberger et Fortin, 1990). En milieu urbain, celle-ci infeste par ordre d'importance décroissante les abords de routes et d'autoroutes, les parcs, les terre-pleins et les terrains vagues. En milieu rural, elle abonde principalement en bordure des champs cultivés.

Les programmes de répression contre l'herbe à poux dans le but de diminuer le taux de pollen de l'herbe à poux dans l'air existent depuis longtemps (Cabana, 1951; Francoeur, 1990; Schneeberger, 1989; Vincent, 1990; Walzer et Siegel, 1955). L'emploi de l'herbicide 2,4-D a été la méthode de contrôle recommandée depuis les années 1940 (Cabana, 1951; Walzer et Siegel, 1955), mais les contraintes reliées à l'utilisation des herbicides ont favorisé, depuis, le développement de méthodes alternatives (Batra, 1982).

Les méthodes alternatives comme l'emploi de paillis allélopathiques, les cultures de couverture, l'établissement de plantes compétitrices, la lutte biologique à l'aide d'agents pathogènes et d'insectes, le désherbage thermique et les micro-ondes sont des méthodes intéressantes, mais plusieurs d'entres elles sont encore à l'état de recherche expérimentale, de plus, elles sont souvent trop dispendieuses et peu applicables à grande échelle (Ayres et Paul, 1990; Barker et Craker, 1991; Batra, 1982; Daar et al., 1986; Facelli et Pickett, 1991;

Miller, 1991; Morez, 1985, Vincent, 1990)). Même le désherbage manuel, pourtant efficace, est dispendieux en temps et en personnel et devient fastidieux lorsque l'infestation est importante comme le long des abords routiers (Vincent et al., 1992).

Au Québec, un règlement de la loi sur les abus préjudiciables à l'agriculture oblige les municipalités à détruire les mauvaises herbes avant la maturité de leurs graines, c'est-à-dire entre le 20 juin et le 10 juillet de chaque année (Article 748, chapitre C-27.1 des Lois refondues du Québec). Comme les considérations environnementales, reliées à l'utilisation des pesticides, sont de plus en plus importantes, le fauchage est devenu la seule méthode préconisée le long des abords routiers (Schneeberger et Fortin, 1990).

Vue l'importante infestation à laquelle fait actuellement face le sud-ouest du Québec, et en particulier le long des abords routiers, il devenait nécessaire d'évaluer différentes méthodes de contrôle mécanique pour apporter un élément de réponse à la persistance de l'herbe à poux le long des routes. Le projet avait deux objectifs. D'abord, évaluer de nouvelles méthodes mécaniques pour contrôler l'herbe à poux le long des abords routiers et ensuite de déterminer l'efficacité de différentes méthodes présentement utilisées dans certaines municipalités de la région de Joliette pour contrôler cette plante.

L'étude est présentée sous la forme d'un article scientifique dans le chapitre 1 de la thèse. Celui-ci sera soumis à la revue "Weed Technology". Une partie des données qui a servi à l'élaboration de l'article scientifique, n'est pas incluse dans l'article, faute d'espace. Cependant, ces données sont présentées dans le chapitre 2 sous la forme de tableaux ou de figures.

Description générale du projet

L'expérience s'est déroulée dans la municipalité régionale de comté (MRC) de Joliette au Québec, pendant l'été 1990. Deux sites ont été choisis pour compléter le premier objectif de l'étude et neuf pour le deuxième objectif, dans différentes municipalités toutes fortement infestées par l'herbe à poux. Dès le début, deux des neuf sites ont été éliminés en raison de facteurs incontrôlables.

Dans la première partie de l'étude, des traitements mécaniques effectués en bordure d'une autoroute et d'un terrain vacant ont été expérimentés durant l'été 1990. Ce sont, le fauchage à 2 cm, 5 cm et 8 cm de hauteur de coupe ainsi que les traitements d'écrasement et d'arrachage. Chaque traitement de fauchage, a eu lieu le 5 juillet et le 22 août; le 1er août et le 22 août; le 9 août et le 5 septembre. Le traitement d'écrasement a eu lieu le 26 juillet. Les arrachages ont eu lieu dans la première semaine de juillet, la première et la deuxième d'août. Ils ont permis d'extrapoler le nombre de plants par m^2 et de suivre la germination de l'herbe à poux au cours de la saison de croissance.

La deuxième partie de l'étude consiste à évaluer l'efficacité de l'entretien des espaces municipaux. Les sept sites choisis étaient: un parc public, un terrain vacant, trois abords routiers en milieu péri-urbain et deux en bordure de champs cultivés en milieu rural. Nous avons comparé des parcelles traitées à des parcelles non traitées (témoin) pour évaluer l'efficacité des méthodes utilisées par les municipalités sur le potentiel reproductif de la petite herbe à poux. Les méthodes de fauchage utilisées sont, principalement, le tracteur faucheur le long des abords routiers et la tondeuse dans les parcs et certains terrains vacants de petites dimensions.

Les méthodes d'échantillonnage sont les mêmes pour les neuf sites expérimentaux. Tous les sept jours à partir du 5 juillet, des plants, choisis au hasard, ont été observés et ont servi à évaluer la hauteur des plants, le nombre de feuilles, le nombre de tiges, le nombre et la hauteur des inflorescences mâles et le pourcentage de plants ayant formé des achaines.

Pour mieux caractériser le milieu, la végétation dominante a été évaluée qualitativement dans tous les sites expérimentaux. Des échantillons de sol ont été prélevés pour connaître la composition chimique et la salinité des sols. Des échantillons de pollen ont été récoltés sur le balcon de l'étage supérieure du Centre Hospitalier de Lanaudière pendant 43 jours. Les décomptes polliniques ont été calculés à l'Universtié de Montréal, au laboratoire d'aérobiologie du département de géographie. Dans la deuxième partie de l'étude, nous avons noté: l'appareil de fauchage utilisé, la hauteur de la faux, la hauteur de coupe à différents endroits dans les pentes des fossés, bris et retards dans les dates de tonte.

Les données, transformées lorsque nécessaire, ont été soumises à l'analyse de variance au moyen du logiciel SAS pour comparer la hauteur des plantes, la biomasse végétative et reproductive en fonction des répétitions et des traitements. Nous avons utilisé le test de Waller-Duncan ou le test de *t* pour établir les comparaisons de moyennes.

Résultats généraux

De façon générale, on a remarqué lors des essais expérimentaux sur le contrôle mécanique que la tonte à 2 cm entraîne une réduction significative de la longueur cumulative des inflorescences mâles et qu'elle abaisse aussi significativement le nombre de graines produit par plant. Par contre, la tonte effectuée le 1er août suivie d'une deuxième le 22 août semble la meilleure combinaison pour contrôler la libération de pollen puisqu'il n'y a pas nouvelles inflorescences produites entre les deux traitements. La tonte à 5 cm diminue aussi significativement la longueur cumulative des inflorescences mâles, mais, les inflorescences peuvent atteindre une longueur moyenne de 1 cm entre les deux tontes et potentiellement libérer du pollen. De plus, la réduction du nombre de graines produites est moins importante. L'écrasement et les traitements de tonte à 8 cm se sont avérés totalement inefficaces.

Le deuxième objectif du projet à caractère très pratique a l'avantage de confirmer et d'appuyer les résultats obtenues à partir des travaux expérimentaux sur le contrôle mécanique. Dans les différents sites échantillonnés, on a observé une variabilité importante entre les plants d'herbe à poux au niveau de la densité, de la hauteur des plants et du nombre de graines et d'inflorescences mâles. Cette variabilité explique en partie l'efficacité plus ou moins grande des méthodes utilisées le long des routes. En effet, quatre des sept méthodes évaluées ont réduit significativement la longueur cumulative des inflorescences mâles. Lorsqu'un tracteur faucheur est utilisé, la hauteur moyenne de tonte est de 10 cm. Comme on a vu lors des essais expérimentaux, des plants d'herbe à poux ayant une hauteur moyenne inférieure à 15 cm sont peu affectés par une tonte égale ou supérieure à 8 cm. Par contre, dans certains cas, lorsque les plants atteignent une hauteur moyenne de 30 cm, un traitement à 8 cm diminue significativement la longueur cumulative des inflorescences mâles.

Des informations complémentaires ont aussi été notés pour caractériser la plante et son environnement. Les analyses de sol prélevées au début de l'expérience ont montré une corrélation positive entre le % de calcium, la saturation en calcium et la capacité d'échange cationique. Le long de l'autoroute, la végétation dominante est composée principalement de l'herbe à poux (*Ambrosia artemisiifolia* L.), de la lupuline (*Medicago lupulina* L.) et des graminées, alors que sur le site vacant dans le parc industriel, en plus de l'herbe à poux, on retrouve du trèfle (*Trifolium* spp.) et des marguerites (*Chrysantemum leucanthemum* L.). Dans les autres sites, la végétation dominante varie d'une place à l'autre. On a aussi effectué des arrachages pour connaître les densités de plants d'herbe à poux au cours de la saison. On observe peu de repousse pour le reste de la saison, suivant l'arrachage. Finalement, la concentration de pollen libérée dans l'air en 1990 à Joliette a atteint son pic maximal le 22 août avec 307 grains / m^3.

Chapitre 2

Mechanical Control of Common Ragweed (*Ambrosia artemisiifolia*) in Urban and Suburban Areas[1]

SYLVIE DESLAURIERS, DANIEL CLOUTIER, GILLES VINCENT and SUZANNE FORTIN[2]

Abstract. Common ragweed is a major weed problem along roads in urban or suburban areas of Quebec because of its aeroallergenic properties which affect approximately 10 % of the population. The use of herbicides along road sides is becoming increasingly restricted and therefore new strategies must be developed to control this weed. The efficacy of mechanical control methods was evaluated in vacant land along an expressway and an access road during the summer of 1990. Plants were mowed twice in the season at 2 cm, 5 cm, or 8 cm above ground level. The first and second mowing were done July 5 and August 22; August 1 and August 22; August 9 and September 5. In general, mowing at 2 cm above ground level, significantly reduced both pollen and seed production. The

2 cm treatment done August 1 and August 22 reduced more pollen production during the season than any other treatments and was effective in reducing seed production. Mowing 8 cm high was not effective in controlling ragweed. The efficacy of the current municipal vegetation management of road sides and parks was also assessed in the course of this study. The level of control varied broadly between municipalities. In general, it has been determined that only one mowing treatment along road sides during the season was not an effective method of control. The average mowing height was 10 cm, when a tractor-mounted blade is used. Under intensive management, the cumulative length of racemes was decreased by 90% in a park where the lawn was mowed weekly at 5 cm, but 65% of the plants produced seeds. With the current equipments, ragweed control could be optimized by mowing at 5 cm in early and late August. **Nomenclature:** Common ragweed, *Ambrosia artemisiifolia* L.#[3] AMBEL.

Additional index words: Current municipal vegetation management, mowing, replacement of herbicides, road sides, vacant land.

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[3]Letters following this symbol are a WSSA-approved computer code from Composite List of Weeds, Revised 1989. Available from WSSA, 309 West Clark Street, Champaign, IL 61820.

INTRODUCTION

Common ragweed is an erect annual weed native to North America and a member of the Compositae family (22). Rarely considered a problem in agricultural fields, it is an undesirable weed close to cities because of its aeroallergenic properties (22). In Quebec, at least 10% of the population suffers from allergenic nasal disorders caused by ragweed pollen in August and September (20). The weed is a prevalent pioneer species of disturbed habitats (5, 18). In Quebec, common ragweed has invaded roads, highways and other urban or industrial sites, partly because of the restrictions on herbicide use close to ditches and waterways (20).

Common ragweed usually emerge in May or early June (23). It is a successful pioneer species of early successional ecosystems and exhibits wide morphological plasticity depending on growing conditions and morphological ecotypes (5, 9, 10). Great difference in plant height within an ecotype can be apparent, however, time of reproductive development is relatively uniform within the same ecotype (9, 10). The stem axis and laterals are terminated by racemes of staminate heads facilitating air dispersal of the pollen between mid-August and mid-September when terminated by the first frost (10, 23). Pistillate heads are borne on short racemes at the base of the staminate racemes and in leaf axis (10). The seeds are formed in mid-August (23). Many genotypes are maintained within the population, further adapting the species for successful establishment in unpredictable environments (18).

The problem of ragweed control arise from three particular habits of the plants. Ragweed grows best in disturbed areas where the soil has been loosened and the competing plants removed (1, 13, 14, 17, 22). Road sides are a good example of disturbed habitats, having excessive drainage, compaction, poor soil texture and annually exposure to de-icing salt and snow storage (21). The second factor aiding the perpetuation of ragweed population is the longevity of its seeds and the third factor is the large number of seeds produced per plant (13, 22).

Local control of ragweed populations by methods such as mowing, hand hoeing and burning has been practiced for years in both urban and agricultural areas of North America, but the standard control for ragweed over the past four decades has been to spray with 2,4-D (3, 23, 26). Many eradication campaign in cities failed with the exception of the Campagna campaign, which was successfully done in a geographic area where the weed was recently introduced and where the infestation level was still low (13, 23, 26).

Mowing to control ragweed could be environmentally safe and practical because most road sides are actually mowed each year before July 10 under the weed control act and regulations (Article 748, chapitre C-27.1 des Lois refondues du Québec). However, there is little information on the effect of mowing date on the regrow and flowering of ragweed. Barbour and Meade (3) worked in recently disturbed land and found that the optimum time to cut ragweed was just prior to flowering (around August 11 in New Jersey). They also reported that mowing height seemed to be of relatively slight significance in influencing the final control of ragweed. Vincent and Ahmim (25) worked with a mowing height of 5 cm above ground in a field and they also found that after the beginning of the flowering stage (end of July in Montreal), mowing reduced the male inflorescence production.

Little is still known about mechanical ragweed control along roads, highways and other disturbed habitats (20). Current control information has originated from work conducted on agricultural land or in other geographic areas and may not be applicable to these conditions (2, 3, 4, 13, 23). Since ragweed pollen is still a major air contaminant and the use of herbicides is increasingly restricted along road sides, new strategies must be developed to control this weed, or at least reduce the amount of airborne allergenic pollen produced in urban and suburban areas. The objectives of this research were to evaluate the response of common ragweed to mechanical control treatments and to assess the efficacy of the current municipal vegetation management program of road sides, parks and waste grounds.

MATERIALS AND METHODS

General. The studies were conducted in six municipalities of the county of Joliette, approximately 40 km northeast of Montreal on the north shore of the St-Laurence River (46° 02'N, 73° 26'W), during the summer of 1990. The sites chosen for the studies were a road side along an expressway, a park, two waste grounds, three medians along suburban roads, and two road sides in rural areas along cultivated fields, all naturally infested with common ragweed (20). Most of these sites received de-icing salt during winter months, have been used for snow storage, are excessively drained, compacted and have poor soil texture (21). These sites did not receive any fertilisation or irrigation. Precipitation from June to September was above average amounts while May was below average. Temperature from June to September was average in 1990 except for May who was below average.

Mechanical control studies. Mechanical control studies were conducted along an expressway and a vacant lot while seven sites were used to assess the efficacy of current road sides management practices. The mechanical treatments evaluated in this project consisted of mowings repeated twice in the season and set at 2 cm, 5 cm and 8 cm above ground (Table 1). Crushing was evaluated because it seemed an efficient method of reducing the number of male racemes.

Expressway site. The first site was a 1 km portion along a four lanes expressway in the county of Joliette. Ragweed was present in a 1,5 m flat strip along both sides of the pavement. Ragweed and black medic (*Medicago lupulina* L. #

MEDLU) were the dominant species in the strip and the remaining vegetation consisted mostly of grasses. The rest of the road side was slightly sloped and terminated in a ditch dominated by grasses and broadleaf perennials. The soil was sandy, with a pH of 7.2, an organic matter content of 3.6% and 0.3 mmho cm^{-1} of electrical conductivity.

The experiment was designed as a randomized complete block with three replications. Each replication included an untreated control and ten mechanical treatments. Plot size was 1 by 1 m and each plot was separated by a 1 by 1 m guard space in which the vegetation was kept closely clipped. Two mowings were done per treatment and treatments were selected according to the following growth stages: vegetative stage and full bloom; bud stage and full bloom; early bloom, and senescence. The actual dates were: July 5 and August 22; August 1 and August 22; August 9 and September 5 (Table 1). The mowing heights were either 2 cm, 5 cm or 8 cm. A hand held gas trimmer was used to cut the plants about 2 cm above the soil surface, while a domestic gas power mower with the mowing blade set at 5 cm and 8 cm above ground was used for the other mowing heights. Crushing was done using a 250 kg road roller. It was run once over the plot, at bud stage (Table 1).

Vacant land. The second site was a vacant land recently disturbed by construction in the industrial park of the city of Joliette. The experiment was located in a heavy stand of ragweed located in a 6 m strip along a new access road. The vacant land was mowed every summer, in mid-July, by the company. Before establishing the plots, the vegetation cover which consisted mostly of white daisy (*Chrysanthemum leucanthemum* L. # CHYLE), was cut above the ragweed plants with a sickle to prevent ragweed from being smothered. Treatments were initiated a week later. Some species were co-dominants in biomass in the strip: common ragweed, clover spp. (*Trifolium* spp.), quack grass (*Elytrigia repens* L. # AGRRE) and white daisy. However, none of the species was dense enough to smother ragweed. The soil was a loamy sand with an organic matter content of 2.3%, a pH of 7.2 and an electrical conductivity of 0.5 mmho cm^{-1}.

The experimental design was similar to the one used in the expressway site, except for the crushing treatment, which was not done on this site. Treatments were replicated two times in a randomized complete block design. Individual plot size was 1 by 1 m. Two mowings were done per treatment at the following dates: July 5 and August 22; August 1 and August 22; August 9 and September 5. The mowing heights were either 2 cm, 5 cm or 8 cm.

Assessment of current practices. This study was conducted on sites naturally infested with the weed to evaluate the efficacy of the current municipal vegetation management of road sides, waste grounds and a park. Table 2 shows both the sites evaluated and treatment dates. Chemin des Prairies site, a road side in urban area, was mowed with a manually operated trimmer. Prevost park, was used as a snow dump until 1988. Municipal employees mowed the grass every week at 5 cm above ground. Carrefour du Moulin site, a vacant lot, was mowed four times during the season with a power mower set at 5 cm above ground. The St-Charles-Borromée and Crabtree sites, two road sides in rural areas along cultivated fields and Notre-Dame de Lourdes and Ste-Mélanie sites, both medians along suburban roads, were mowed with a tractor-mounted blade.

The sites chosen were almost entirely covered with young ragweed plants in June 1990. The soil texture of the sites were mainly sandy or sandy loam, the pH neutral, with an organic matter content between 1.3% and 6.5% and an electrical conductivity of 0.5 to 1.1 mmho cm^{-1}. A 15 by 1 m portion was not mowed in each site. The experimental design was a randomized complete block with two replications. In each 15 by 1 m block, a 1 by 1 m quadrat was selected as a weedy control to enable comparaison between a weedy check and the municipal treatment. The municipal treatment was a 1 by 1 m quadrat selected in the mowed portion.

Data collection. Every plot in the nine sites were sampled weekly from July 5 to September 17 1990. The measurements were made in a 0.5 by 0.5 m quadrat located in the center of each plot. Ten plants growing in each quadrat were non-destructively measured to estimate treatment effects. Height, number of main-stem leaves, number of branches, number and length of male inflorescences were recorded for each plant. Height was measured from the ground to the extended tip of the highest leaf. Number and length of male inflorescences were converted in cumulative length of male raceme per plant [(number of racemes by specific length) summed together] for statistical analysis and data presentation. The number of plants having seeds was also noted.

All quadrats were harvested during the second week of September. Twenty plants were randomly selected within the quadrat, each plant was harvested, dried and weighed separately. For the remaining plants in the quadrat, ragweed density m^{-2} was recorded. All the ragweed plants were clipped at soil level, oven-dried at 70°C and then weighed together to determine aboveground biomass m^{-2}. The total number of seeds and their weight were also measured. Female reproductive effort was measured as the number and weight of seeds. Seeds were counted directly from each of the 20 dried plants. For each of the 20 individual plants, male inflorescences were sorted, counted and measured, then dried and weighed. Ratios for male racemes biomass, seed biomass and vegetative biomass were established from the values of the 20 individual plants. The vegetative ratio was multiplied by the above ground biomass m^{-2} to have the vegetative above ground biomass m^{-2}.

Soils were sampled in early July at the beginning of the experiment and salinity and fertility were determined. Every week, the vegetation of each plot was estimated visually as percent of bare soil and percent cover of dominant species. Volumetric counts of air-borne ragweed pollen were taken in Joliette during 43 days, in 1990, using a Buckard apparatus (7)

Where necessary, data were log-transformed or square-root transformed to homogenize variances prior to analysis of variance (19). Means were separated using Waller-Duncan's Multiple Range test or *t* test at the 5% level of probability.

RESULTS AND DISCUSSION

Mechanical control studies. *Expressway site.* Results from both tables 3 and 4 show that crushing does not meet the objectives of a good weed control program which are to: maximise mortality, reduce the number of viable seeds produced and reduce crop loss, but in this case, reduce pollen liberation (6). The final density of plants in the crushing treatment is statistically similar to the control with 271 plants m^{-2} and despite a significantly lower number of seeds, the crushing treatment still produced over 1100 seeds m^{-2} (Table 3). The cumulative length of racemes of the crushing treatment was not significantly shorter than the control during the growing season. When it was significantly different, it did not reduce racemes length effectively (Table 4). Since crushing has little effects on the final density of plants, seed production and male inflorescence, the ragweed problem will persist the following years in areas of continual disturbance such as road sides (22). Thus, crushing is not efficient on ragweed control and will not be discussed further.

In the following discussion, the growth stage of the first of the two mowing treatment and the mowing height will be used to identify specific treatments.

Ragweed was not eradicated by any of the mechanical treatments, according to the final sampling data (Table 3). However, mowing at 2 cm above ground at any date significantly reduced the final densities by 70 to 90% compared to the control. The early bloom treatment caused the greatest decrease in density (Table 3). Because of its growth habit and of the environmental restrictions on the use of herbicides close to ditches, common ragweed is still abundant along road sides in 1990, than it was in the 1950's (10, 23). In view of these results, complete eradication of ragweed in urban and suburban areas appears to be virtually impossible (13). Pollen control and reduction of the number of seeds produced per plant seems a more realistic goal than eradication in a ragweed control program (13, 23).

At the last sampling date, all mowing treatments had significantly reduced the final plant height. Plant heights were consistently equal or shorter than the mowing height of the treatment (Table 3). The vegetative biomass followed a similar pattern although the treatments with mowing at 5 cm and 8 cm at bud stage, or at 8 cm at early bloom were not significantly different from the control. Since ragweed do not regenerate after early to mid-August, the height of the last mowing treatment dictates the final plant height. These results are consistent with the ones from Barbour and Meade (3) and Vincent and Ahmim (25).

Cumulative raceme lengths at the September 17 sampling date were significantly reduced by all the mowing treatments compared with the control. The control treatment had a cumulative length of 5.7 cm, while the next longest raceme was 1.2 cm. Treatments at bud stage and the 8 cm treatment at vegetative stage were less effective in reducing raceme lenghts. The raceme did not regrow when mowed at vegetative or early bloom stage, with the exception of the mowing treatment at 8 cm. There was no significant difference in raceme biomass among the mowing treatments. However, raceme biomass followed a similar trend to that of cumulative raceme length, with higher biomass being recorded at a 8 cm mowing height.

Mowing treatments, regardless of height or date, reduced significantly the number of seeds produced per m^{-2} compared with the control except for the 5 cm treatment at the bud stage (Table 3). This exception, however, disappears for the number of seeds produced per plant (data not shown). It might be attributed to the great variation among plants in producing of male and female heads (10,16). McKone and Tonkyn (16) also found a great variability in sex expression among individuals within different locations of the same field partly caused by environment factors and found a poor correlation between gender and plant size. The most effective treatment was a 2 cm mowing height applied at the early bloom stage (table 3). However, the production of a few seeds by each of many individuals can maintain a large seed bank in the soil since ragweed seeds may remain viable for extended periods (5, 10). According to these results and as mentionned earlier, complete eradication of ragweed in urban and suburban areas seems impossible in the short term, but the number of seeds produced can be decreased by 99% in the best situation as shown in table 3.

Table 4 shows the pollen potential expressed in terms of cumulative raceme lengths per plant during the growing season. The first mowing treatment at the vegetative stage was done on July 5. On July 19, the control plants were beginning to initiate flower buds. The first mowing treatment at the bud stage was done on August 2. At that date, control plants had mature flower buds with a cumulative length of 3 cm. In Joliette, on August 2, the concentration of pollen in the air exceeded 5 grains m^{-3} (data not shown), which is considered to be the critical threshold for allergies (8). These observations are consistent with the literature, since the critical threshold of 5 grains m^{-3} was reported to be reached two weeks after the appearance of male flowers (8). Consequently, on August 2, the 2 cm, 5 cm and 8 cm treatments at bud stage, and the 8 cm treatment at vegetative stage had cumulative raceme lengths not significantly shorter than the control and could have liberated some pollen. The first mowing treatment at early bloom was done on August 10. Like the 8 cm treatment at the vegetative stage, treatments at early bloom, with a cumulative raceme length between 3.5 and 4.3 cm, were not significantly different from the control and the pollen potential was probably high enough to cause hay fever symptoms.

On August 21 1990, when pollen liberation reached its peak in Joliette (data not shown), the 8 cm treatment mowed at the vegetative stage had the greatest regrow with a cumulative raceme length of 5.4 cm, not significantly different from the control with 7.1 cm (Table 4). The cumulative raceme lengths of the 2 cm and the 5 cm treatments at vegetative stage were significantly shorter than the control, but not significantly different than the 8 cm treatment done at vegetative stage or from all the treatments done at bud stage (Table 4). A first mowing on July 5 appears to have delayed raceme production by 10 days. These results concur with findings from Vincent and Ahmim (25) and Bassett and Crompton (4). Since there is a delay of six weeks before the second mowing for the treatments at vegetative stage, the racemes had time to regrow and possibly had the potential to shed pollen. The 8 cm treatment at vegetative stage was not significantly different, only on August 21. It produced a 90% longer cumulative raceme length than the ones from the 2 cm and 5 cm treatments. This is probably caused by the staminate inflorescence of branches which were too short to be touched by the mower blade and they maturated later than those on the axis (10).

On August 21, since there is only three weeks between the first and second mowing at bud stage, it seems improbable that the plants from the 2 cm treatment, almost completely defoliated in the first mowing, would have had time to initiate and maturate new racemes and liberate fresh pollen. (10, 14, 25). When cut at a height of 5 cm, plants were not completely defoliated and might produce raceme from the undamaged portions (10). However, the cumulative raceme length for these plants was approximately 1 cm, a value similar to control plants in early summer when they were at bud stage and not able to liberate pollen. The 8 cm treatment at bud stage, although not significantly different on August 21, always had a longer cumulative raceme length compared to the other treatments done at bud stage. The reason mentioned before for the 8 cm treatment at vegetative stage can also apply in this case.

On August 21, at the early bloom treatment, all the cumulative raceme lengths were significantly shorter than the control since the first mowing had been done two weeks before (Table 4). The second mowing for the early bloom treatment was done on September 5. The regrow of the racemes after the second mowing was not important and it concur with findings showing that after mid-August, the plants stop regenerating (3, 25). Early bloom treatments might seem a good ragweed control method, but in August 10, the plants were not significantly shorter than the control and might produced a higher pollen quantity during the pollen liberation season than the mowings done at bud stage.

On September 12, both mowing dates and mowing height reduced the cumulative length of racemes per plant (Table 4). The late mowing dates and the shorter mowing reduced the total length more. These results follow the same trend than the ones shown in table 3.

Vacant land. The results observed in the vacant land site were similar to the ones from the expressway site. However, although significant, the differences were smaller for the density, the cumulative length of racemes and the number of seeds produced per plant (Table 5)

When the 2 cm and 5 cm mowing treatments were done at the vegetative stage, they significantly reduced final densities by 95% compared with the control (Table 5). The 2 cm treatment when done at bud and early bloom stage, although not significantly different from the control, reduced final densities by 73% and 89%, respectively. Althought not all significant in the vacant land site, the reduction in densities follows the same trend than the expressway site. Since the control in the vacant land site has more plants m^{-2}, the mowing treatments will have a higher number of plants m^{-2} left under a similar density reduction. A good example is the vegetative treatment at 2 cm in the vacant land, showing the greatest decrease in density with 56 plants m^{-2} left compared to 27 plants in the expressway site.

The cumulative raceme length for all treatments applied at early bloom, the 2 cm treatment at bud stage and the 8 cm treatment at vegetative stage were significantly shorter than that of the control (Table 5). Unexpectively, the raceme did not regrow when the mowing was done at 8 cm at vegetative stage. This is the opposite of what was observed in the expressway site, where the mowing done at 8 cm at the vegetative stage was the least effective treatment. However, as mentioned earlier, the data from the last sampling date are not always representative of the real pattern of the cumulative lengths during the growing season. The cumulative raceme lengths in the growing season were lower than the ones observed in the expressway site, but they followed the same patterns of response to initial mowing height (data not shown). The vacant land site is not an area of continual disturbance such as the expressway site. The successionnal process may be more advanced in the vacant land site and in response to restrictive environmental variables, intra and interspecific competition, ragweed may have exhibit phenotypic plasticity such as reduction in vegetative and reproductive growth explaining the lower cumulative lengths and seed production (6, 10, 13, 17, 18).

All mowing treatments significantly reduced the number of seeds compared with the control. However, the mowing treatments cut at 8 cm still produced a large number of seeds (Table 5). The seed reduction follows again the same trend than the expressway site. Although the number of seeds produced m^{-2} is higher in the vacant land site, the number of seeds produced per plant is lower for the reasons mentioned above.

From the results of both sites, some general principles can be developed for an effective ragweed control program. Results from the final sampling indicate that the later the mowing and the shorter the mowing height, the better the racemes and seed control (Table 3 and 5). At the September 17 sampling, the 2 cm treatments, regardless of the mowing date, prevented any raceme development, except for the treatment at bud stage. Althought the 2 cm treatment at vegetative stage reduced significantly raceme length on September 12 (Table 4) and 17 (Table 3), this treatment had the raceme potential to liberate fresh pollen before the second mowing (Table 4). Following these results, the best treatment would be the 2 cm treatment at bud stage. The second and third best treatments would be the 2 cm treatment at early bloom, possibly shedding pollen early in August before the first mowing, and the 2 cm treatment at vegetative stage.

In 1981, Barbour and Meade (3) concluded that mowing height was of relatively slight significance in influencing final pollen control. In our study, both mowing height and dates had a significant effect, since treatment at 2 cm at bud stage, gave a better control of pollen liberation than the 5 cm at bud stage or the 2 cm treatment at early bloom. However, their study was done in a vacant land with control plants having a final height of 82.3 cm, while the control in this study was 12.1 cm in expressway site and 13.1 cm in the vacant land site. The wide morphological plasticity of ragweed may explain the differences between both studies.

At the 5 cm mowing height, trends were similar to that observed for the 2 cm mowing treatments. Therefore, the greatest raceme reduction during the seasonwas achieved, in decreasing order, when treatments were performed at the bud, early bloom and vegetative stage.

The production of seed was less affected by the 5 cm than by the 2 cm treatments. However, a program targetting reduced pollen liberation rather than ragweed eradication could recommend these treatments. Vincent and Ahmim (25) also worked with mowing at 5 cm and found that a single mowing after the beginning of flowering could significantly reduce pollen production. However, plants growing along road sides differ from agricultural and urban plants and thus, recommendations from research in agricultural field may not be appropriate for disturbed habitats such as road sides.

Mowings at 8 cm controlled neither pollen liberation nor seed production in both study sites. Therefore, mowing at 8 cm is not an effective treatment in disturbed habitats such as the expressway site and the vacant land site.

The least effective treatment consisted of an initial mowing July 5 followed by a second mowing in August. Between June 20 and July 10, in Québec, when the control of the noxious weeds is required (Article 748, chapitre C-27.1 des Lois refondues du Québec), ragweed is still growing and a mowing treatment at that time does not prevent flowering or seed production. Traditionnally, herbicides were applied once at the start of the growing season followed by a mowing before July 10, therefore providing a good ragweed control (10). Because of the current restriction in herbicide use, the best approach to control ragweed would be to add two more mowings to complement the mowing required by law. The two mowing treatments should be done either 2 cm or 5 cm above ground in early and in late August. There should be only three or four weeks between the two treatments, otherwise ragweed will be able to regrow new racemes and possibly shed pollen between the two treatments.

Assessment of current practices. Ragweed plants varied considerably in final height, density, raceme length, biomass and production of seeds among the seven sites (Table 6). These differences can be partially explained by the variation in date of treatment and in the efficacy of the mowing heights between the sites (Table 2).

At the Crabtree and St-Charles-Borromée sites, all mowing variables were significanlty shorter than the control, except for the final density in St-Charles Borromée site (Table 6). Although the mowing height was higher than the 8 cm treatment at bud stage or early bloom in the expressway site, the efficacy of the mowing treatments was still very good. These results suggest that the 8 cm treatments could give some ragweed control for taller plants.

At the Prévost park, the frequency of mowing combined with a mowing height of 5 cm, was very effective and decreased raceme length by 90% (Table 6). However, despite a significant reduction in the number of seeds produced m-^{2}, 65% of the treated plants still produced seeds (data not shown). In a lawn, common ragweed can be successfully controlled by good management of native or planted vegetation. Fertilizing, mowing at the recommended height and dethatching should be done to encourage dense ground cover and heavy shading of the soil in spring and early summer to inhibit ragweed growth (22).

At the Notre-Dame de Lourdes site, the control plants did not differ significantly from those of the mowing treatment (Table 6). As shown in the first part of the study, mowing height was probably the reason for the lack of control since the timing corresponded roughly to that of vegetative stage (Table 1, 3, 4). Following these results, the best maintenance practice using the same equipment would have been to cut twice in the season when the plants were at bud stage and three weeks later , at a height of 5 cm or preferably at ground level.

At the Ste-Mélanie site, plants from the mowed treatment produced significantly longer cumulative racemes and more raceme biomass than did the control (Table 6). These results are similar to those of other researchers who report that one mowing early in the season might increase pollen production instead of reducing its production (3, 22, 25). This may be caused by lack of interspecific competition from the surrounding vegetation in early summer or by the action of mowing the apex head which might cause an intensive regrow of secondary flowering heads (5, 10,14, 18).

At the Chemin des Prairies site, the control plants did not differ significantly from those of the mowing treatment (Table 6). These data might seem surprising since a hand held trimmer was used to perform the mowing operation. At this site, the mowings occurred before the 6th of August and ragweed may still have had time to produce male inflorescences and mature seeds (21, 25). In addition, the trimmer mowing height was greater than 5 cm and therefore less effective than a power mower set at 5 cm and used when the plants were at bud stage followed by a second mowing three weeks later.

At the Carrefour du Moulin site, the control plants were significantly taller, heavier, with more racemes and seeds than those from the mowed treatments. These results can be explained by the timing and the frequency of mowing (Table 2, 6). Two of the four dates correspond roughly to the 5 cm treatment at bud stage in the expressway site, which has already proved to be an efficient ragweed control with smaller plants (Table 3, 4).

An integrated ragweed control program should try to reduce the number of disturbed habitats, increase the use of biological and mechanical control and create artificial community in the exposed medians to favorise interspecific competition (13, 14, 15, 18, 21). As long as de-icing salt will be used and excessive drainage, compaction, poor soil texture will be present, the reduction in the number of disturbed habitats will be difficult to accomplish and biological control, although very promising needs further research (11, 12, 15, 17, 21). Implanting vegetation into the more exposed medians has been tried in the northeastern U.S. and have proven sucessfull, but in Ontario under similar conditions, the results were highly variable (21). Still, the search for native species or varieties showing resistance to higher salt level in the soil and offering an appropriate form of growth with respect to maintenance, should be an alternative to ragweed control. Hand hoeing is the best way to control both pollen and seed production, however, it is time consuming and becomes a near impossible task when the infestation is endemic such as along roadsides (24). Meanwhile, in most municipalities, mowing can be an efficient short-term control method when done closer to the ground in early and late August and might be compatible with the actual maintenance practices of urban and suburban roadsides.

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Table 1. Description of the mechanical treatments and growth stages of common ragweed in the expressway site.

		Date of first mowing		Date of second mowing	
Treatments	Mowing height	Day	Growth stage	Day	Growth stage
	cm				
mowing	2	July 5	vegetative	August 22	full bloom
mowing	5	July 5	vegetative	August 22	full bloom
mowing	8	July 5	vegetative	August 22	full bloom
mowing	2	August 1	bud stage	August 22	full bloom
mowing	5	August 1	bud stage	August 22	full bloom
mowing	8	August 1	bud stage	August 22	full bloom
mowing	2	August 9	early bloom	September 5	senescence
mowing	5	August 9	early bloom	September 5	senescence
mowing	8	August 9	early bloom	September 5	senescence
crushing	-	July 26	bud stage	___	___

Table 2. Site location, description, date of treatments and average mowing height of the current management practices of six municipalities of the county of Joliette.

Location	Description	Methods	Date of treatments	Average mowing height
				cm
Crabtree	along cultivated field	tractor-mounted blade	July 3; August 14	9.5
St-Charles Borromée	along cultivated field	tractor-mounted blade	July 14; August 14	16.8; 14.8
Prévost Park in Joliette	park	power mower	every week	5
Notre-Dame de Lourdes	suburban road	tractor-mounted blade	July 7; August 25	9.4
Ste-Mélanie	suburban road	tractor-mounted blade	July 4	8
Chemin des Prairies	urban road	hand held trimmer	July 12; August 2	9.1
Carrefour du Moulin	waste ground	power mower	July 15; August 2	9.8; 5.5
			August 29; September 17	7.1; 5.1

Table 3. Effect of mowing treatments on ragweed density, plant height, vegetative biomass, cumulative length of the racemes, racemes biomass and number of seeds produced. Plants were harvested September 17, 1990 in the expressway site.

Mowing height	Density[1]	Average[2] plant height	Aboveground[1] vegetative biomass	Cumulative[2] length of the racemes	Male[2] racemes biomass	Number of[1] seeds
cm	m^{-2}	cm	g m^{-2}	cm $plant^{-1}$	mg $plant^{-1}$	m^{-2}
Vegetative stage						
2	88 cde[3]	2.00 d	2.47 ef	0.00 e	0.00 b	46 e
5	344 ab	3.92 c	6.69 de	0.01 de	0.04 b	256 cde
8	240 abc	6.28 b	9.16 cd	1.20 c	0.77 b	364 cde
Bud stage						
2	96 de	1.87 d	3.38 ef	1.00 c	0.98 b	197 de
5	196 abc	4.66 bc	13.72 abcd	0.70 cde	0.44 b	1820 ab
8	209 abc	6.15 b	11.24 bcd	0.75 cd	0.87 b	679 bcd
Bloom stage						
2	37 e	1.15 d	1.52 f	0.00 e	0.00 b	27 e
5	137 bcd	3.80 c	5.57 de	0.00 e	0.00 b	396 cde
8	445 a	6.28 b	19.42 abc	0.05 de	0.27 b	835 bcd
Crushing	271 abc	11.07 a	26.49 ab	4.30 b	16.65 b	1104 bc
Control	348 ab	12.07 a	31.06 a	5.69 a	34.31 a	2974 a

1: Actual value of the harvested quadrat (0.5 by 0.5 m).

2: Each value represents the mean of 10 or 20 measures.

3: Means within column followed by the same letter(s) are not significantly different at the 5% level according to Waller-Duncan K-ratio test.

Table 4. Cumulative length of the male racemes produced per plant during the growing season at the expressway site in 1990.

Mowing height	July 5	July 19	July 26	August 2	August 10	August 16	August 21	August 29	September 5	September 12
	Cumulative length									
cm	cm									
Vegetative stage										
2	0.0 *[2]	0.0	0.1 b[4]	0.8 b	1.0 de	2.2 b	2.8 bc*	0.0 d	0.0 d	0.0 d
5	0.0 *	0.1	0.4 b	0.9 b	1.9 cd	2.2 b	2.7 bc*	0.0 d	0.0 d	0.0 d
8	- *	0.5	1.3 a	2.7 a	4.6 a	4.2 a	5.4 ab*	3.0 b	0.5 cd	1.8 c
Bud stage										
2	-[3]	-	-	2.2 a*	0.3 e	0.5 de	1.0 cde*	0.3 cd	0.6 cd	0.7 cd
5	-	-	-	2.5 a*	0.6 de	0.8 cd	1.3 cde*	1.0 c	1.0 c	1.2 c
8	-	-	-	2.9 a*	1.3 cd	1.4 bc	1.9 cd*	0.9 cd	1.2 bc	1.4 c
Early bloom										
2	-	-	-	-	4.3 ab*	0.0 e	0.0 e	0.2 d	0.1 cd*	0.0 d
5	-	-	-	-	3.8 ab*	0.0 e	0.1 de	0.5 cd	0.5 cd*	0.0 d
8	-	-	-	-	3.5 ab*	0.2 de	0.4 de	0.9 cd	1.0 cd*	0.0 d
Crushing	-	-	2.0 a*	1.5 b	2.6 bc	3.5 a	7.2 a	4.1 b	4.6 b	6.6 b
Control	1.0	1.4	1.6 a	3.0 a	3.8 ab	4.5 a	7.1 a	6.7 a	10.3 a	10.4 a

1: Pollen concentrations at Joliette, Quebec, Canada in 1990.

2: * Date of treatment.

3: Dashes indicate that no values were measured

4: Means within a column followed by the same letter(s) are not significantly different at the 5% level according to the Waller-Duncan K-ratio test.

Table 5. Effect of mowing treatments on ragweed density, plant height, vegetative biomass, cumulative length of the racemes, racemes biomass and number of seeds produced. Plants were harvested September 17, 1990 in a vacant land along an access road.

Mowing height	Density[1]	Average[2] plant height	Aboveground[1] vegetative biomass	Cumulative[2] length ot the racemes	Male[2] racemes biomass	Number of[1] seeds
cm	m^{-2}	cm	g m^{-2}	cm $plant^{-1}$	mg $plant^{-1}$	m^{-2}
Vegetative stage						
2	56 c[3]	3.35 bc	1.50 e	1.4 ab	1.0 b	124 d
5	88 bc	4.03 bc	46.69 ab	2.1 ab	3.4 b	758 cd
8	636 ab	6.05 b	23.02 bcd	0.0 b	0.5 b	1760 bcd
Bud stage						
2	368 abc	2.75 c	8.97 de	0.8 b	1.2 b	660 cd
5	920 ab	4.53 bc	30.70 abc	1.7 ab	3.2 b	1996 bc
8	1466 a	6.13 b	31.13 abc	1.5 ab	3.9 b	2554 b
Early bloom						
2	150 abc	2.45 c	1.92 e	0.0 b	0.0 b	132 d
5	514 abc	3.93 bc	12.07 cde	0.0 b	0.0 b	678 cd
8	1136 a	5.35 bc	22.50 bcd	0.6 b	0.3 b	1312 bcd
Control	1366 a	13.05 a	51.74 a	5.2 a	24.2 a	5440 a

[1]: Actual value of the harvested quadrat (0.5 by 0.5 m).

[2]: Each value represents the mean of 10 or 20 measures.

[3]: Means within column followed by the same letter(s) are not significantly different at the 5% level according to Waller-Duncan K-ratio test.

Table 6. Effect of seven different management practices on ragweed density, plant height, vegetative biomass, cumulative lenght of the racemes, racemes biomass, and number of seeds produced. Plants were harvested September 17, 1990.

Site location	Density	Average plant height	Aboveground vegetative biomass	Cumulative length of the racemes	Male racemes biomass	Number of seeds
	m^{-2}	cm	$g\ m^{-2}$	cm $plant^{-1}$	mg $plant^{-1}$	m^{-2}
Crabtree						
control	348 *	36.0 *	227.44 *	50.4 *	351.5 *	16748 *
mowing	16	9.0	32.97	3.4	32.7	2986
St-Charles Borromée						
control	364	34.72 *	189.35 *	36.4 *	212.4 *	3100 *
mowing	252	11.60	20.17	0.0	0.0	30
Prevost Park						
control	706	13.40 *	45.62 *	8.8 *	69.3 *	4506 *
mowing	498	3.93	17.01	0.8	9.1	482
Notre-Dame de Lourdes						
control	474	15.43	27.02	2.3	7.8	2094
mowing	156	13.38	13.29	4.7	21.6	1980
Ste-Melanie						
control	620	20.05	45.46	7.9 *	50.4 *	3862
mowing	332	19.65	85.62	19.8	160.5	7168
Chemin des Prairies						
control	3120*	18.05	121.68	3.8	28.3	6856
mowing	592	18.13	50.23	6.2	30.3	2656
Carrefour du Moulin						
control	712 *	30.35 *	148.15 *	11.7 *	73.3 *	10356 *
mowing	28	3.48	1.03	0.1	0.4	12

*: Means are significantly different at the 5% level according to *t* tests.

CHAPITRE 3

AUTRES RÉSULTATS

Concentration du pollen

De façon générale, on remarque qu'en 1990, à Joliette, la saison pollinique, déterminée à partir des données échantillonnées à l'étage supérieure du Centre hospitalier régional de Lanaudière, a débuté le 2 août avec une concentration de 6.6 grains/m^3 (figure 1). Jusqu'au 16 août, les indices polliniques étaient en dessous de 100 grains/m^3, concentration à partir duquelle les fleurs de l'herbe à poux sont toutes ouvertes (Comtois et Gagnon, 1988)), et le pic maximal a été atteint le 22 août avec 307 grains/m^3. Après le 22 août, les indices polliniques ont diminué progressivement jusqu'au 28 septembre. A Québec et à Montréal, la saison pollinique a suivi une distribution similaire (annexe D et F). A Joliette, le pic maximal de concentration a eu lieu trois jours plus tôt que Montréal et deux jours plus tard que Québec.

Précipitations et température

Au mois de mai 1990, à Joliette, les précipitations moyennes étaient inférieures à la moyenne des 23 dernières années, mais en juin la moyenne était supérieure de 46 mm. Pour le reste de l'été, les précipitations ont été supérieures à la moyenne des 23 dernières années (figure 2). La température moyenne en 1990, à Joliette, pour les mois de mai à septembre est similaire à la moyenne des 23 dernières années (figure 3).

Végétation dominante pour le site de l'autoroute

A l'été 1990, en début de saison dans les parcelles témoins, la lupuline et les graminées ont dominé le long de l'autoroute. Par contre, le 18 juillet, l'herbe à poux a atteint son pic maximal de recouvrement et domine les parcelles. Par la suite, la lupuline et les graminées occupent 50% du couvert végétal. La tonte à 2 cm et à 5 cm diminue considérablement la présence des espèces végétales et en particulier, celle de l'herbe à poux. La tonte à 8 cm favorise la lupuline et les graminées qui se partagent presque exclusivement l'espace disponible (Figure 4). Toutes ces données sont qualitatives.

Végétation dominante sur le site vacant dans le parc industriel

Sur le site vacant, le couvert végétal occupe environ 70% de l'espace disponible. L'herbe à poux occupe entre 30% et 60% de ce couvert végétal. Tout comme le long de l'autoroute, les traitements à 2 cm et à 5 cm diminuent la fréquence des espèces végétales et en particulier, l'herbe à poux (figure 5).

Végétation dominante pour les autres sites

Dans certains cas, comme le site à Notre-Dame de Lourdes et le site à St-Charles Borromée, la tonte a diminué la fréquence des espèces végétales potentiellement compétitrices, alors que dans d'autres cas, comme le site du Chemin des Prairies, le site de Crabtree et le site du Carrefour du Moulin, la tonte a augmenté la fréquence des autres espèces végétales au détriment de l'herbe à poux (figure 6). Au site de Ste-Mélanie, une seule tonte en début juillet, n'a pas modifié la fréquence de l'herbe à poux pour le reste de la saison de croissance. Au site du parc Prévost, la tonte n'a pas modifié la fréquence des espèces végétales présentées.

Apparition des inflorescences mâles et des graines

La fréquence relative des plants ayant formés des graines nous permet de visualiser l'apparition des graines au cours de la saison de croissance (figure 7, 8, 9). Les inflorescences mâles commencent à libérer leur pollen dans la quatrième semaine de juillet (figure 1) et les graines apparaissent entre la deuxième et la troisième semaine d'août (figure 7, 8, 9)

Densités

Les densités d'herbe à poux sont très variables d'un site à l'autre. Elles varient entre 278 et 4158 plants m^{-2} (figure 10). Les arrachages nous ont permis d'observer la germination de l'herbe à poux au cours de la saison. Dans la majorité des cas, les densités sont importantes en juillet et elles diminuent progressivement ou restent constantes au cours de la saison. Ces observations, conformes avec la littérature, montrent que l'herbe à poux germe surtout au printemps et que la repousse est faible par la suite (Baskin et Baskin, 1980; Gebben, 1965; Miller, 1987; Willemesen, 1975.).

Analyse de sol

Le tableau 1 présente les analyses de sol prélevées aux neuf sites en début d'expérience. Elles montrent une corrélation positive entre la première mesure de hauteur (5 Juillet 1990) et le % de calcium, la saturation en calcium et la capacité d'échange cationique (CEC) ($r=0.72$, $P=0.01$; $r=0.65$, $P=0.03$; $r=0.78$, $P=0.002$).

Longueur cumulative des inflorescences mâles au site terrain vacant du parc industriel

Le tableau 2 montre la longueur cumulative des inflorescences mâles au cours de la saison de croissance au site du terrain vacant du parc industriel. Ces valeurs sont similaires à celles de l'autoroute présentées dans le chapitre 1, et c'est pourquoi elles n'ont pas été incluses dans l'article scientifique.

Poids sec, nombre de graines et biomasse par plant

Les valeurs de poids secs, nombre de graines et biomasses, présentées dans les tableaux 3, 5, 6 de l'article scientifique, sont des mesures par m^2. Les données par plant n'ont pas été publiées. Elles sont présentées avec leur déviation standard aux tableaux 3, 4, 5 de ce chapitre. Les tendances sont les mêmes que dans l'article scientifique.

Comparaison entre les sites à l'étude

Le tableau 6 montre la variabilité observée entre les plants d'herbe à poux dans les différents sites de l'étude. On remarque une grande variabilité au niveau du nombre de plants m^{-2}, de la hauteur des plants et du nombre de graines m^{-2}. Certains auteurs ont déjà remarqué cette variabilité dans un même site (Bonan, 1991; Dickerson et Sweet, 1971; Gebben, 1965; McKone et Tonkyn, 1986). Il serait intéressant de déterminer si cette variabilité est d'origine génétique ou controlée par des variables environnementales.

Ceci résume les résultats traités au cours de ce projet de maîtrise, mais non publiés, faute d'espace, dans l'article scientifique.

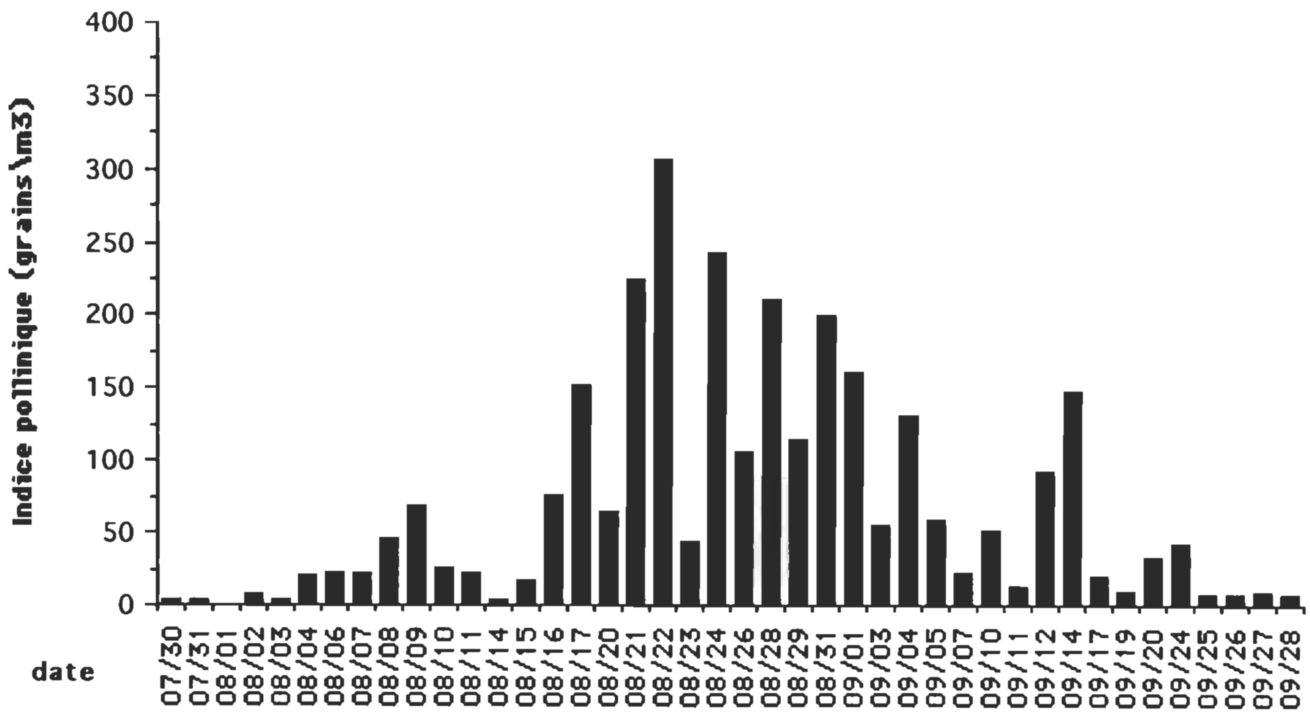


Figure 1. Concentration du pollen de la petite herbe à poux pour l'année 1990 à Joliette.

Source: Département de santé communautaire de Lanaudière, Joliette.

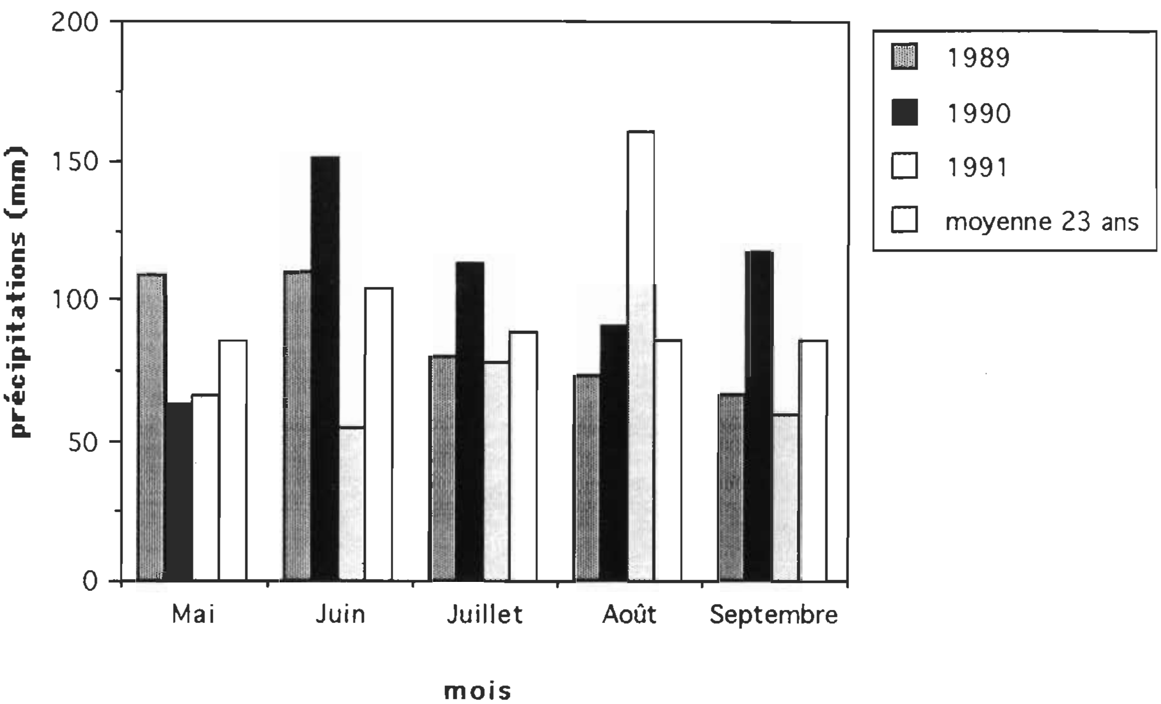


Figure 2. Moyenne des précipitations pour la saison de croissance de 1989, 1990, 1991 et des 23 dernières années à Joliette.

Source: Ministère de l'Environnement du Québec. Direction des réseaux atmosphériques.

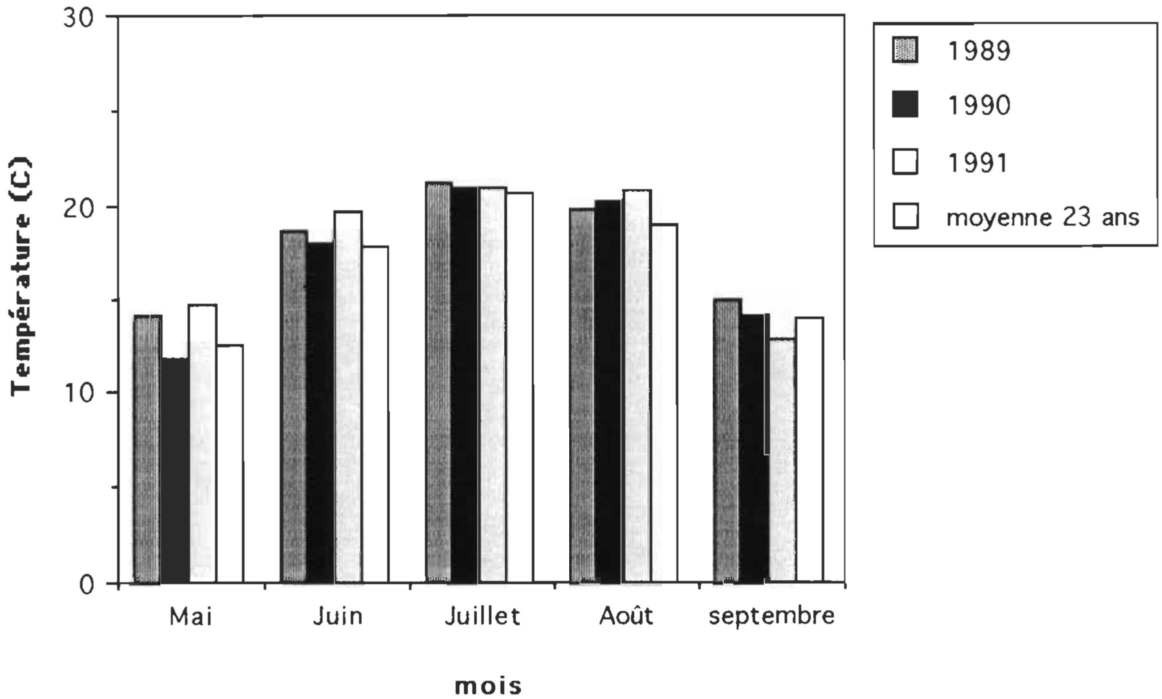
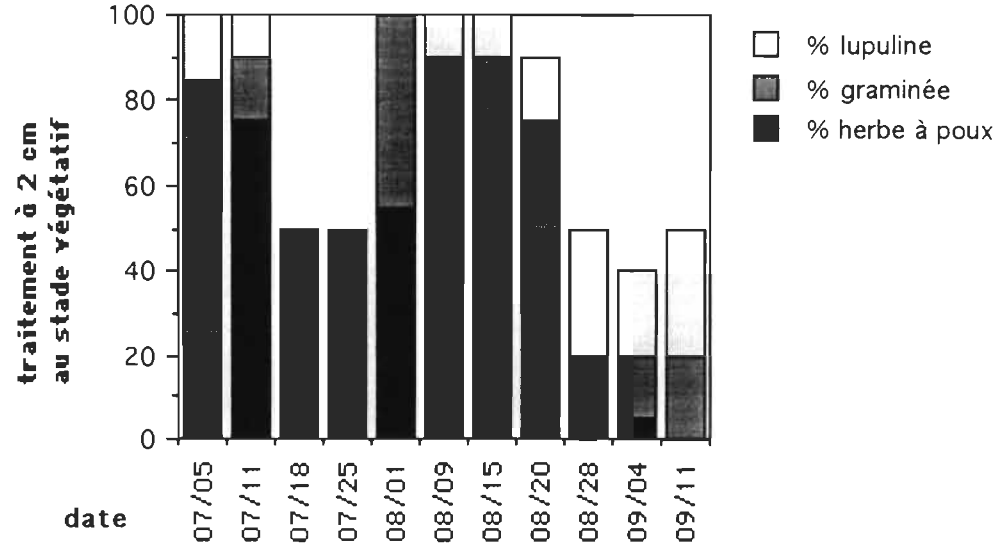


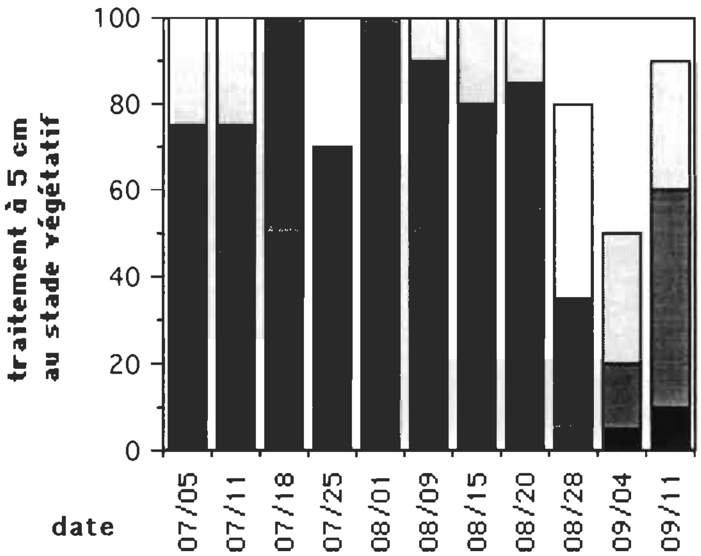
Figure 3. Température moyenne pour l'année 1989, 1990, 1991 et les 23 dernières années à Joliette.

Source: Ministère de l'Environnement du Québec. Direction des réseaux atmosphériques.

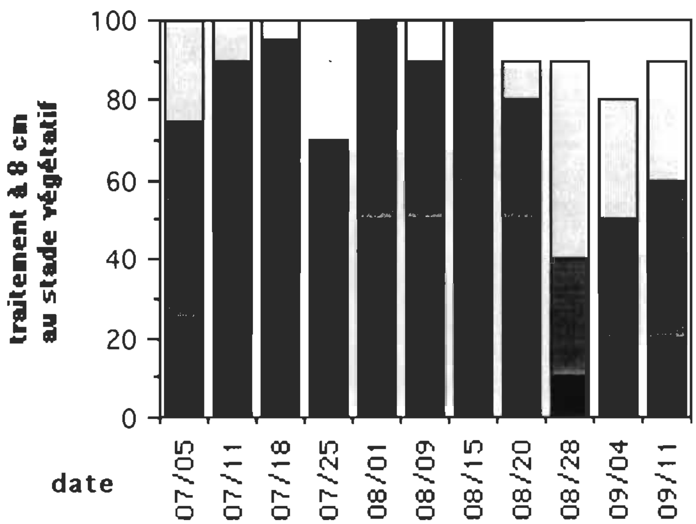
Figure 4. Végétation dominante au cours de la saison 1990 selon les différents traitements du site de l'autoroute 31.



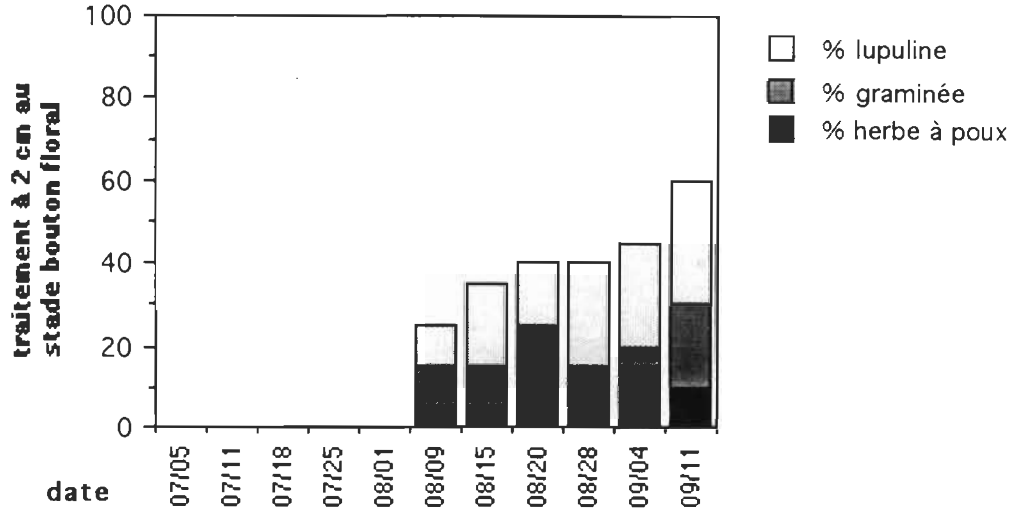
100
80
60
40
20
0
traitement à 2 cm
au stade végétatif
date
07/05
07/11
07/18
07/25
08/01
08/09
08/15
08/20
08/28
09/04
09/11
% lupuline
% graminée
% herbe à poux



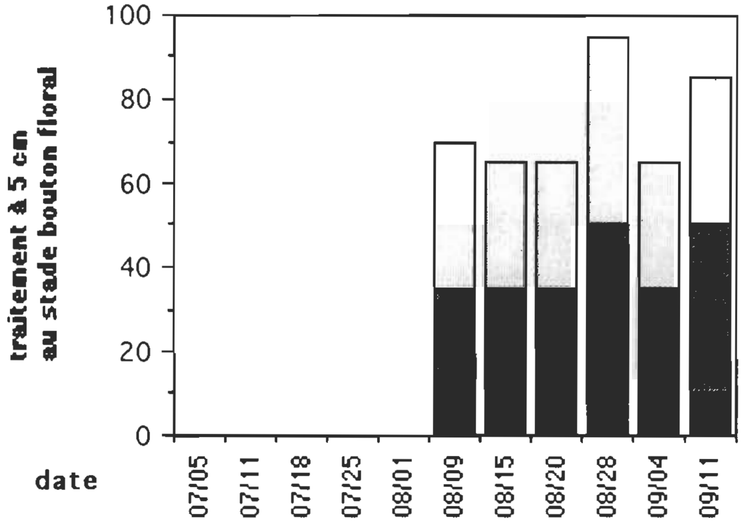
100
80
60
40
20
0
traitement à 5 cm
au stade végétatif
date
07/05
07/11
07/18
07/25
08/01
08/09
08/15
08/20
08/28
09/04
09/11



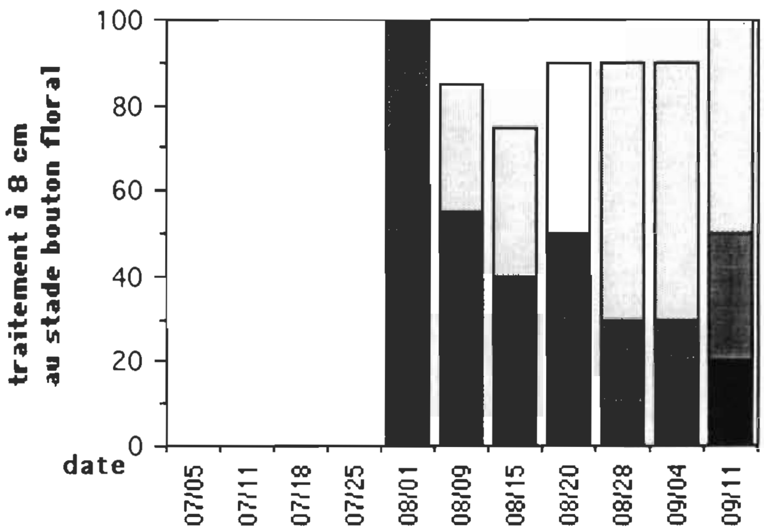
100
80
60
40
20
0
traitement à 8 cm
au stade végétatif
date
07/05
07/11
07/18
07/25
08/01
08/09
08/15
08/20
08/28
09/04
09/11



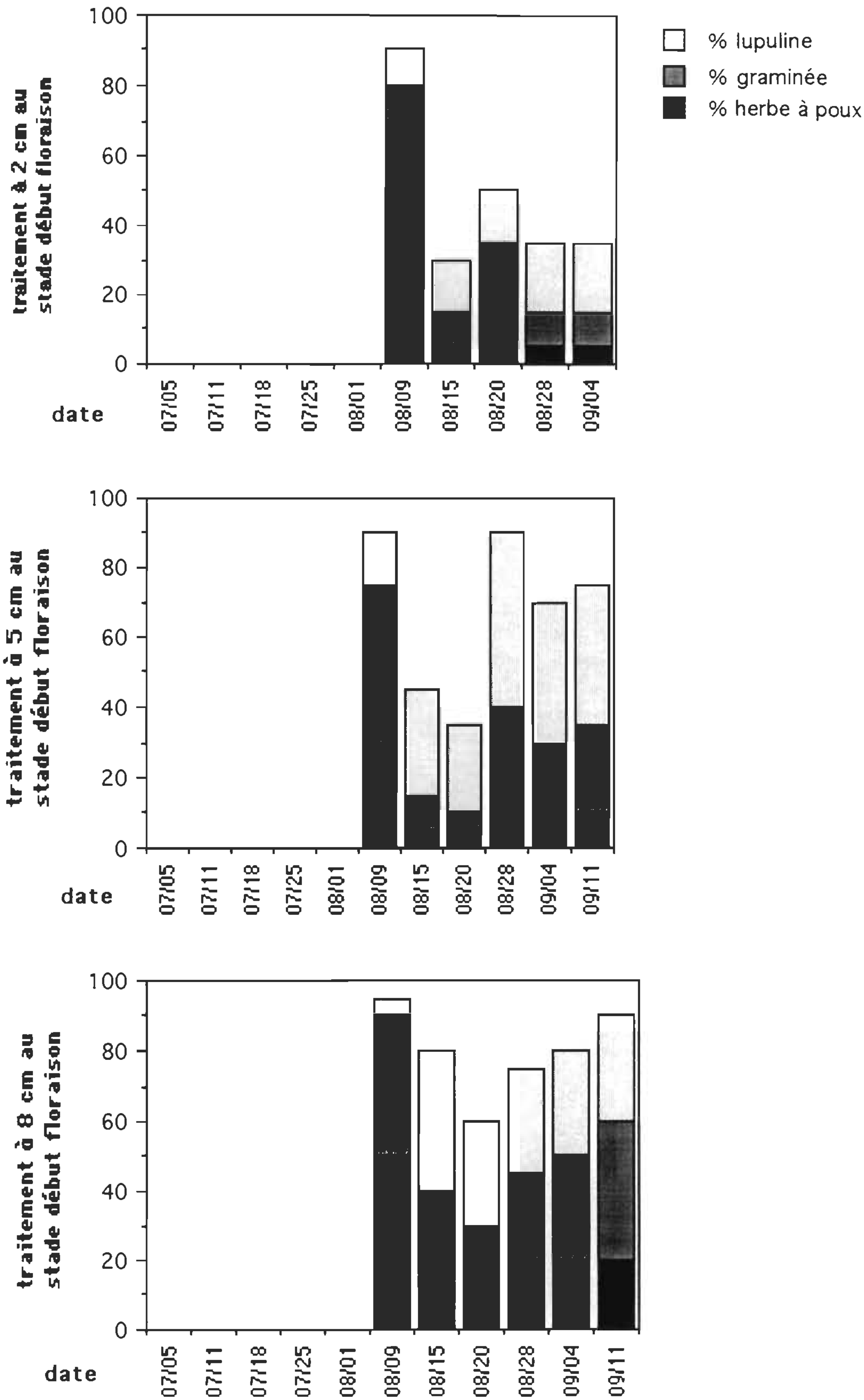
% lupuline
% graminée
% herbe à poux
traitement à 2 cm au stade bouton floral
100
80
60
40
20
0
date
07/05
07/11
07/18
07/25
08/01
08/09
08/15
08/20
08/28
09/04
09/11

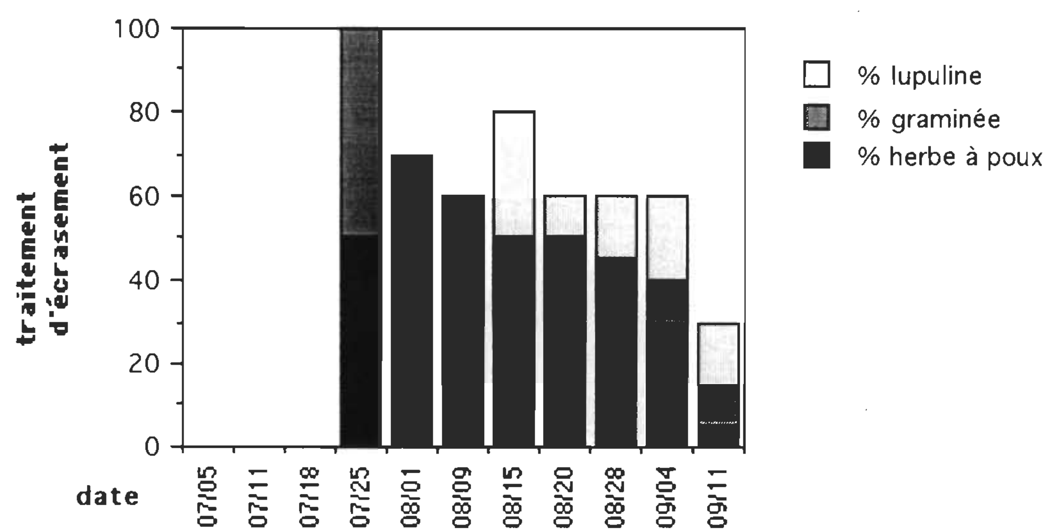


traitement à 5 cm au stade bouton floral
100
80
60
40
20
0
date
07/05
07/11
07/18
07/25
08/01
08/09
08/15
08/20
08/28
09/04
09/11



traitement à 8 cm au stade bouton floral
100
80
60
40
20
0
date
07/05
07/11
07/18
07/25
08/01
08/09
08/15
08/20
08/28
09/04
09/11


traitement à 2 cm au stade début floraison
traitement à 5 cm au stade début floraison
traitement à 8 cm au stade début floraison
date
% lupuline
% graminée
% herbe à poux
0
20
40
60
80
100
07/05
07/11
07/18
07/25
08/01
08/09
08/15
08/20
08/28
09/04
09/11


100
80
60
40
20
0
traitement d'écrasement
date
07/05
07/11
07/18
07/25
08/01
08/09
08/15
08/20
08/28
09/04
09/11
% lupuline
% graminée
% herbe à poux

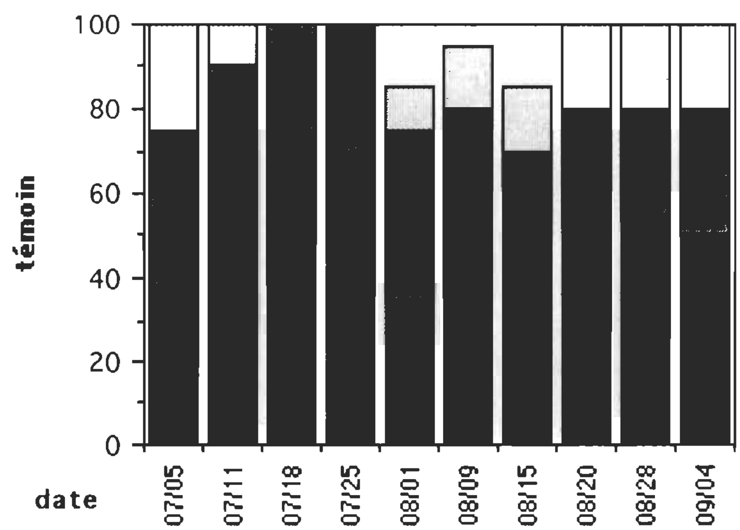
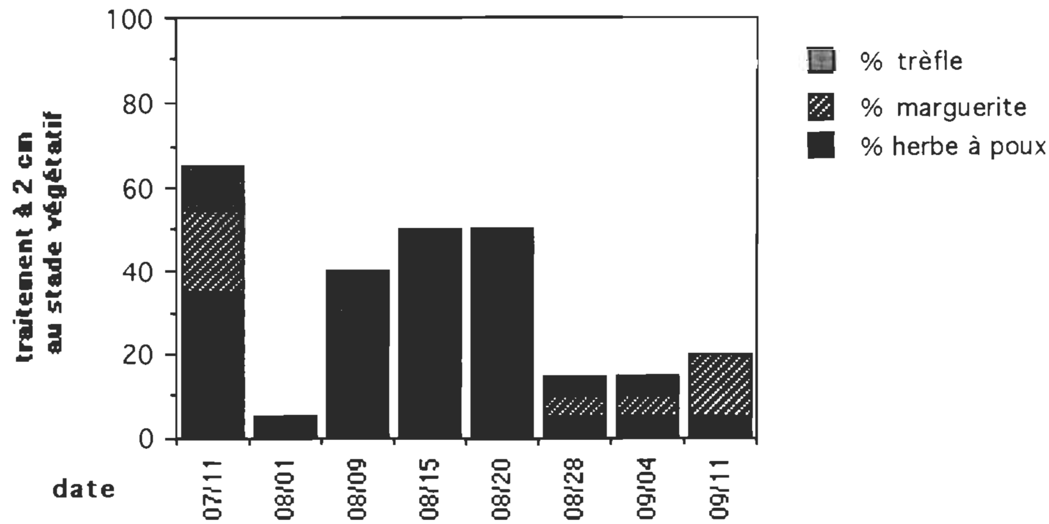
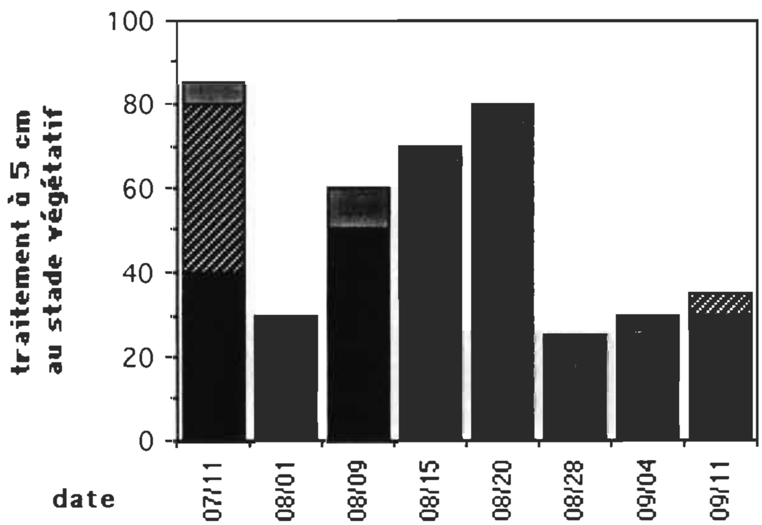
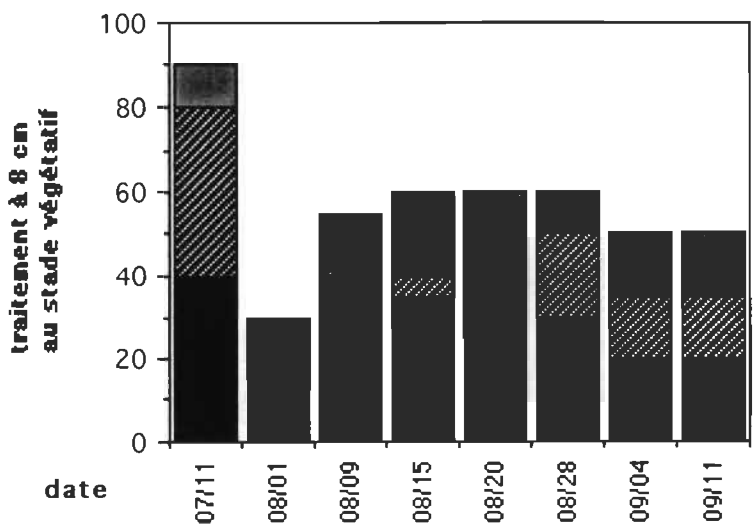
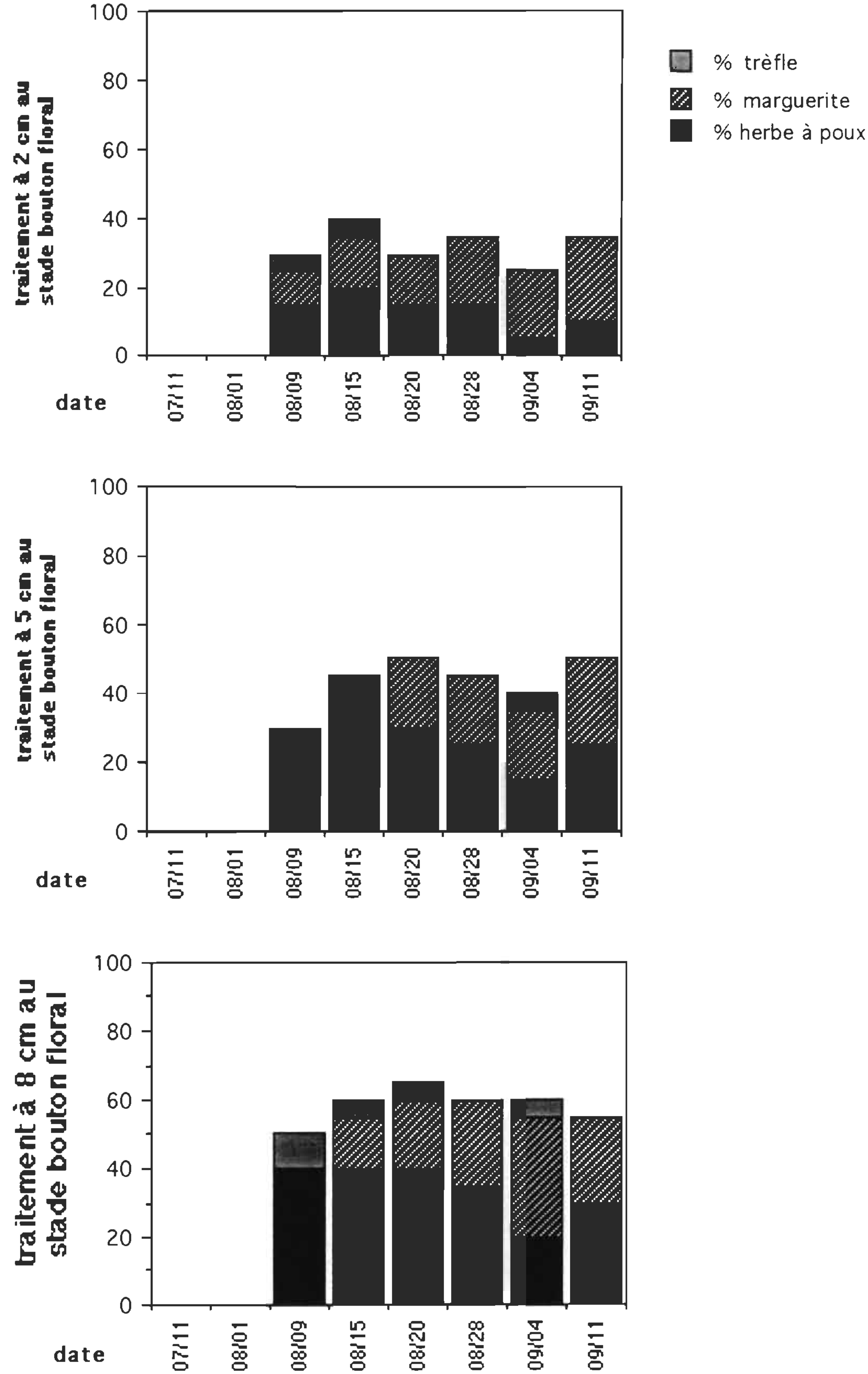

100
80
60
40
20
0
témoin
date
07/05
07/11
07/18
07/25
08/01
08/09
08/15
08/20
08/28
09/04

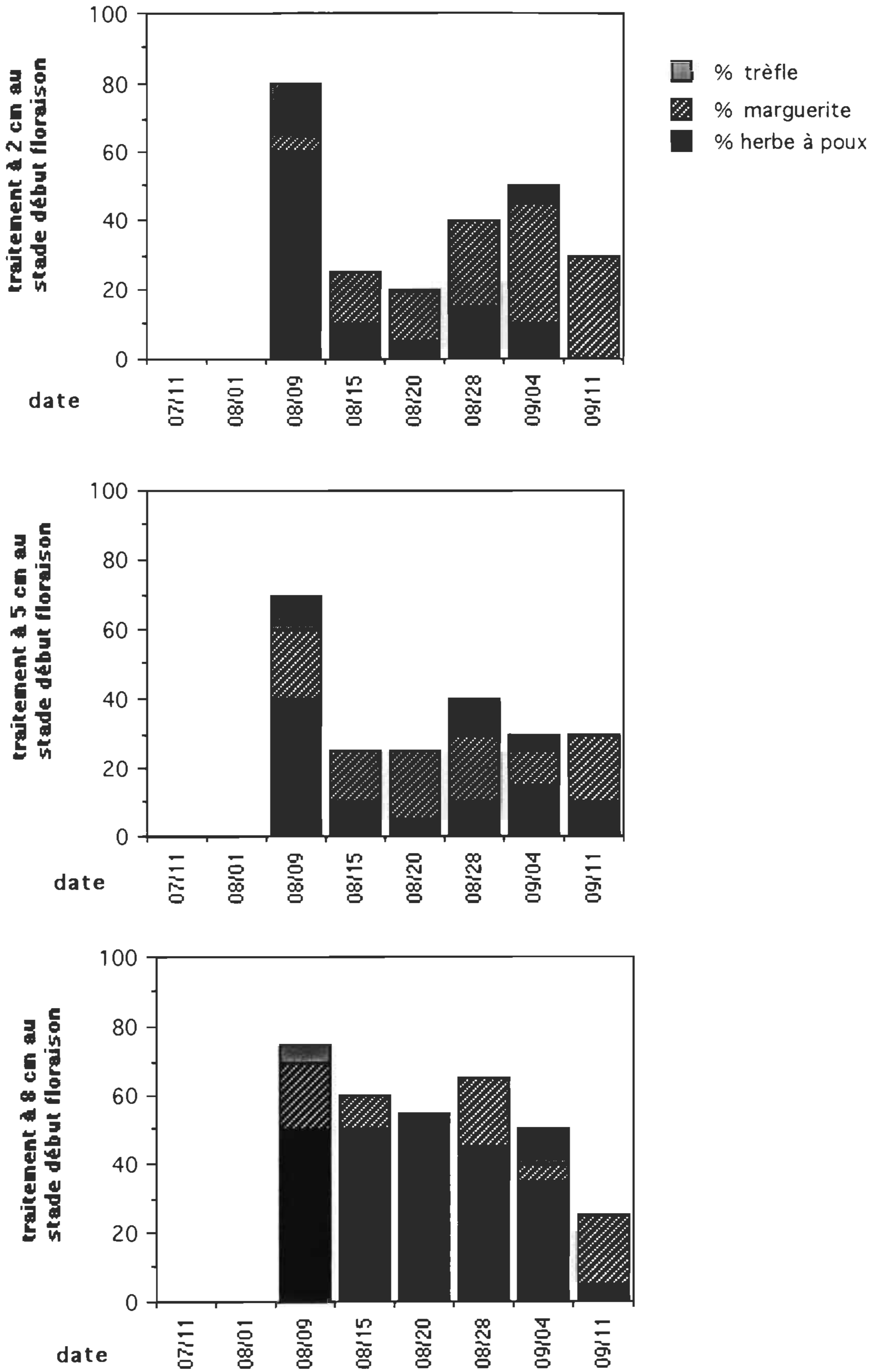
Figure 5. Végétation dominante au cours de la saison 1990 selon les différents traitements du site vacant du parc industriel.


traitement à 2 cm
au stade végétatif
100
80
60
40
20
0
date
07/11
08/01
08/09
08/15
08/20
08/28
09/04
09/11
% trèfle
% marguerite
% herbe à poux


traitement à 5 cm
au stade végétatif
100
80
60
40
20
0
date
07/11
08/01
08/09
08/15
08/20
08/28
09/04
09/11


traitement à 8 cm
au stade végétatif
100
80
60
40
20
0
date
07/11
08/01
08/09
08/15
08/20
08/28
09/04
09/11


% trèfle
% marguerite
% herbe à poux
traitement à 2 cm au stade bouton floral
traitement à 5 cm au stade bouton floral
traitement à 8 cm au stade bouton floral
date
0
20
40
60
80
100
07/11
08/01
08/09
08/15
08/20
08/28
09/04
09/11



traitement à 2 cm au stade début floraison
traitement à 5 cm au stade début floraison
traitement à 8 cm au stade début floraison
100
80
60
40
20
0
date
07/11
08/01
08/09
08/15
08/20
08/28
09/04
09/11
% trèfle
% marguerite
% herbe à poux

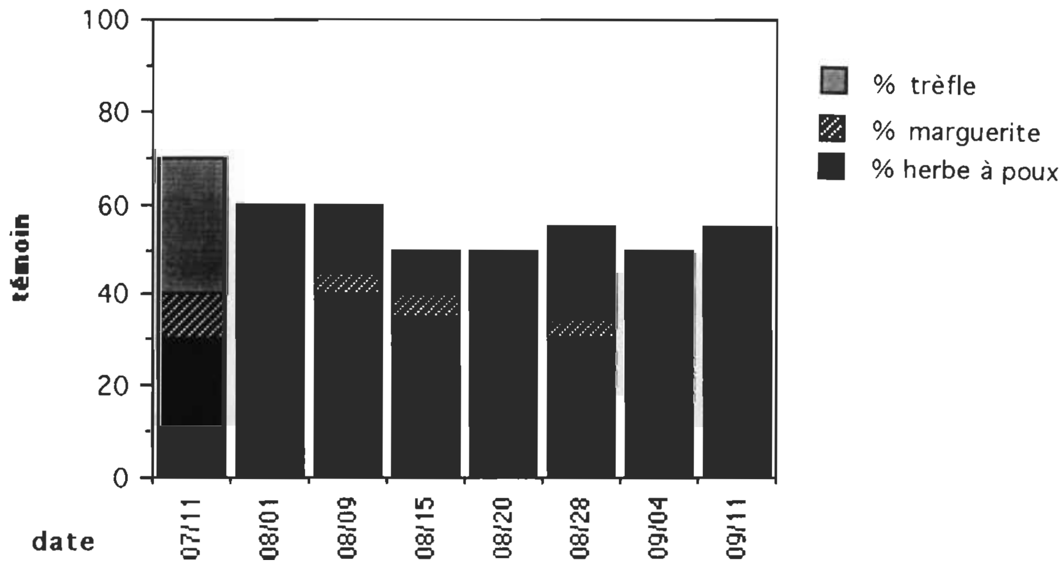
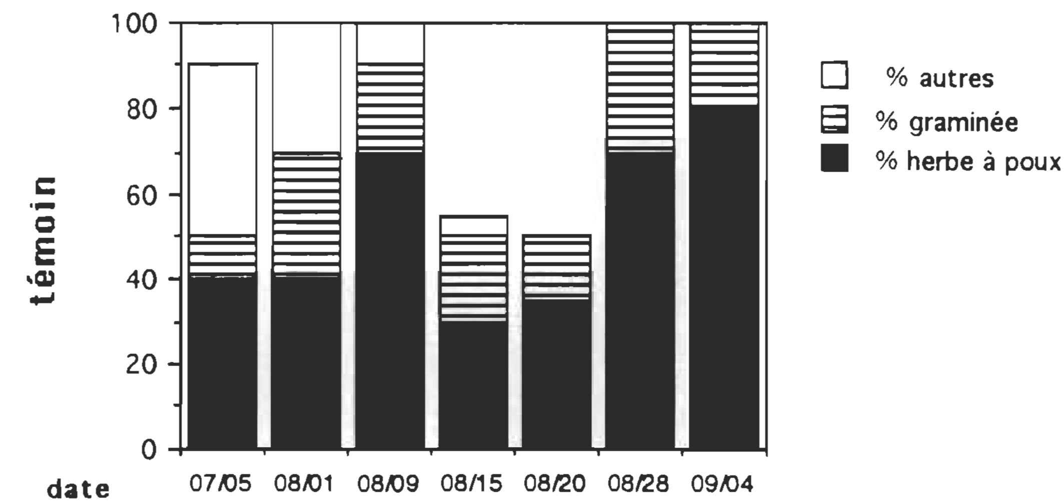
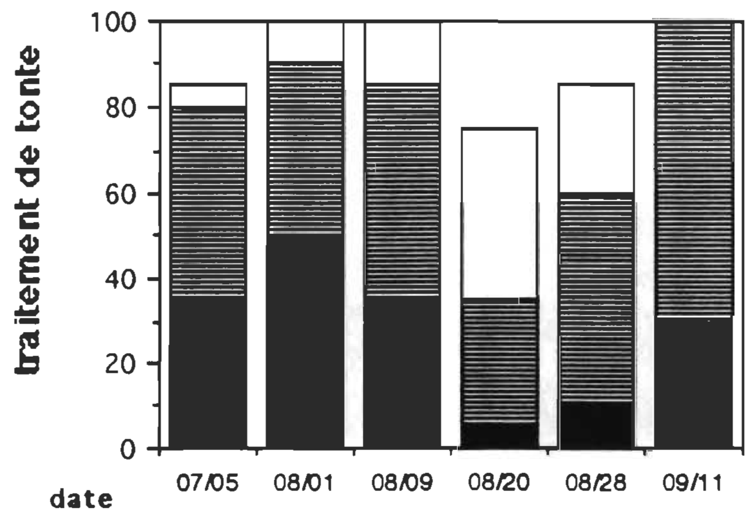

100
80
60
40
20
0
témoin
date
07/11
08/01
08/09
08/15
08/20
08/28
09/04
09/11
% trèfle
% marguerite
% herbe à poux

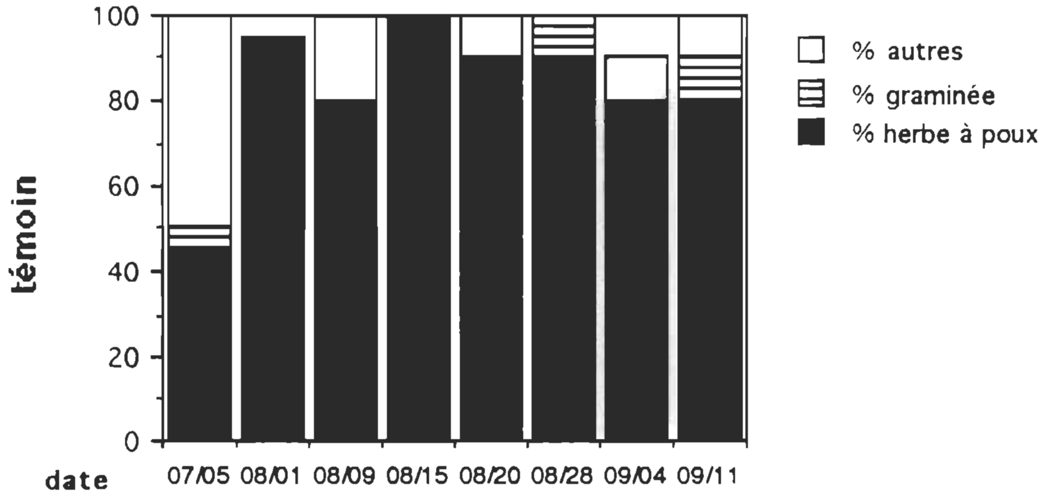
Figure 6. Végétation dominante au cours de la saison 1990 selon les différents traitements aux sites de Crabtree, St-Charles Borromée, parc Prévost, Notre-Dame de Lourdes, Ste-Mélanie, Chemin des Prairies et Carrefour du Moulin.

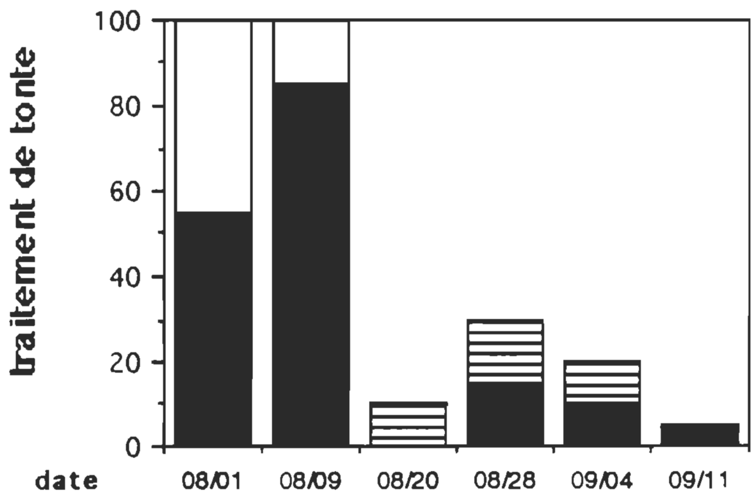
Crabtree


100
80
60
40
20
0
témoin
date
07/05
08/01
08/09
08/15
08/20
08/28
09/04
% autres
% graminée
% herbe à poux

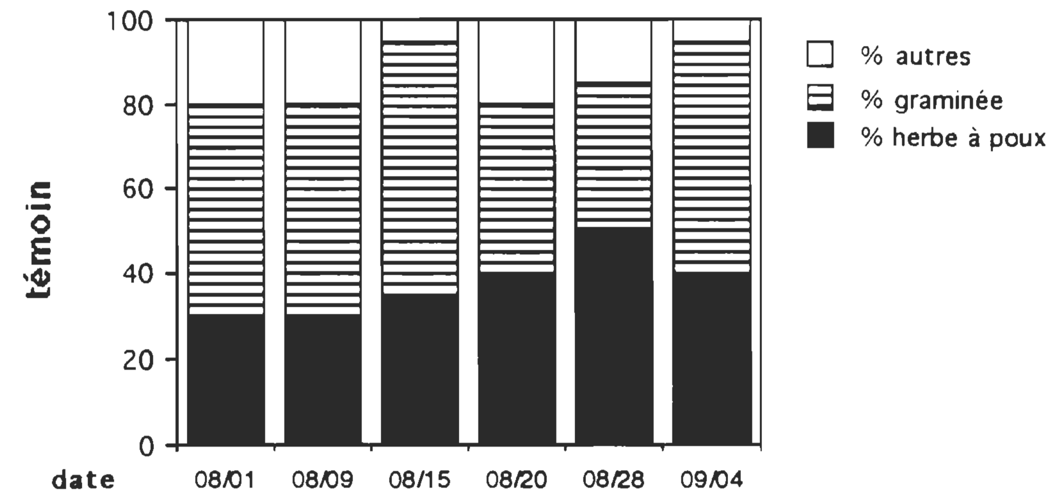

100
80
60
40
20
0
traitement de tonte
date
07/05
08/01
08/09
08/20
08/28
09/11

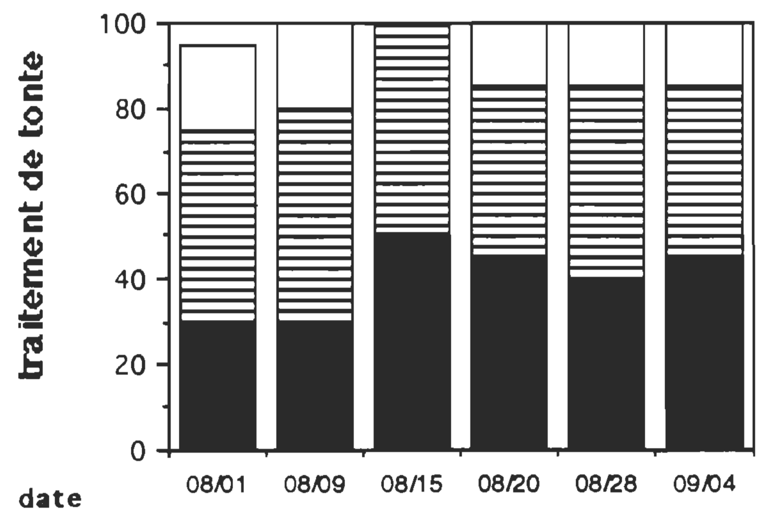
St-Charles Borromée



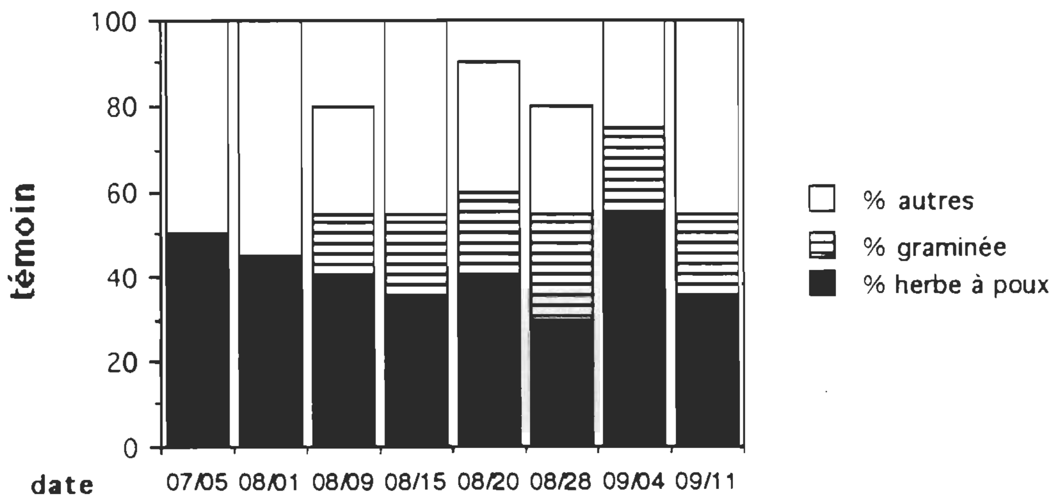


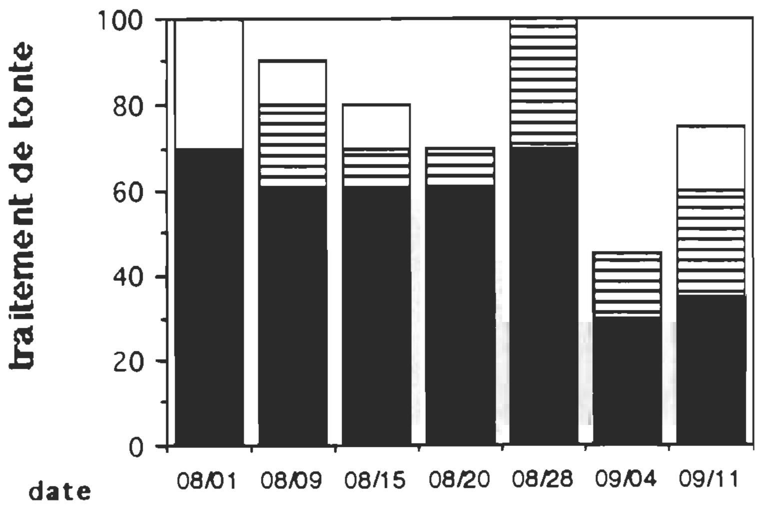
Parc Prévost



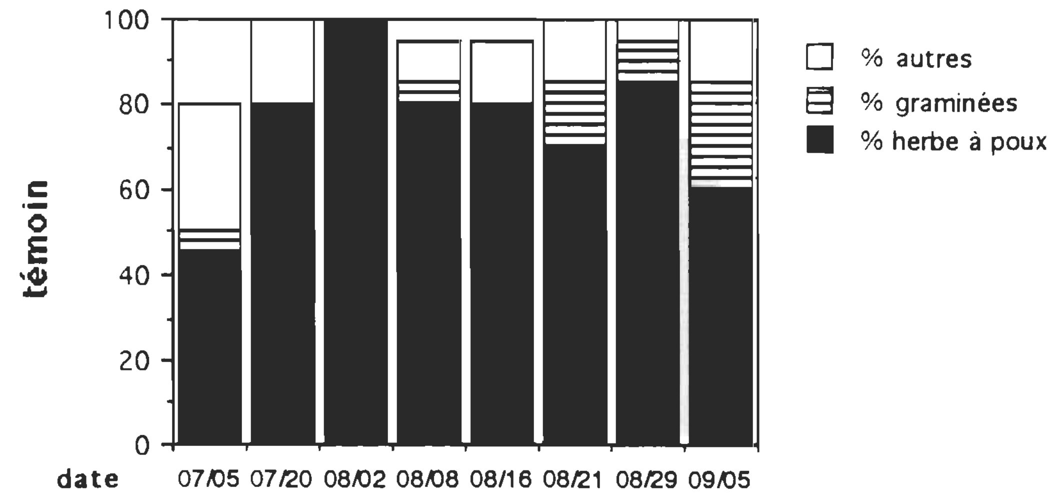


Notre-Dame de Lourdes

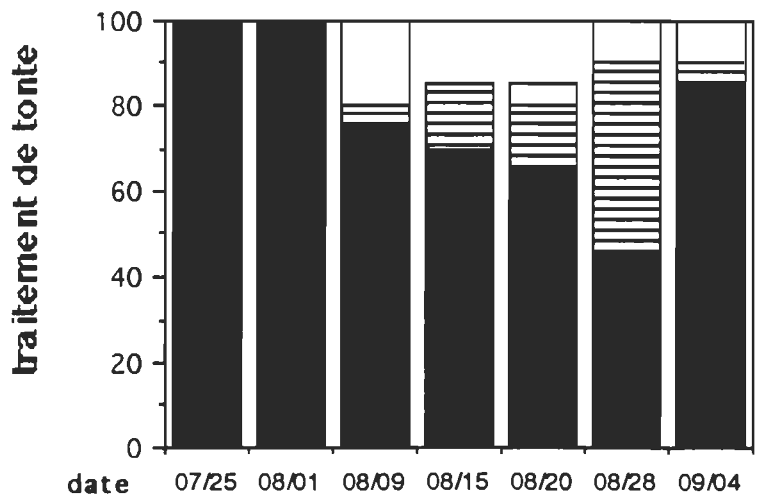




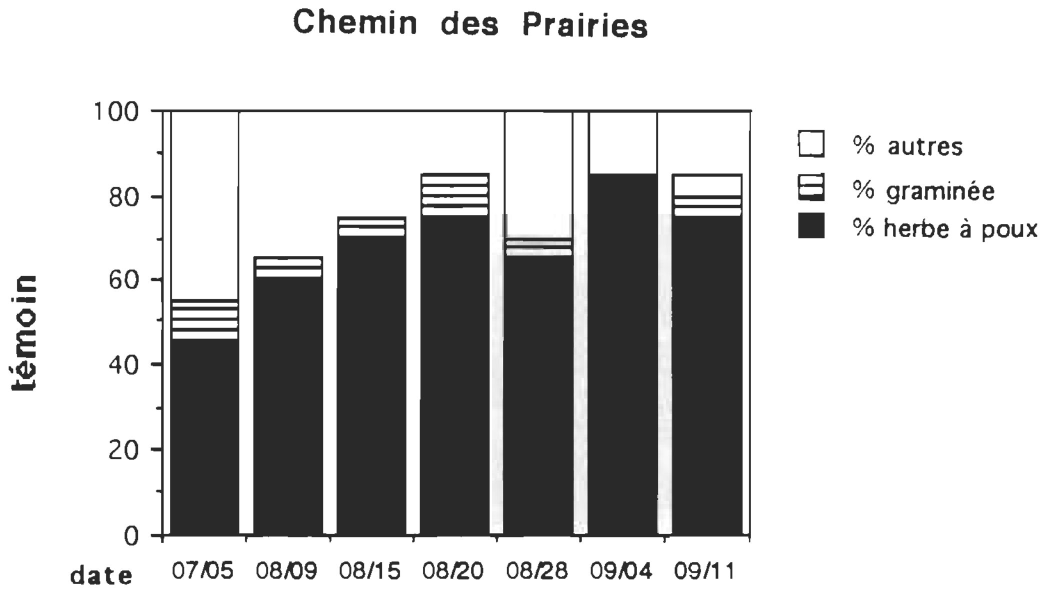
Ste-Mélanie

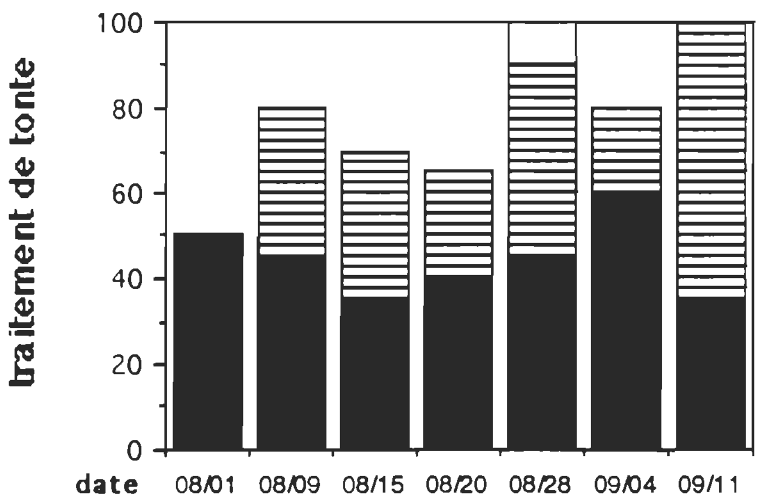


100
80
60
40
20
0
témoin
date
07/05
07/20
08/02
08/08
08/16
08/21
08/29
09/05
% autres
% graminées
% herbe à poux

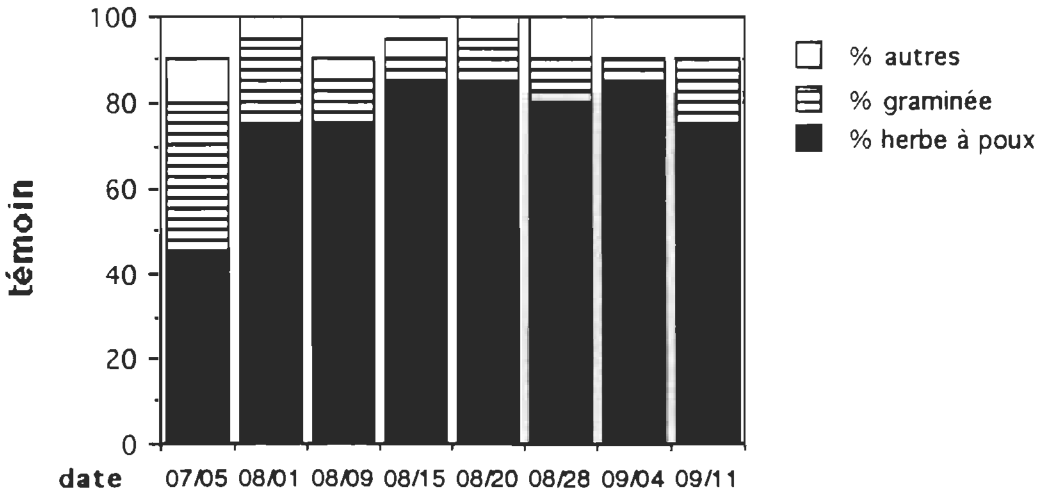


100
80
60
40
20
0
traitement de tonte
date
07/25
08/01
08/09
08/15
08/20
08/28
09/04


Chemin des Prairies
100
80
60
40
20
0
témoin
date
07/05
08/09
08/15
08/20
08/28
09/04
09/11
% autres
% graminée
% herbe à poux


100
80
60
40
20
0
traitement de tonte
date
08/01
08/09
08/15
08/20
08/28
09/04
09/11

Carrefour du Moulin



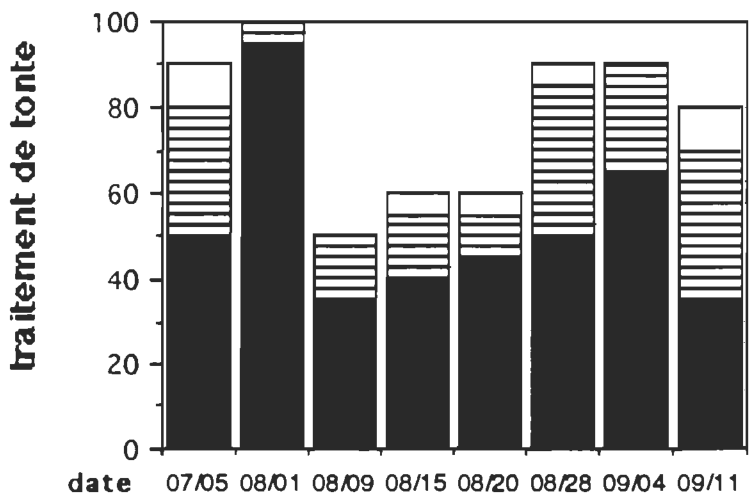


Figure 7. Pourcentage de plants ayant formés des graines au cours de la saison 1990 au site de l'autoroute 31.

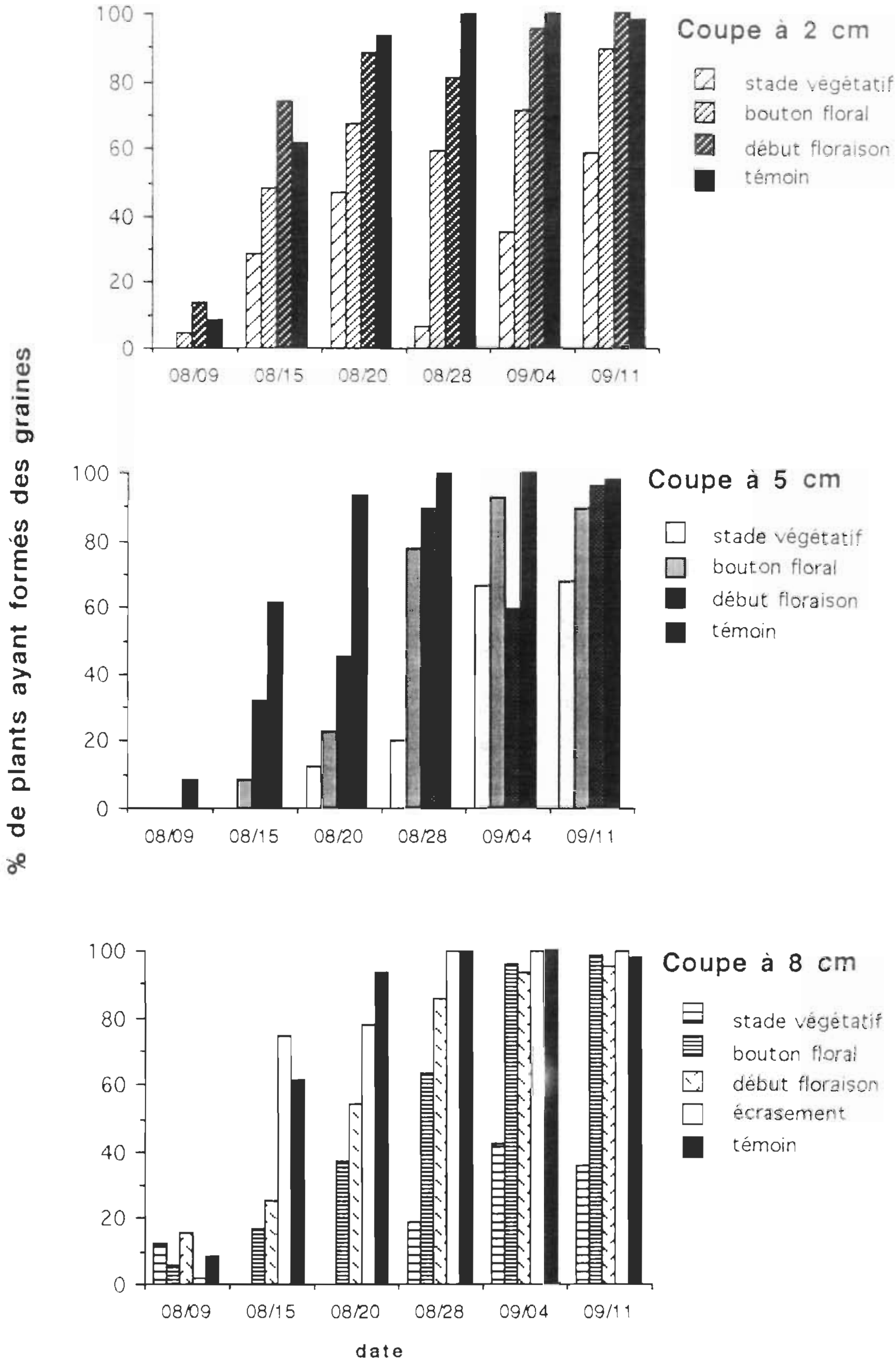

% de plants ayant formés des graines
Coupe à 2 cm
stade végétatif
bouton floral
début floraison
témoin
100
80
60
40
20
0
08/09
08/15
08/20
08/28
09/04
09/11
Coupe à 5 cm
stade végétatif
bouton floral
début floraison
témoin
Coupe à 8 cm
stade végétatif
bouton floral
début floraison
écrasement
témoin
date

Figure 8. Pourcentage de plants ayant formés des graines au cours de la saison 1990 au site vacant du parc industriel.

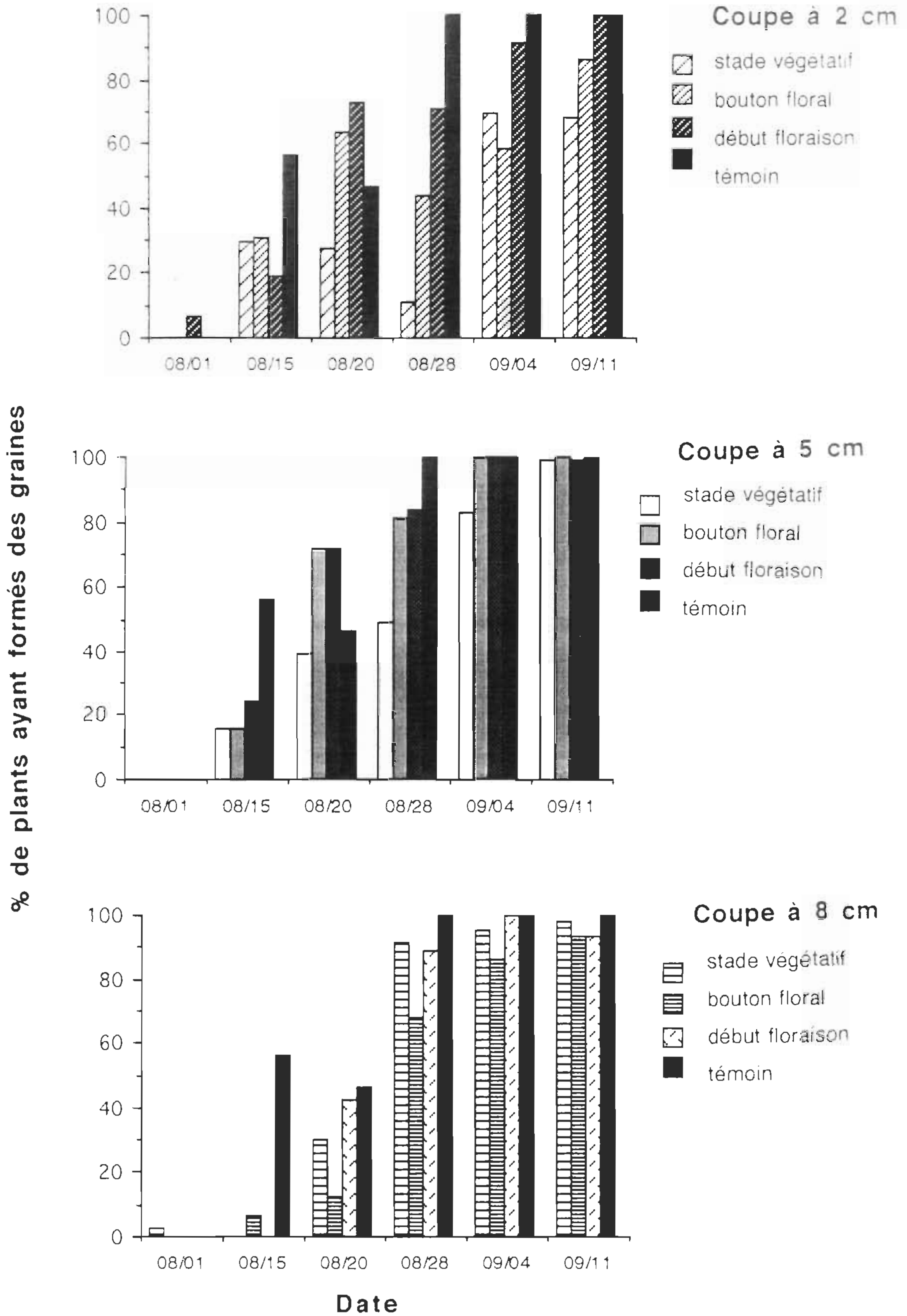
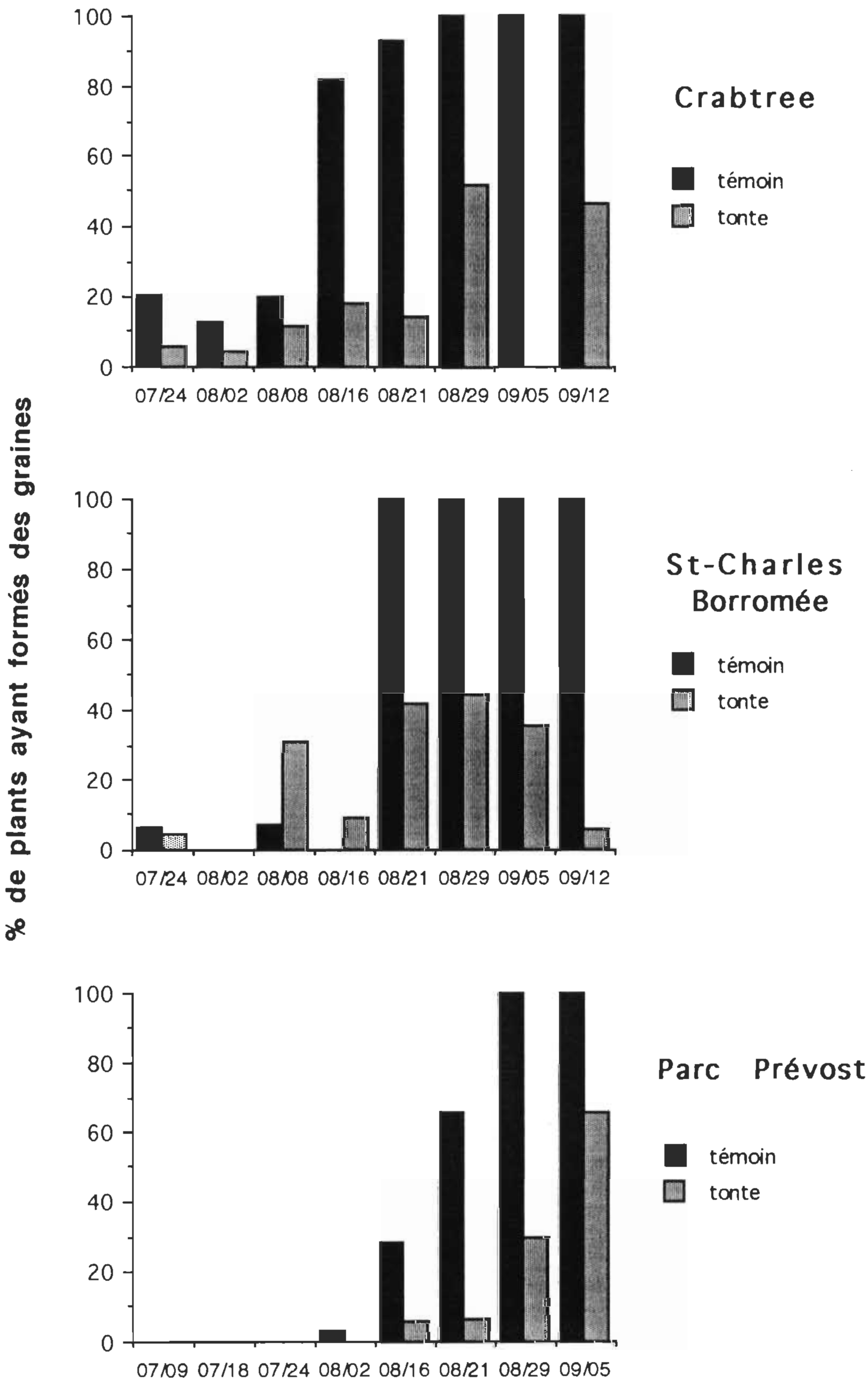
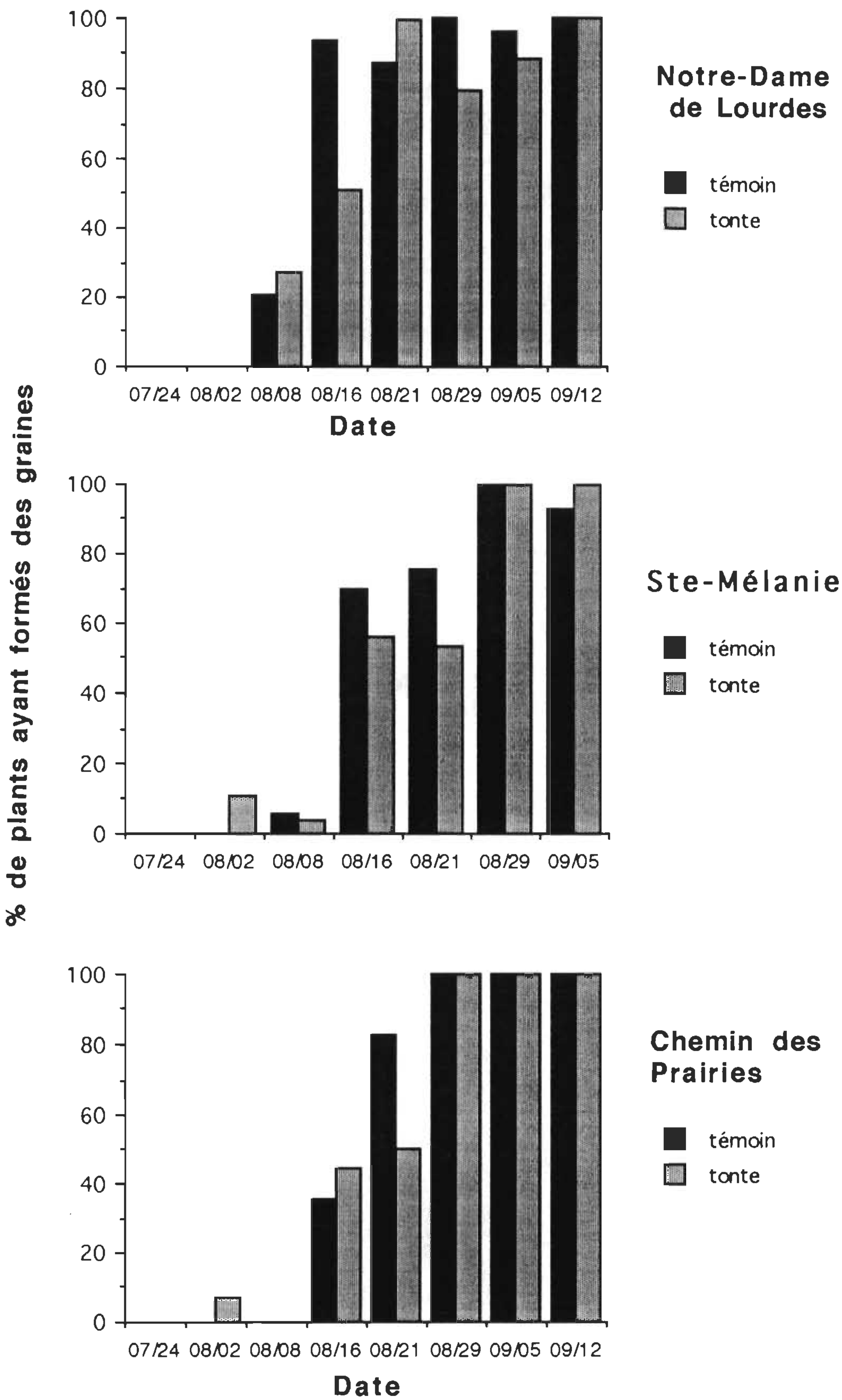
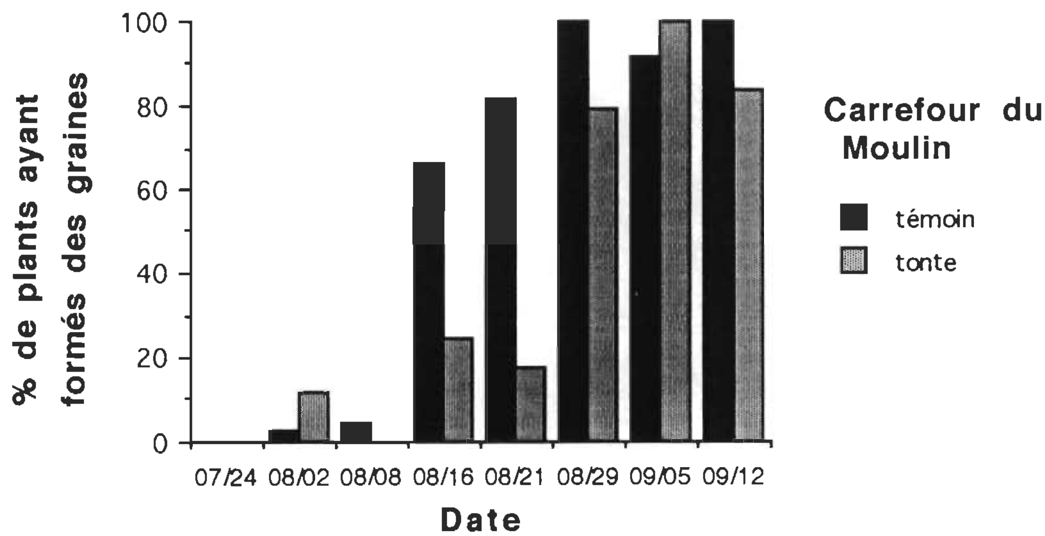

Coupe à 2 cm
stade végétatif
bouton floral
début floraison
témoin
Coupe à 5 cm
stade végétatif
bouton floral
début floraison
témoin
Coupe à 8 cm
stade végétatif
bouton floral
début floraison
témoin
% de plants ayant formés des graines
100
80
60
40
20
0
08/01
08/15
08/20
08/28
09/04
09/11
Date

Figure 9. Pourcentage de plants ayant formés des graines au cours de la saison 1990 aux sites de Crabtree, St-Charles Borromée, parc Prévost, Notre-Dame de Lourdes, Ste-Mélanie, Chemin des Prairies et Carrefour du Moulin.

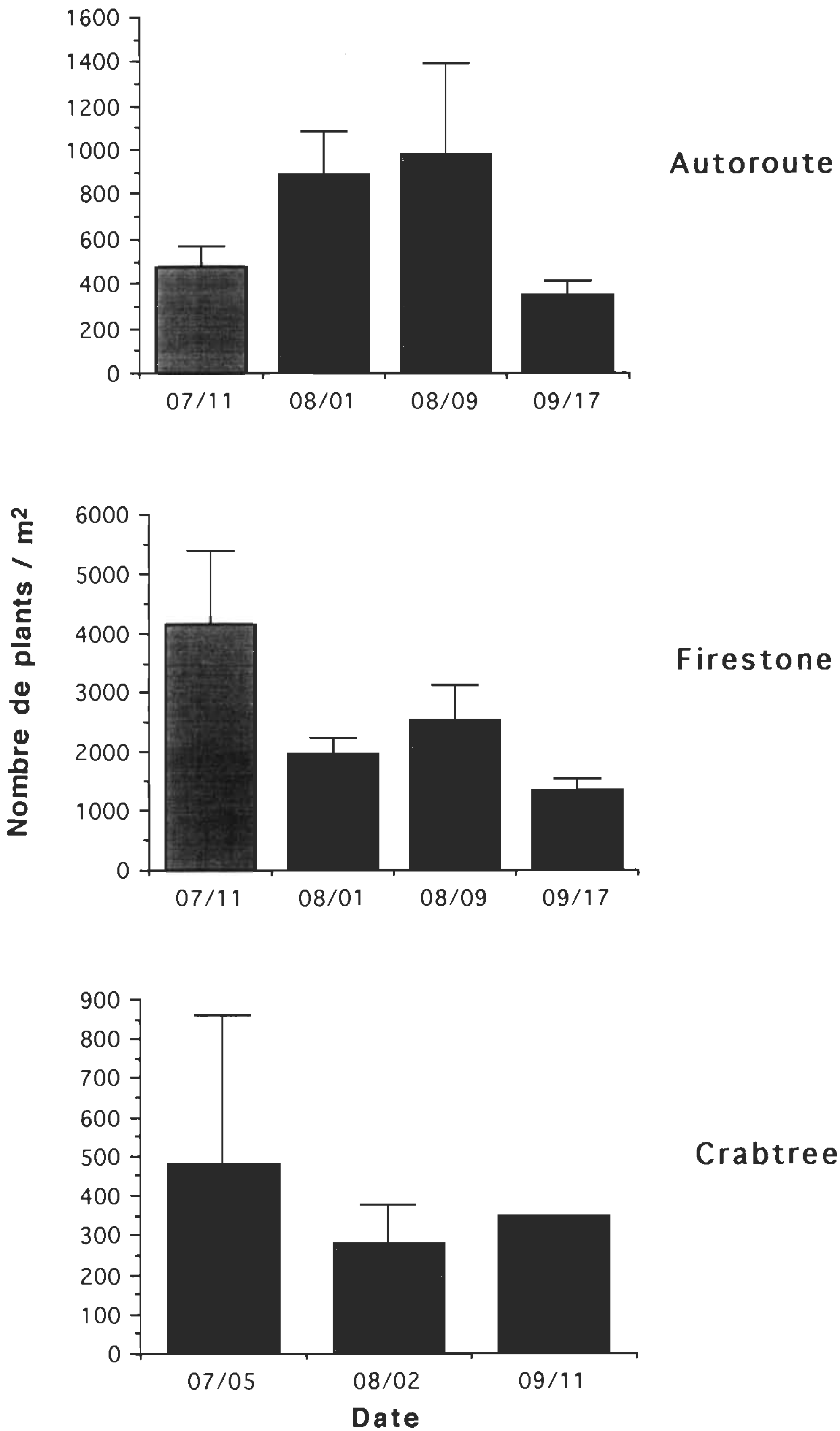

% de plants ayant formés des graines
Crabtree
témoin
tonte
100
80
60
40
20
0
07/24 08/02 08/08 08/16 08/21 08/29 09/05 09/12
St-Charles Borromée
témoin
tonte
100
80
60
40
20
0
07/24 08/02 08/08 08/16 08/21 08/29 09/05 09/12
Parc Prévost
témoin
tonte
100
80
60
40
20
0
07/09 07/18 07/24 08/02 08/16 08/21 08/29 09/05

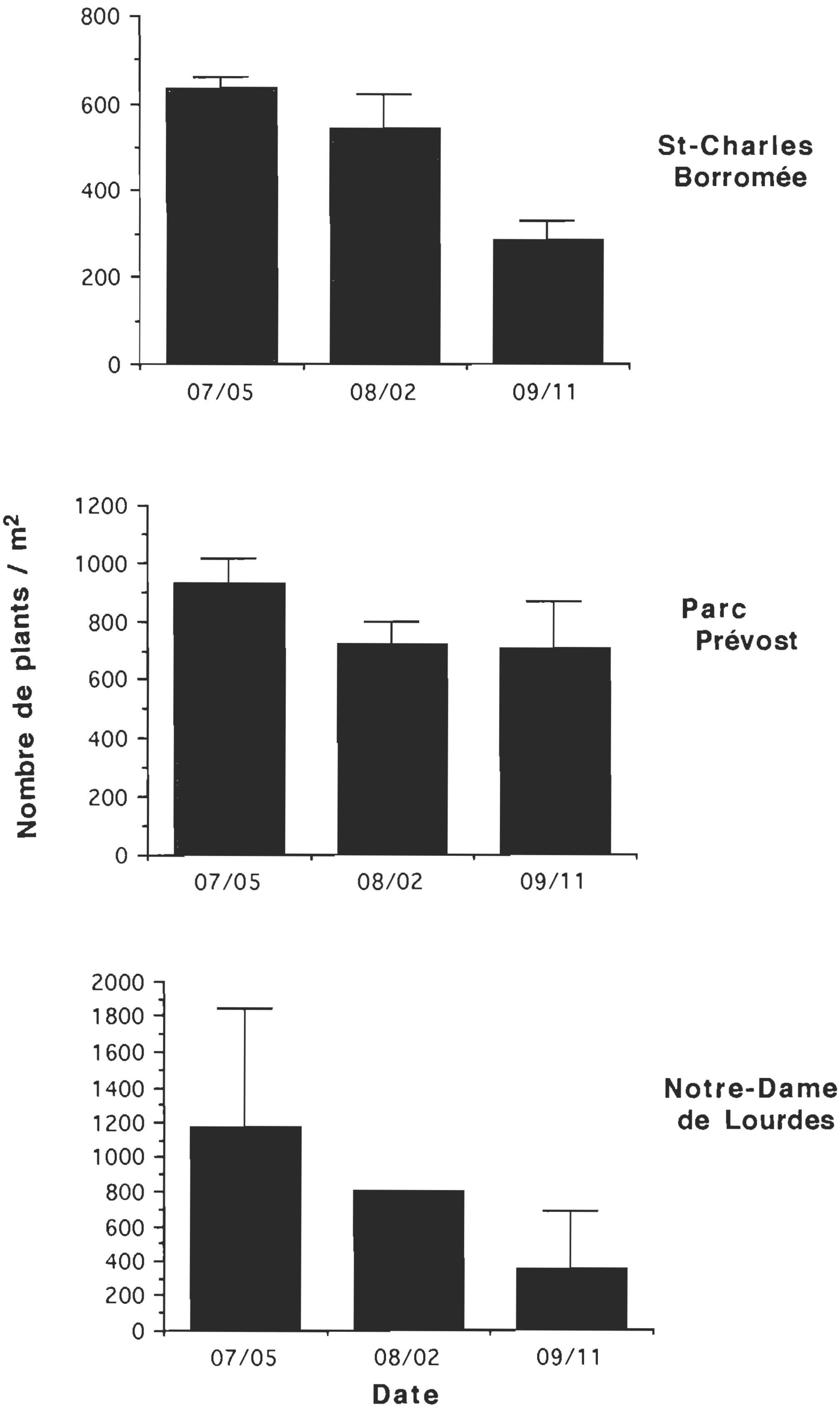

% de plants ayant formés des graines
100
80
60
40
20
0
07/24 08/02 08/08 08/16 08/21 08/29 09/05 09/12
Date
Notre-Dame de Lourdes
témoin
tonte
100
80
60
40
20
0
07/24 08/02 08/08 08/16 08/21 08/29 09/05
Ste-Mélanie
témoin
tonte
100
80
60
40
20
0
07/24 08/02 08/08 08/16 08/21 08/29 09/05 09/12
Date
Chemin des Prairies
témoin
tonte



% de plants ayant formés des graines
100
80
60
40
20
0
07/24
08/02
08/08
08/16
08/21
08/29
09/05
09/12
Date
Carrefour du Moulin
témoin
tonte

Figure 10. Densité de l'herbe à poux au cours de la saison de croissance 1990 pour les différents sites à l'étude.


1600
1400
1200
1000
800
600
400
200
0
07/11
08/01
08/09
09/17
Autoroute
Nombre de plants / m²
6000
5000
4000
3000
2000
1000
0
07/11
08/01
08/09
09/17
Firestone
900
800
700
600
500
400
300
200
100
0
07/05
08/02
09/11
Crabtree
Date


800
600
400
200
0
07/05
08/02
09/11
St-Charles Borromée
Nombre de plants / m2
1200
1000
800
600
400
200
0
07/05
08/02
09/11
Parc Prévost
2000
1800
1600
1400
1200
1000
800
600
400
200
0
07/05
08/02
09/11
Notre-Dame de Lourdes
Date

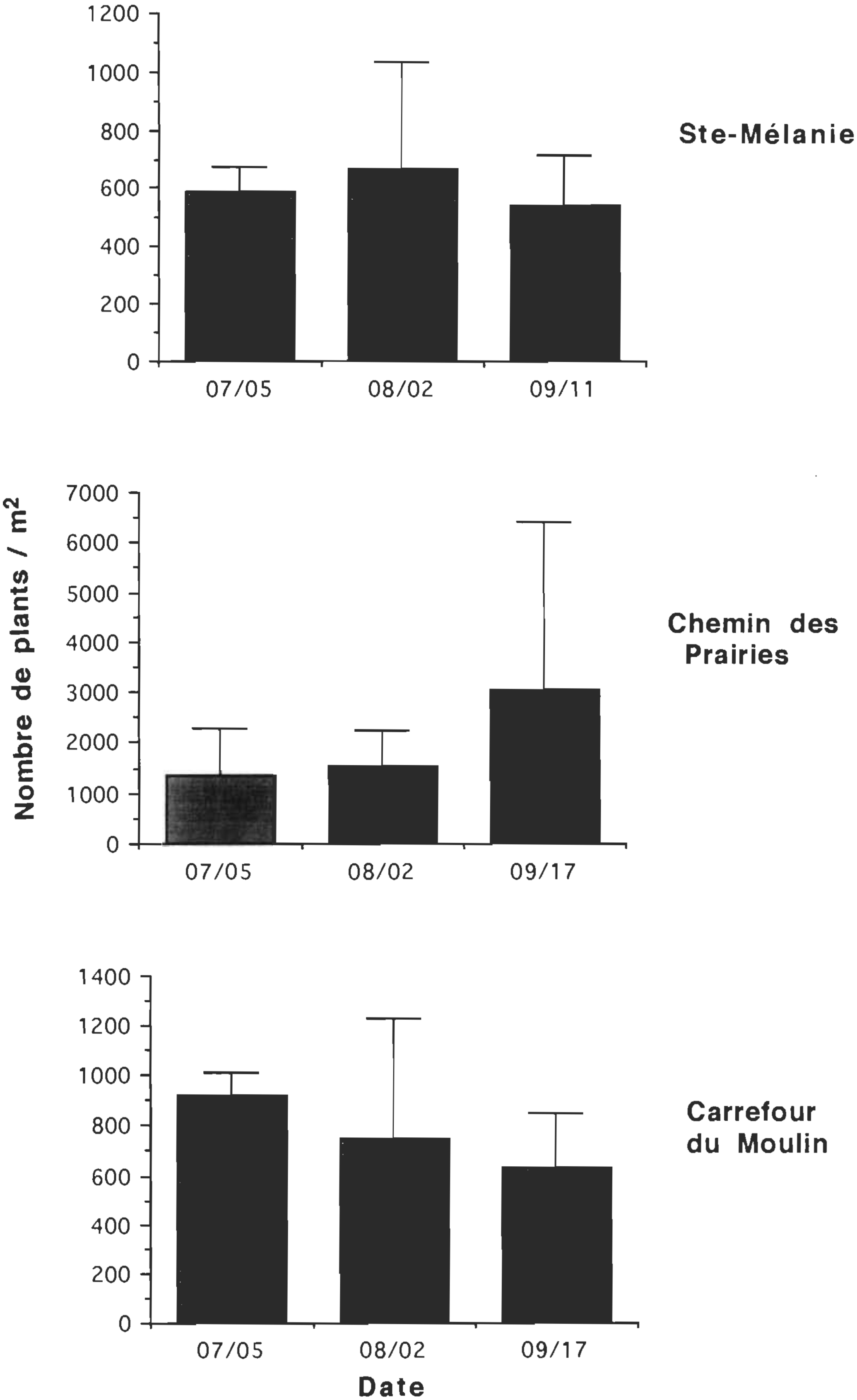

1200
1000
800
600
400
200
0
07/05
08/02
09/11
Ste-Mélanie
Nombre de plants / m²
7000
6000
5000
4000
3000
2000
1000
0
07/05
08/02
09/17
Chemin des Prairies
1400
1200
1000
800
600
400
200
0
07/05
08/02
09/17
Carrefour du Moulin
Date

Tableau 1

Analyse de sol des sites échantillonnés dans les municipalités régionales de comté de Joliette à l'été 1990

Les valeurs reportées sont la moyenne ± la déviation standard.

Site	Phosphore	Potassium	Calcium	Magnésium	pH
	kg ha^{-1}				
Autoroute (fossé)	24.0±1.7	49.3±7.8	12678.0±5185.3	114.7±42.8	6.8±0.1
Autoroute (parcelle)	68.2±21.8	65.5±14.4	11860.0±2397.7	134.0±21.5	7.2±0.2
Parc industriel	37.5±4.9	78.0±15.0	8416.8±542.5	93.3±2.9	7.2±0.0
Crabtree	303.5±50.2	571.0±45.3	15618.0±1049.3	343.0±1.4	7.0±0.1
St-Charles Borromée	80.0±18.4	134.0±0.0	10138.0±390.3	177.5±10.6	7.2±0.0
Parc Prévost	84.0±12.7	76.0±7.1	10226.0±1069.9	128.5±6.4	7.2±0.1
Notre-Dame de Lourdes	118.5±23.3	41.5±6.4	18970±794.8	153.5±2.1	7.3±0.1
Ste-Mélanie	50.5±12.0	49.5±13.4	20822±924.9	203.5±19.1	7.4±0.2
Chemin des Prairies	22±0.0	68.5±0.7	21982.0±398.8	207.0±5.7	7.3±0.1
Carrefour du Moulin	78±12.3	72.0±0.5	10243.0±5064.7	109.0±1.9	7.1±0.0

Tableau 1 (suite)

Site	Saturation en Potassium	Saturation en Calcium	Saturation en Magnésium	Saturation totale	CEC*
	%				
Autoroute (fossé)	0.2±0.0	81.7±4.9	0.9±0.6	83.1±4.9	34.2±11.8
Autoroute (parcelles)	0.2±0.1	81.2±3.1	1.5±0.1	83.0±2.9	32.5±5.4
Parc industriel	0.4±0.1	76.3±1.2	1.4±0.1	78.0±1.1	24.6±1.2
Crabtree	1.6±0.0	82.6±0.8	3.0±0.2	87.2±0.7	42.2±2.4
St-Charles Borromée	0.5±0.0	78.5±0.5	2.3±0.1	81.3±0.6	28.9±0.9
Parc Prévost	0.3±0.0	79.2±1.8	1.7±0.2	81.2±1.5	28.8±2.4
Notre-Dame de Lourdes	0.1±0.0	87.5±0.5	1.2±0.0	88.8±0.4	48.4±1.8
Ste-Mélanie	0.1±0.0	88.2±0.	1.4±0.1	89.8±0.4	52.7±2.2
Chemin des Prairies	0.1±0.0	88.3±0.2	1.4±0.1	90.2±0.2	55.3±0.9
Carrefour du Moulin	0.3±0.0	79.5±0.8	1.1±0.2	81.2±0.7	28.8±1.4

*Capacité d'échange cationique

Tableau 1 (suite)

Site	Matière Organique	Sable	Limon	Argile	Conductivité
	%				mmhos
Autoroute (fossé)	2.1±0.7	89.9±2.6	7.5±1.5	2.7±1.2	0.4±0.2
Autoroute (parcelles)	3.6±0.6	89.2±1.4	7.5±1.7	3.3±1.0	0.3±0.1
Parc industriel	2.3±0.1	77.2±0.7	18.8±0.7	4.0± 0.0	0.5±0.1
Crabtree	6.5±0.1	66.8±1.2	22.3±0.2	11.0±1.4	1.1±0.1
St-Charles Borromée	3.5±0.1	81.6±2.6	14.5±2.6	4.0±0.0	0.8±0.1
Parc Prévost	4.6±0.1	85.1±1.6	11.0±1.6	4.0±0.0	0.8±0.1
Notre-Dame de Lourdes	2.7±0.3	89.2±1.2	6.9±1.2	4.0±0.0	0.7±0.1
Ste-Mélanie	1.4±0.2	89.6±0.4	8.4±0.4	2.0±0.0	0.6±0.1
Chemin des Prairies	1.5± 0.0	79.0±1.3	17.0± 1.3	4.0±0.0	0.8±0.1
Carrefour du Moulin	1.3±0.1	93.5±1.1	4.5±0.7	2.0±0.0	0.5±0.1

Tableau 2

Longueur cumulative des inflorescences mâles par plant durant la saison de croissance 1990 au site vacant du parc industriel.

Traitement de tonte	Longueur cumulative — Juillet 5	Juillet 26	Août 2	Août 10	Août 16	Août 21	Août 29	Septembre 5	Septembre 12
cm	cm								
Stade végétatif									
2	0.0*[1]	0.0	0.1	0.3	0.9	2.0*	0.0	0.8	0.0 d[3]
5	0.0*	0.1	0.1	0.8	3.0	3.0*	0.0	0.1	0.1 d
8	-*	-[2]	0.4	1.5	2.3	3.5*	1.3	1.4	1.3 bc
Bouton floral									
2	-	-	0.1*	0.1	0.1	0.4 *	0.0	0.1	0.0 d
5	-	-	0.8*	0.7	0.8	2.1 *	0.8	1.2	1.3 bc
8	-	-	0.5*	0.6	1.4	2.1 *	1.1	1.6	2.0 b
Début floraison									
2	-	-	-	1.1 *	0.0	0.1	0.1	0.5*	0.0 d
5	-	-	-	3.2 *	0.1	0.2	0.9	1.6*	0.0 d
8	-	-	-	1.8 *	1.5	1.5	2.3	2.3*	0.8 c
Témoin	-	2.0	1.0	1.9	3.3	2.9	3.5	4.9	6.6 a

[1]: * = date du traitement.

[2]: Pas de mesures pour cette date.

[3]: Les valeurs affectées de la même lettre ne sont pas significativement différentes entre elles au seuil de 5% de probabilité selon le test de Waller-Duncan.

Tableau 3

Effet des différents traitements mécaniques sur la hauteur des plants, la biomasse végétative aérienne, la longueur cumulative et la biomasse des épis, le nombre de graines et la biomasse des graines par plant.
Les plants ont été récoltés le 17 septembre 1990 au site de l'autoroute 31.
Les valeurs reportées sont la moyenne ± la déviation standard.

Traitement	Hauteur des plants	Biomasse végétative	Longueur cumulative des épis	Biomasse des épis	Nombre de graines	Biomasse des graines
cm	cm	mg plant^{-1}	cm plant^{-1}	mg plant^{-1}	plant^{-1}	mg plant^{-1}
stade végétatif						
2	2.00±0.94 d*	39.4±42.5 b	0.00±0.0 e	0.00±0.0 b	1.7±1.0 c	4.5±3.5 c
5	3.92±0.96 c	34.1±25.2 b	0.01±0.06 de	0.04±0.29 b	2.8±2.0 bc	7.2±8.9 bc
8	6.28±0.88 b	69.2±59.4 b	1.20±1.04 c	0.77±3.81 b	4.7±5.5 bc	17.5±22.6 bc
bouton floral						
2	1.87±1.73 d	56.9±30.1 b	1.00±0.50 c	0.98±3.00 b	3.7±2.5bc	10.2±7.3 bc
5	4.66±1.43 bc	84.8±49.5 b	0.70.±0.27 cde	0.44±1.51 b	7.3±5.2 b	25.3±21.0 b
8	6.15±1.36 b	93.7±66.0 b	0.75±0.42 cd	0.87±3.62 b	6.1±4.9 bc	21.7±20.1 bc
début floraison						
2	1.15±1.36 d	57.5±37.7 b	0.0±0.0 e	0.0±0.0 b	2.2±2.0 c	5.9±8.5 c
5	3.80±0.86 c	57.1±39.6 b	0.0±0.0 e	0.0±0.0 b	4.5±3.9 bc	12.8±13.2 bc
8	6.28±0.85 b	97.0±96.2 ab	0.05±0.129 de	0.27±1.58 b	5.6±5.1 bc	20.2±20.6 bc
écrasement	11.07±3.765 a	163.6±127.7 b	4.30±3.71 b	16.65±39.7 b	15.0±15.0 a	46.3±47.0 b
témoin	12.07±3.91 a	161.5±129.0 a	5.69±5.00 a	34.31±40.18 a	15.7±10.7 a	49.8±38.1 a

*Les valeurs affectées par la même lettre ne sont pas significativement différentes au seuil de probabilité de 5% selon le test de Waller-Duncan.

Tableau 4

Effet des différents traitements mécaniques sur la hauteur des plants, la biomasse végétative aérienne, la longueur cumulative et la biomasse des épis, le nombre de graines et la biomasse des graines par plant.
Les plants ont été récoltés le 17 septembre 1990 au site vacant du parc industriel.
Les valeurs reportées sont la moyenne ± la déviation standard.

Traitement	Hauteur des plants	Biomasse végétative	Longueur cumulative des épis	Biomasse des épis	Nombre de graines	Biomasse des graines
cm	cm	mg plant^{-1}	cm plant^{-1}	mg plant^{-1}	plant^{-1}	mg plant^{-1}
stade végétatif						
2	3.35±3.92 bc*	17.9±26.0 c	1.36±0.99 ab	1.0±2.6 b	1.6±2.8 b	4.5±8.6 b
5	4.03±1.35 bc	89.1.4±65.2 ab	2.13±1.49 ab	3.4±12.9 b	2.1±4.3 b	6.0±13.1 b
8	6.05±1.43 b	65.0±42.5 bc	0.04±0.13 b	0.5±2.1 b	4.3±4.5 ab	12.8±15.9 ab
bouton floral						
2	2.75±1.03 c	47.7±47.1 c	0.83±0.61 b	1.2±3.2 b	4.7±5.3 ab	14.0±15.4 ab
5	4.53±1.15 bc	61.5±49.1 bc	1.67±1.13 ab	3.2±5.7 b	4.2±4.4 ab	15.1±19.3 ab
8	6.13±1.04 b	57.1±37.7 bc	1.47±0.95 ab	3.9±.8.1b	4.3±4.3 ab	16.0±16.4 ab
début floraison						
2	2.45±0.78 c	16.4±10.3 c	0.0±0.0 b	0.0±0.0 b	1.4±1.4 b	4 2±5.0 b
5	3.93±0.73 bc	46.2±43.6 bc	0.0±0.0 b	0.0±0.0 b	3.6±5.0 ab	14.7±14.6 ab
8	5.35±0.95 bc	46.4±38.6 bc	0.63±0.25 b	0.3±0.9 b	3.1±3.3 ab	10.4±12.6 ab
témoin	13.05±3.40 a	131.1±98.4 a	5.17±4.69 a	24.2±29.9 a	10.4±11.5 a	36 6±40 5 a

*Les valeurs affectées par la même lettre ne sont pas significativement différentes au seuil de probabilité de 5% selon le test de Waller-Duncan.

Tableau 5

Effet de l'entretien municipal sur la hauteur des plants, la biomasse végétative aérienne, la longueur cumulative et la biomasse des épis, le nombre de graines et la biomasse des graines par plant. Les plants ont été récoltés le 17 septembre 1990. Les valeurs reportées sont la moyenne± la déviation standard.

Site	Hauteur des plants	Biomasse végétative	Longueur cumulative des épis	Biomasse des épis	Nombre des graines	Biomasse des graines
	cm	mg plant^{-1}	cm plant^{-1}	mg plant^{-1}	plant^{-1}	mg plant^{-1}
Crabtree						
témoin	36.00±13.65*	2292.2±3413.3*	50.42±64.67*	351.5±525.9*	168.0±240.2*	669.3±953.9*
tonte	8.95±10.87	412.1±1653.6	3.38±13.20	32.7±130.8	37.3±162.0	61.0±223.3
St-Charles Borromée						
témoin	34.72±6.05*	1265.5±968.6*	36.44±34.53*	212.4±206.5*	29.4±54.1*	130.0±271.3*
tonte	11.60±8.82	136.5±134.0	0.0±0.0	0.0±0.0	0.3±0.8	0.4±1.4

Tableau 5 (suite)

Site	Hauteur des plants	Biomasse végétative	Longueur cumulative des épis	Biomasse des épis	Nombre des graines	Biomasse des graines
	cm	mg plant^{-1}	cm plant^{-1}	mg plant^{-1}	plant^{-1}	mg plant^{-1}
Prévost						
témoin	13.40±2.99*	206.2±136.2*	8.80±4.08*	69.3±53.5*	15.2±15.4*	51.2±55.1*
tonte	3.93±0.73	55.3±35.3	0.78±1.52	9.1±18.4	1 6±2.6	3 4±5 7
Notre-Dame de Lourdes						
témoin	15.43±5.27	144.4±133.5	2.33±2.55	7.8±10.4	10.4±12.6	35.3±48 0
tonte	13.38±4.33	139.0±162.8	4.65±7.29	21.6±33.8	14.4±17.2	40.6±55 0
Ste-Mélanie						
témoin	20.05±4.52	199.5±169.3*	7.93±5.88*	50.4±56.2*	13.5±13.4*	48.5±57 0*
tonte	19.65±4.90	568.8±622.2	19.81±16.30	160.5±203.2	38.8±51.0	143 1±193 3

Tableau 5 (suite)

Site	Hauteur des plants	Biomasse végétative	Longueur cumulative des épis	Biomasse des épis	Nombre des graines	Biomasse des graines
	cm	mg plant^{-1}	cm plant^{-1}	mg plant^{-1}	plant^{-1}	mg plant^{-1}
Chemin des Prairies						
témoin	18.05±5.15	260.4±238.5	3.83±3.48	28.3±31.5	22.3±29.2	84.4±91.4
tonte	18.13±5.48	330.9±418.9	6.15±7.64	30.3±64.3	15.2±36.6	61.7±145.2
Carrefour du Moulin						
témoin	30.35±6.05*	617.0±681.4*	11.66±13.03*	73.3±89.7*	43.6±52.8*	189.3±244.7*
tonte	3.48±2.68	45.8±56.2	0.05±0.22	0.4±2.0	2.0±4.4	7.9±18.4

*Les valeurs affectées d'une étoile sont significativement différentes au seuil de probabilité de 5% selon le test de ***t***.

Tableau 6

Nombre de plants, hauteur moyenne, maximale et minimale, nombre d'épis mâles et nombre de graines par m^2 entre les différents sites en 1990. Les valeurs reportées sont la moyenne ± la déviation standard.

Site	Nombre de plants	Hauteur moyenne	Hauteur maximale	Hauteur minimale	Nombre d'épis	Nombre de graines
	m^2	———	cm	———	$plant^{-1}$	m^2
Autoroute	348±61	12.1±3.9	27	6	1.4±1.2	2974±1807
Parc industriel	1366±195	13.1±3.4	24	8	1.4±1.1	5440±2641
Crabtree	348±0	36.0±13.7	75	3	12.4±16.9	16748±5928
St-Charles Borromée	364±45	34.7±6.1	55	24	8.8±8.1	3100±650
Parc Prévost	706±161	13.4±3.0	19	7	1.6±1.1	4506±1802
Notre-Dame de Lourdes	474±161	15.4±5.3	25	3	0.6±0.5	2094±1349
Ste-Mélanie	620±175	20.1±4.5	33	13	1.8±1.8	3862±1626
Chemin des Prairies	3120±3355	18.1±5.2	30	7	1.0±10.8	6856±2160
Carrefour du Moulin	712±221	30.4±6.1	45	15	2.5±4.1	10356±509

CONCLUSION

Nous avions comme objectif principal dans ce travail, l'évaluation de nouvelles méthodes mécaniques de répression de l'herbe à poux le long des abords routiers, milieu propice à sa distribution. Notre deuxième objectif était la détermination de l'efficacité des différentes méthodes présentement utilisées dans les municipalités pour contrôler cette plante.

Les résultats de nos expériences démontrent que l'herbe à poux peut être contrôlée efficacement par le contrôle mécanique, à des hauteurs de tonte inférieures à 5 cm. Une première tonte, à 2 cm, dans la première semaine d'août (1er août) suivie d'une seconde tonte dans la quatrième semaine d'août (22 août), diminuent significativement la production d'inflorescences mâles et de graines.

Même si le contrôle mécanique, tel qu'il a été pratiqué dans cette étude le long des abords routiers, permet de contrôler la production d'inflorescences mâles, et par conséquent, la libération du pollen de l'herbe à poux, l'utilisation d'une seule méthode de répression ne s'est jamais avérer la meilleure solution à long terme. L'exemple des pesticides, où un même pesticide est utilisé année après année sur une même surface peut facilement nous en convaincre. Dans un programme de lutte intégré en agriculture, on vise plutôt à proposer une vaste gamme de méthodes pour contrôler les problèmes de maladies, de mauvaises herbes et de ravageurs (Batra, 1982). Cette logique pourrait tout aussi bien s'appliquer au contrôle de l'herbe à poux le long des abords routiers, même si les conditions d'établissement et de répression des plantes sont différentes de celles rencontrées dans un champ en milieu agricole.

Un programme intégré de répression de l'herbe à poux le long des routes pourrait viser à diminuer le nombre de sites perturbés le long des abords routiers, augmenter le contrôle biologique et mécanique et implanter une végétation qui favoriserait la compétition interspécifique.

Afin de diminuer le nombre de sites perturbés le long des abords routiers, il faudrait, dans un premier temps, réduire l'utilisation du sel de déglaçage qui affecte chaque saison la diversité biologique et retarde le processus de succession naturel (Bazzaz, 1974; Busing et Clebsch, 1983; Lewis, 1973; Miller et Werner, 1987; Vincent et Bergeron, 1982). L'utilisation du sable semble une alternative, mais ne remplacera pas complètement l'utilisation du sel. Il est donc difficile de prévoir une diminution des habitats perturbés, à court terme, tant que le sel sera utilisé comme agent de déglaçage. Par conséquent, l'herbe à poux, qui abonde dans les sites perturbés, risque d'envahir les abords routiers encore intacts du Québec. Des recherches doivent être poursuivies pour trouver un produit de remplacement au sel de déglaçage. De plus, des analyses de sol devraient être prélevées au début du printemps, le long des abords routiers, pour avoir une meilleure connaissance de la salinité dans ces milieux particuliers.

Le contrôle biologique de l'herbe à poux peut être très intéressant. L'utilisation de bioherbicides ou d'insectes et d'arthropodes, pourraient aider à diminuer la population d'herbe à poux à un niveau acceptable, c'est-à-dire sans effet allergène pour l'organisme humain (Hartmann et Watson, 1978; Goeden et al., 1974; Harris et Piper, 1970; Maw, 1980, Hasan et Ayres, 1990; Dennill et Hokkanen, 1990)). Par contre, ce genre de recherche est coûteux en temps et en argent. Les méthodes alternatives comme le désherbage thermique et l'utilisation de paillis allélopathiques semblent aussi des avenues intéressantes à explorer.

L'établissement de végétation pour favoriser la compétition interspécifique semble la méthode la plus facile à court terme, en excluant, bien sûr, le contrôle mécanique (Maryushkina, 1991; Navas, 1991). Des essais ont été tenté en Ontario et aux États-Unis et certaines plantes indigènes semblent s'adapter aux conditions exigantes des abords routiers (St-Arnaud et Vincent, 1988). Des recherches devraient être entreprises pour adapter ces résultats à la situation québécoise.

Comme on a vu dans ce mémoire, le contrôle mécanique peut diminuer la production de pollen de façon significative, à court terme. Par contre, notre étude ne permet pas de prévoir le comportement de l'herbe à poux, traitée par contrôle mécanique pendant plusieurs saisons. Des études à plus long terme pourraient être entreprises afin de combler cette lacune qui n'a pu être approfondie dans ce travail. De plus, connaissant la grande adaptabilité et la variabilité de cette plante, il est fort possible qu'à plus ou moins court terme, les plants subissant un stress répétitif modifient leur physiologie et leur comportement (Raynal et Bazzaz, 1975). Même si la biologie, l'habitat et l'importance économique de l'herbe à poux sont connus, il reste du travail à faire pour tenter d'expliquer la grande variabilité de cette plante le long des abords routiers.

A plus long terme, et dans le but d'élaborer des stratégies de répression de l'herbe à poux plus efficaces le long des routes, une étude démographique pourrait aider à élaborer un modèle de simulation des infestations sous différentes stratégies de lutte (Benoit et Lemieux, 1987). Il faudrait faire des études concernant le réservoir de graines dans le sol. De plus, il faudrait approfondir les connaissances sur la compétition intraspécifique et interspécifique de cette plante le long des abords routiers (Bowers et Dooley, 1991).

Malgré la durée limitée de cette étude et son caractère régional, les connaissances fournies par ce travail seront certainement utiles aux villes et aux municipalités prises avec le problème de l'herbe à poux le long des abords routiers.

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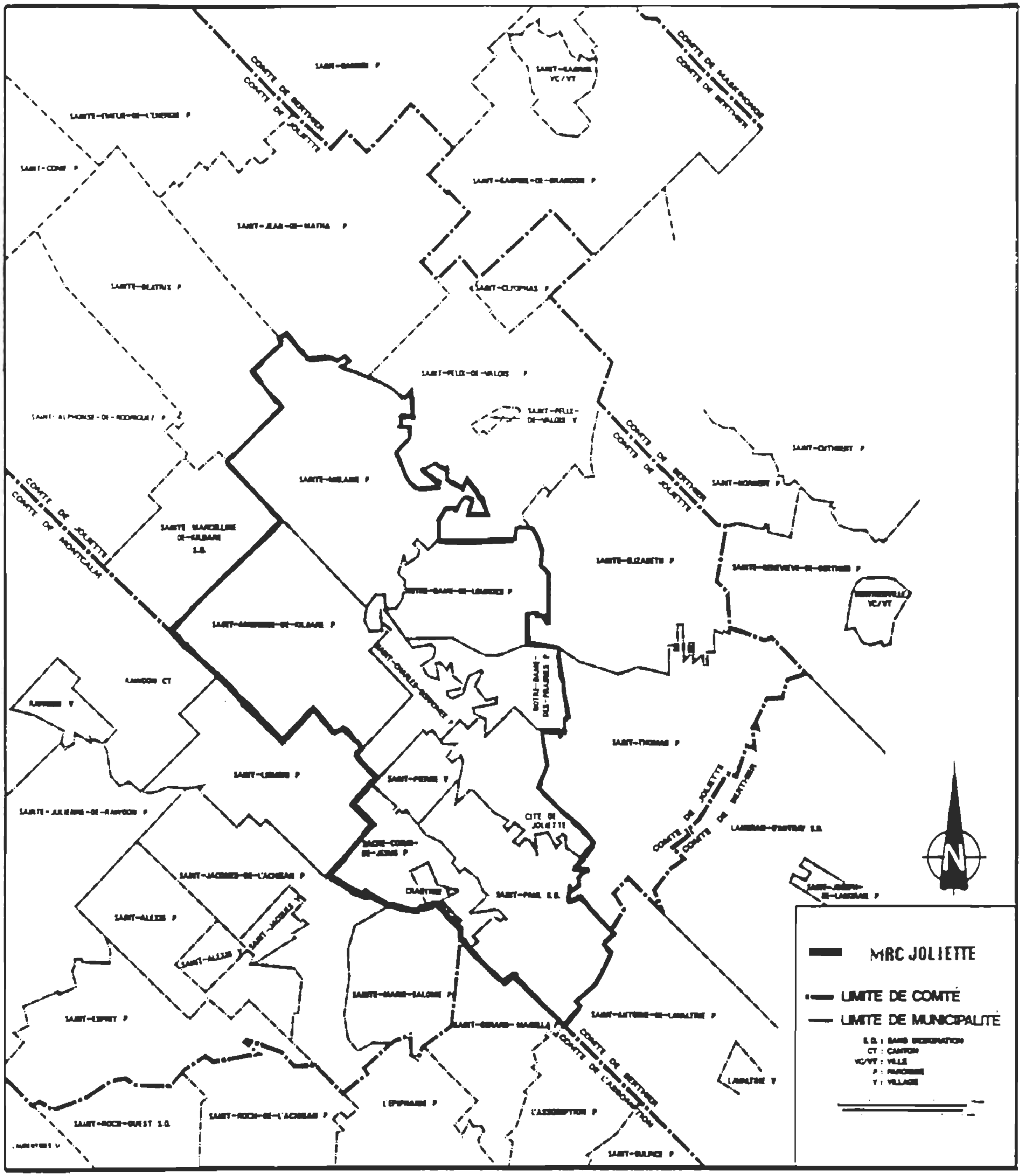
ANNEXE A

Limite de la MRC de Joliette

Source: Rapport d'inventaire. Études préliminaires. Région de Joliette (Les unités administratives). Direction projets de lignes de transport. Hydro-Québec. 1980. p. 14


COMTE DE JOLIETTE
COMTE DE MONTCALM
COMTE DE BERTHIER
CITE DE JOLIETTE
MRC JOLIETTE
LIMITE DE COMTÉ
LIMITE DE MUNICIPALITÉ

Captage du pollen d'*Ambrosia artemisiifolia* L. pour l'été 1990 à Joliette. Indice pollinique et données météorologiques.

Date	Nombre de grains de pollen	Pluie	Température	Vitesse du vent	Direction du vent
	m^3	mm	°C	km heure^{-1}	
26-08-90	106	0.0	24	10	S[1]
28-08-90	211.2	7.0	21.8	20	SW
29-08-90	116	0.0	20	10	W
31-08-90	201	0.0	19.5	15	S
01-09-90	162	0.0	21	20	S
03-09-90	56	0.0	15.8	10	E
04-09-90	132	4.2	15.8	0.0	C
05-09-90	59	0.0	19	0.0	C
07-09-90	23	0.0	16.8	0.0	C
10-09-90	53	1.0	12.5	15	S
11-09-90	13	0.0	15.5	20	E
12-09-90	92	0.0	14.5	15	E
14-09-90	149	0.0	18.8	0.0	C
17-09-90	20	0.0	7.8	10	W
19-09-90	10	13.0	9.0	0	C
20-09-90	33	-	11.8	0.0	C
24-09-90	43	-	8.8	25	S
25-09-90	7	0.0	13.0	0.0	C
26-09-90	7	0.0	12.5	0	C
27-09-90	10	0.0	15.5	20	W
28-09-90	17	10.8	17.3	15	S

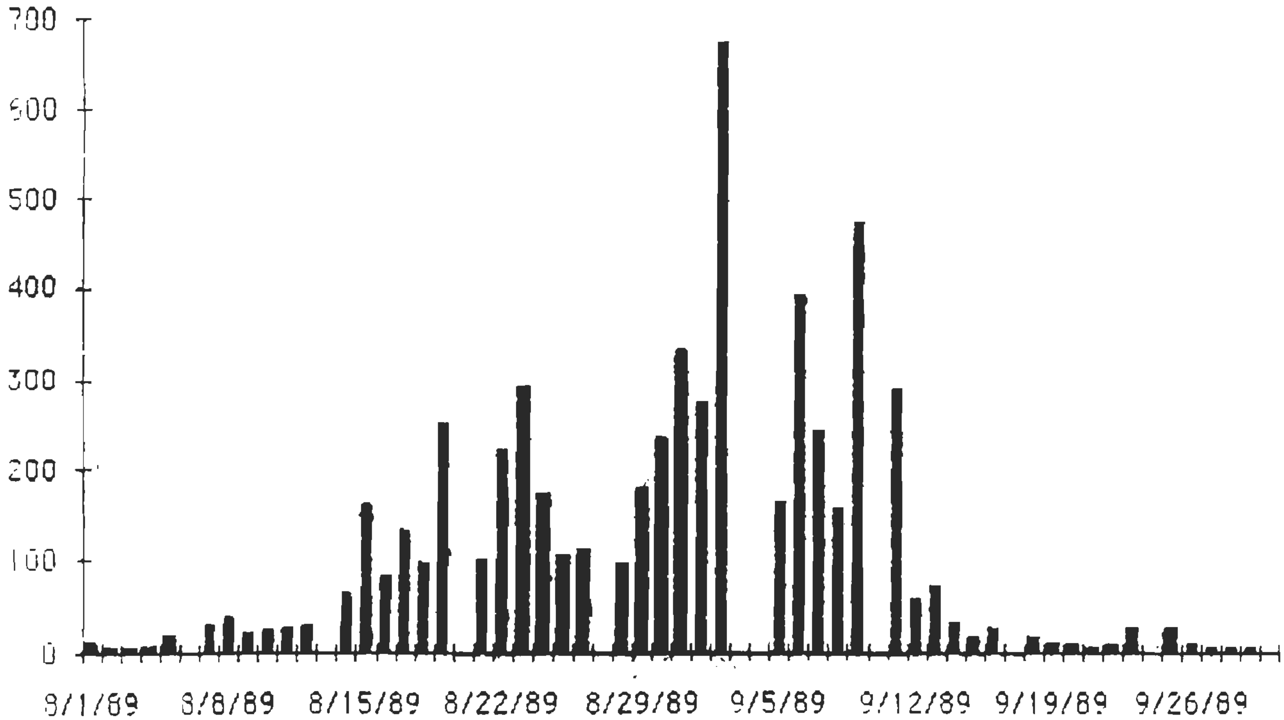
[1]: Direction dominante du vent: E=est; N=nord; S=sud; W=ouest; C=sans vent dominant

ANNEXE B

Date	Nombre de grains de pollen	Pluie	Température	Vitesse du vent	Direction du vent
	m^3	mm	°C	km $heure^{-1}$	
30-07-90	3.	1.8	24	0.0	C[1]
31-07-90	3	25.0	18.8	0.0	C
01-08-90	0	0.0	19.0	20	NW
02-08-90	7	0.0	22.5	0.0	C
03-08-90	3	0.0	24.3	15	W
04-08-90	20	0.0	22.8	0.0	C
06-08-90	23	17.6	19.5	0.0	C
07-08-90	23	4.2	19.0	25	E
08-08-90	46	0.0	20.5	20	W
09-08-90	69	0.0	20.0	25	W
10-08-90	26	0.0	22.3	0.0	C
11-08-90	23	-	22.8	0.0	C
14-08-90	3	0.0	18.5	0.0	C
15-08-90	17	2.0	18.0	25	SW
16-08-90	76	0.0	20.5	15	E
17-08-90	152	0.0	21.8	25	SW
20-08-90	66	0.0	15.8	20	E
21-08-90	224	0.0	15.5	0.0	C
22-08-90	307	0.0	17.5	0.0	C
23-08-90	45	0.0	19.5	0.0	C
24-08-90	244	0.0	20	0.0	C

[1]: Direction dominante du vent: E=est; N=nord; S=sud; W=ouest; C=sans vent dominant

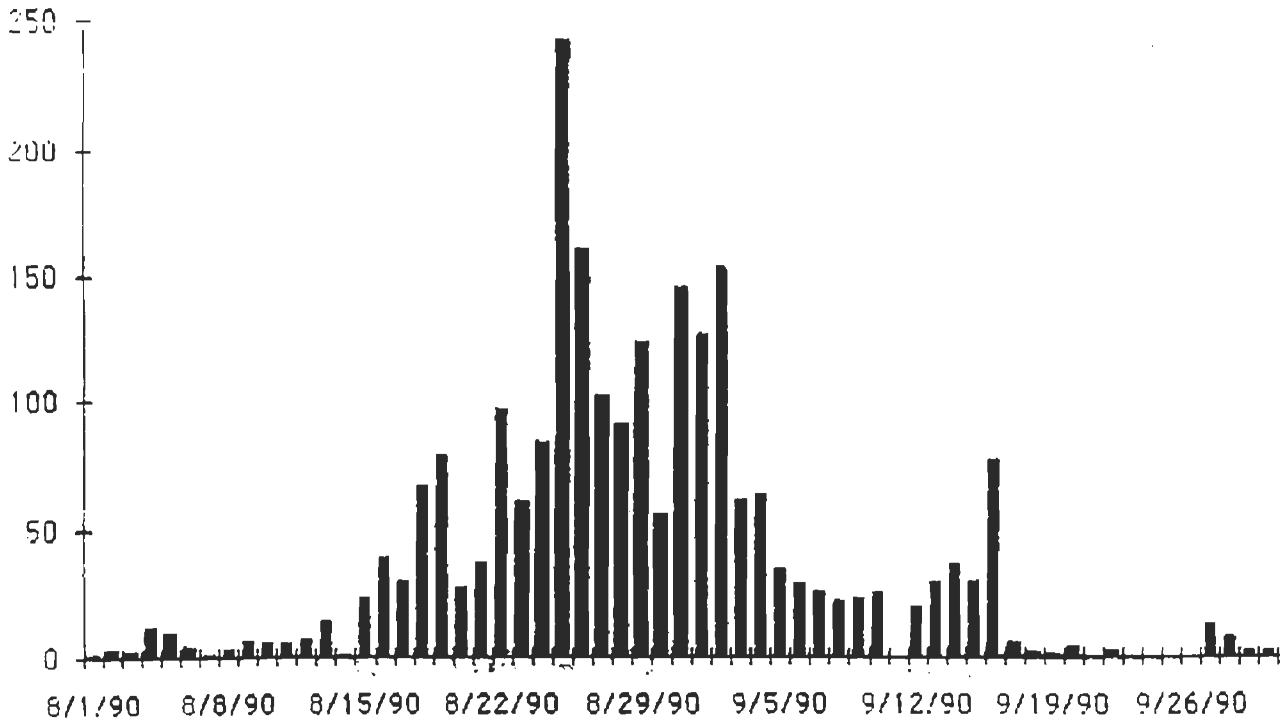
ANNEXE C



Captage du pollen de la petite herbe à poux pour l'année 1989 à Montréal. (Nombre de grains/m^3).

Source: Communication personnelle. Comtois, Paul. Département de géographie. Université de Montréal

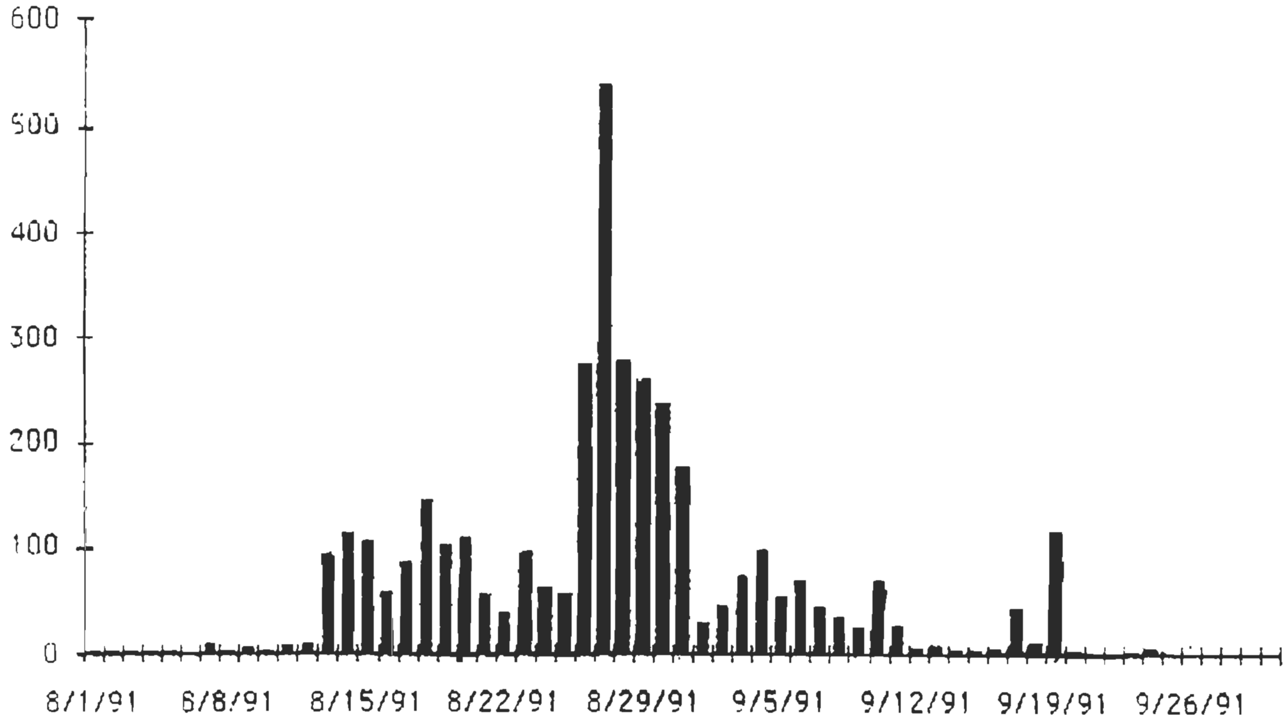
ANNEXE D



Captage du pollen de la petite herbe à poux pour l'année 1990 à Montréal. (Nombre de grains/m³).

Source: Communication personnelle. Comtois, Paul. Département de géographie. Université de Montréal

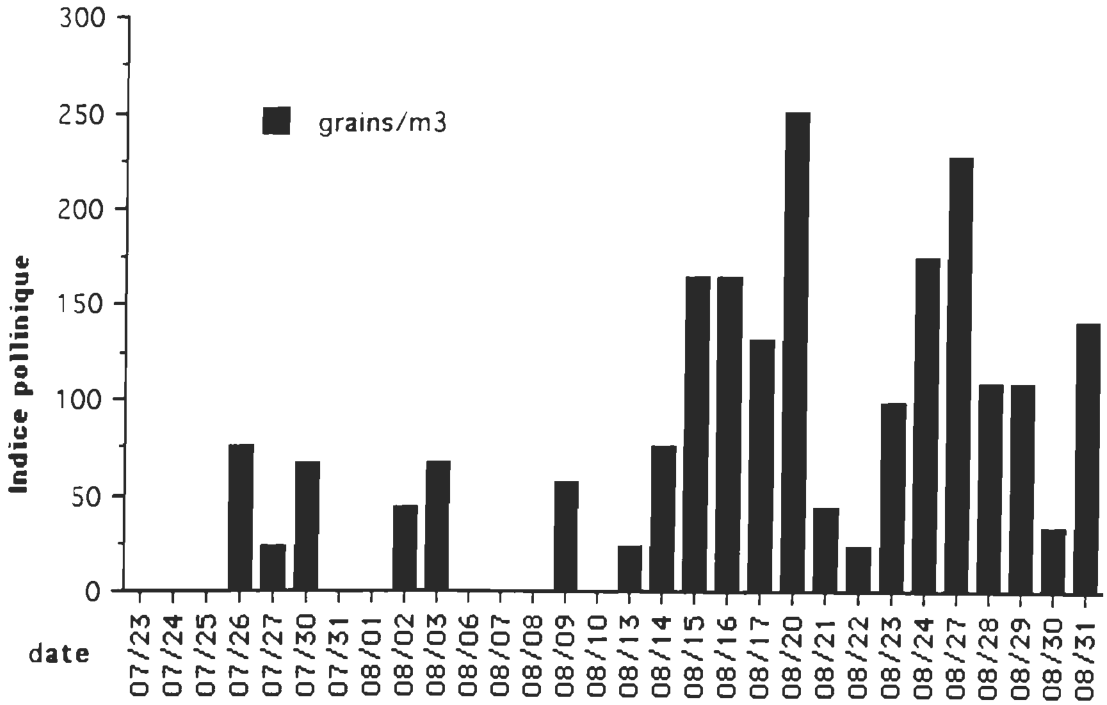
ANNEXE E



Captage du pollen de la petite herbe à poux pour l'année 1991 à Montréal. (Nombre de grains/m³).

Source: Communication personnelle. Comtois, Paul. Département de géographie. Université de Montréal

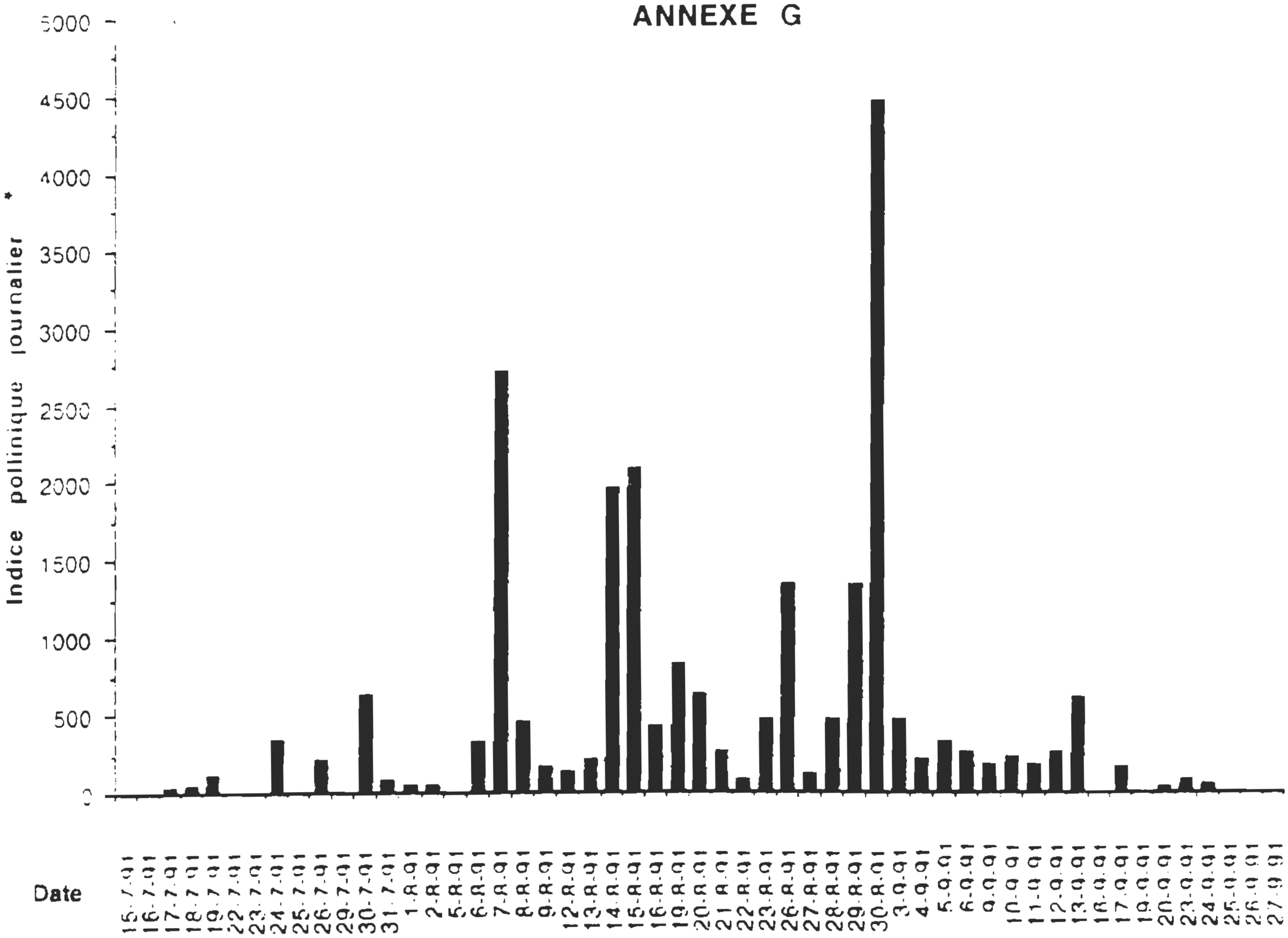
ANNEXE F



Captage du pollen de la petite herbe à poux pour l'année 1990 à Québec.

Source: Desbiens, Denis. Rapport d'analyse des résultats d'indice pollinique pour l'été 1990. Alca-Québec inc., p. 4.

ANNEXE G



Captage du pollen de la petite herbe à poux

pour l'année 1991 à Québec.

*: Indice pollinique journalier = nombre de grains/m^3 d'air multiplié par 24 heures.

Source: Boutin, Nicole. Rapport d'analyse des résultats d'indice pollinique pour l'été 1991. Alca-Québec inc., p. 19.

ANNEXE H

Liste des noms français et latin des principales espèces de plantes observée aux sites à l'étude en 1990.

Site	Nom commun	Nom latin
Autoroute (bord de route)	Petite herbe à poux	*Ambrosia artemisiifolia* L.
	Lupuline	*Medicago lupulina* L.
	Renouée liseron	*Polygonum convolvulus* L.
	Myosotis	*Myosotis stricta* Link
	Sétaire verte	*Setaria viridis* L.
	Chénopode blanc	*Chenopodium album* L.
	Lépidie densiflore	*Lepidium densiflorum* Schrad.
	Graminées	
Autoroute (fossé)	Silène enflée	*Silene cucubalus* Wibel
	Chiendent	*Elytrigia repens* (L.) Nevski.
	Herbe à dinde	*Achillea millefolium* L.
	Asclépiade	*Asclepias syriaca* L.
	Verge d'or	*Solidago graminifolia* (L.) Salisb.
	Vesce jargeau	*Vicia cracca* L.
	Marguerite blanche	*Chrysanthemum leucanthemum* L.
	Fraise des champs	*Fragaria virginiana* Duchesne
	Bouton d'or	*Ranunculus acris* L.
	Rudbeckie hérissée	*Rudbeckia hirta* L.
	Lupuline	*Medicago lupulina* L.
	Petite herbe à poux	*Ambrosia artemisiifolia* L.
	Prêle des champs	*Equisetum arvense* L.
	Trèfle rouge	*Trifolium pratense* L.
	Épervière jaune	*Hieracium pratense* Tausch.
	Chicorée sauvage	*Cichorium intybus* L.
	Digitaire sanguine	*Digitaria sanguinalis* (L.) Scop.
	Potentille ansérine	*Potentilla anserina* L.
	Trèfle alsike	*Trifolium hybridum* L.
	Pissenlit	*Taraxacum officinale* Weber

Site	Nom commun	Nom latin
Autoroute (fossé)	Plantain majeur	*Plantago major* L.
	Vélar fausse giroflée	*Erysimum cheiranthoides* L.
	Renouée des oiseaux	*Polygonum aviculare* L.
	Folle avoine	*Avena fatua* L.
	Prunelle vulgaire	*Prunella vulgaris* L.
	Moutarde des champs	*Brassica kaber* (DC.) Wheeler
	Sétaire verte	*Setaria viridis* L.
	Euphorbe réveille-matin	*Euphorbia helioscopa* L.
	Barbarée vulgaire	*Barbarea vulgaris* R. Br.
	Renouée scabre	*Polygonum scabrum* Moench
	Mélilot blanc	*Melilotus alba* Desr.
	Salicaire	*Lythrum salicaria* L.
terrain vacant (parc industriel)	Petite herbe à poux	*Ambrosia artemisiifolia* L.
	Lupuline	*Medicago lupulina* L.
	Chiendent	*Elytrigia repens* (L.) Beauv.
	Sétaire verte	*Setaria viridis* L.
	Marguerite blanche	*Chrysanthemum leucanthemum* L.
	Trèfle blanc	*Trifolium repens* L.
	Trèfle alsike	*Trifolium hybridum* L.
	Trèfle rouge	*Trifolium pratense* L.
	Asclépiade	*Asclepias syriaca* L.
	Mil	*Phleum pratense* L.
	Prêle des champs	*Equisetum arvense* L.
	Armoise vulgaire	*Artemisia vulgaris* L.
	Vesce jargeau	*Vicia cracca* L.
	Vergerette annuelle	*Erigeron annuus* L.
	Fraise des champs	*Fragaria virginiana* Duchesne

Site	Nom commun	Nom latin
Crabtree	Petite herbe à poux	*Ambrosia artemisiifolia* L.
	Lupuline	*Medicago lupulina* L.
	Pissenlit	*Taraxacum officinale* Weber
	Matricaire odorante	*Matricaria matricarioides* (Less.) Porter
	Vesce jargeau	*Vicia cracca* L.
	Folle avoine	*Avena fatua* L.
	Mil	*Phleum pratense* L.
	Chiendent	*Elytrigia repens* (L.) Beauv.
	Renouée liseron	*Polygonum convolvulus* L.
	Bourse-à-pasteur	*Capsella bursa-pastoris* L.
	Trèfle alsike	*Trifolium hybridum* L.
	Renouée coriace	*Polygonum achoreum* Blake
	Lépidie densiflore	*Lepidium densiflorum* Schrad.
	Armoise vulgaire	*Artemisia vulgaris* L.
	Panais sauvage	*Pastinaca sativa* L.
	Mélilot blanc	*Melilotus alba* Desr.
	Marguerite blanche	*Chrysanthemum leucanthemum* L.
	Verge d'or	*Solidago graminifolia* (L.) Salisb.
	Chicorée sauvage	*Cichorium intybus* L.
	Asclépiade	*Asclepias syriaca* L.
	Petite bardane	*Arctium minus* Hill (Bernh.)
	Chardon des champs	*Cirsium arvense* L.
	Framboisier sauvage	*Rubus idaeus* L.
	Rosier sauvage	*Rosa blanda* Ait.
Parc Prévost	Petite herbe à poux	*Ambrosia artemisiifolia* L.
	graminées	
	Pissenlit	*Taraxacum officinale* Weber
	Lupuline	*Medicago lupulina* L.
	Trèfle alsike	*Trifolium hybridum* L.
	Trèfle rouge	*Trifolium pratense* L.

Site	Nom commun	Nom latin
Parc Prévost	Marguerite blanche	*Chrysanthemum leucanthemum* L.
(suite)	Plantain majeur	*Plantago major* L.
	Léotodon d'automne	*Leotodon autumnalis* L.
	Chiendent	*Elytrigia repens* (L.) Beauv.
Notre-Dame	Petite herbe à poux	*Ambrosia artemisiifolia* L.
de Lourdes	Matricaire odorante	*Matricaria matricarioides* (Less.) Porter
	Plantain majeur	*Plantago major* L.
	Chiendent	*Elytrigia repens* (L.) Beauv.
	Lupuline	*Medicago lupulina* L.
	Chénopode blanc	*Chenopodium album* L.
	Sétaire verte	*Setaria viridis* L.
	Asclépiade	*Asclepias syriaca* L.
	Vesce jargeau	*Vicia cracca* L.
	Marguerite blanche	*Chrysanthemum leucanthemum* L.
	Herbe à dinde	*Achillea millefolium* L.
	Renouée des oiseaux	*Polygonum aviculare* L.
	Prêle des champs	*Equisetum arvense* L.
	Fraise des champs	*Fragaria virginiana* Duchesne
	Panic capillaire	*Panicum capillare* L.
	Verge d'or	*Solidago graminifolia* (L.) Salisb.
St-Charles Borromée	Petite herbe à poux	*Ambrosia artemisiifolia* L.
	Lupuline	*Medicago lupulina* L.
	Chénopode blanc	*Chenopodium album* L.
	Matricaire odorante	*Matricaria matricarioides* (Less.) Porter
	Vesce jargeau	*Vicia cracca* L.
	Renouée des oiseaux	*Polygonum aviculare* L.
	Chiendent	*Elytrigia repens* (L.) Beauv.
	Pissenlit	*Taraxacum officinale* Weber
	Renouée liseron	*Polygonum convolvulus* L.

Site	Nom commun	Nom latin
St-Charles Borromée (suite)	Renouée Persicaire	*Polygonum persicaria* L.
	Lépidie densiflore	*Lepidium densiflorum* Schrad.
	Folle avoine	*Avena fatua* L.
	Renouée coriace	*Polygonum achoreum* Blake
	Mélilot blanc	*Melilotus alba* Desr.
	Asclépiade	*Asclepias syriaca* L.
	Mil	*Phleum pratense* L.
	Trèfle alsike	*Trifolium hybridum* L.
	Chardon des champs	*Cirsium arvense* L.
	Bouton d'or	*Ranunculus acris* L.
	Oxalide dressée	*Oxalis stricta* L.
	Prêle des champs	*Equisetum arvense* L.
	Trèfle agraire	*Trifolium agrarium* L.
	Digitaire sanguine	*Digitaria sanguinalis* (L.) Scop.
	Herbe à dinde	*Achillea millefolium* L.
	Verge d'or	*Solidago graminifolia* (L.) Salisb.
	Chicorée sauvage	*Cichorium intybus* L.
Ste-Mélanie	Petite herbe à poux	*Ambrosia artemisiifolia* L.
	Prêle des champs	*Equisetum arvense* L.
	Chiendent	*Elytrigia repens* (L.) Beauv.
	Lupuline	*Medicago lupulina* L.
	Fraise des champs	*Fragaria virginiana* Duchesne
	Epervière orangée	*Hieracium aurantiacum* L.
	Renouée liseron	*Polygonum convolvulus* L.
	Marguerite blanche	*Chrysanthemum leucanthemum* L.
	Vesce jargeau	*Vicia cracca* L.
	Asclépiade	*Asclepias syriaca* L.
	Pissenlit	*Taraxacum officinale* Weber
	Fougère	
	Verge d'or	*Solidago graminifolia* (L.) Salisb.

Site	Nom commun	Nom latin
Ste-Mélanie (suite)	Salsifis des prés	*Tragopogon pratensis* L.
	Herbe à dinde	*Achillea millefolium* L.
	Framboisier sauvage	*Rubus idaeus* L.
Chemin des Prairies	Petite herbe à poux	*Ambrosia artemisiifolia* L.
	Lupuline	*Medicago lupulina* L.
	Pissenlit	*Taraxacum officinale* Weber
	Chiendent	*Elytrigia repens* (L.) Beauv.
	Digitaire sanguine	*Digitaria sanguinalis* (L.) Scop.
	Mélilot blanc	*Melilotus alba* Desr.
	Plantain majeur	*Plantago major* L.
	Chénopode blanc	*Chenopodium album* L.
	Equinochloa pied-de-coq	*Echinochloa crus-galli* L.
	Epervière orangée	*Hieracium aurantiacum* L.
	Salicaire	*Lythrum salicaria* L.
	Chicorée sauvage	*Cichorium intybus* L.
	Quenouille	*Typha latifolia* L.
	Campanule fausse-raiponce	*Campanula rapunculoides* L.
	Laiteron des champs	*Sonchus arvensis* L.
	Verge d'or	*Solidago graminifolia* (L.) Salisb.
	Herbe à dinde	*Achillea millefolium* L.
Carrefour du Moulin	Petite herbe à poux	*Ambrosia artemisiifolia* L.
	Chiendent	*Elytrigia repens* (L.) Beauv.
	Lupuline	*Medicago lupulina* L.
	Renouée liseron	*Polygonum convolvulus* L.
	Chénopode blanc	*Chenopodium album* L.
	Plantain majeur	*Plantago major* L.
	Trèfle alsike	*Trifolium hybridum* L.
	Sétaire verte	*Setaria viridis* L.
	Vesce jargeau	*Vicia cracca* L.

Site	Nom commun	Nom latin
Carrefour du Moulin (suite)	Pissenlit	*Taraxacum officinale* Weber
	Asclépiade	*Asclepias syriaca* L.
	Mélilot blanc	*Melilotus alba* Desr.
	Marguerite blanche	*Chrysanthemum leucanthemum* L.
	Mil	*Phleum pratense* L.
	Rudbeckie hérissée	*Rudbeckia hirta* L.
	Fraise des champs	*Fragaria virginiana* Duchesne
	Verge d'or	*Solidago graminifolia* (L.) Salisb.
	Petite oseille	*Rumex acetosella* L.
	Armoise vulgaire	*Artemisia vulgaris* L.
	Vergerette annuelle	*Erigeron annuus* L.
	Digitaire sanguine	*Digitaria sanguinalis* (L.) Scop.

ANNEXE I

Recommandations aux auteurs pour la revue "Weed Technology".

DIRECTIONS FOR CONTRIBUTORS TO *WEED TECHNOLOGY* 120

CONTENT

Weed Technology publishes original articles about current weed science research, teaching, extension, industry, consulting, and regulation. *Weed Technology* includes original research on weeds and their control, reports of new weed problems and new technologies for weed science, and feature articles, emphasizing technology transfer to improve weed control.

1. Refereed Articles. A page charge is assessed for refereed articles.
   a. *Research and Education*. Original articles concerning research, teaching, extension, industry, consulting, regulation, and equipment are encouraged. Short research articles (4 to 12 manuscript pages) and nontraditional reports such as surveys and educational programs from extension and teaching are welcomed.
   b. *Note*. Short original articles on topics that do not meet the criteria for "Research" or "Education" papers, such as new weeds discovered in the United States or Canada, new research methods or equipment, research that cannot be repeated such as where frost or hail occurred, and some surveys.
   c. *Invited and Symposia Papers*. Invited articles are intended to review specific problem areas of weed science interest. Papers from WSSA Symposia may be published in *Weed Technology*. Symposia chairmen must obtain approval for publication of symposia no later than the mid-summer WSSA Executive Committee meeting, and an associate editor will be assigned to work with the authors on paper submittal. Symposia authors must submit promptly their manuscript for review and must cooperate so papers are published by a predetermined date normally within 1 year of the symposia. Symposia papers may be distributed over two or more issues of *Weed Technology*.
2. Features. A page charge will not be assessed for features.
   a. *Technology Notes*. Short notes concerning news topics of general weed science interest such as initial herbicide registrations, special meetings, updates on terminology, new publications from weed science organizations, etc. Items must be submitted to the Editor no later than 45 days before issue publication.
   b. *New Technology*. An article prepared by industry concerning a new herbicide or other weed control technology. Herbicides considered for publication should have a WSSA-approved common name, and initial federal registration should be anticipated within 1 year after article publication.
   c. *Intriguing World of Weeds*. Dr. Larry Mitich, the contributing author for this feature, will prepare this article. However, resource information for this feature may be forwarded to Dr. Mitich, and the contributor will receive credit.
   d. *Helpful Hints for Technical Writing*. Dr. J. H. Dawson, the contributing author for this feature will prepare this article.
   e. *Book Review*. Book reviews are included at the request of the Editor. Contact the Editor if you wish to prepare a review of a specific book.
   f. *WSSA Communications*. Items such as the Presidential Address, other general session presentations, and special reports as requested by the WSSA Board of Directors.
3. Advertisements. Suitable paid advertisements for products of interest to weed scientists will be accepted for publication in *Weed Technology*.

SUBMITTING THE MANUSCRIPT

Check List. Following is a check list of information to send to Dr. Chester L. Foy, *Weed Technology* Editor, Dep. of Plant Pathol., Physiol., and Weed Sci., Virginia Polytech. Inst. and State Univ., 503 Price Hall, Blacksburg, VA 24061-0331.

1. Four manuscript copies plus four copies of all illustrative material. Retain a copy of your manuscript and the original photographs or drawings to insure against loss.
2. Seven stick-on labels showing the name and address of the corresponding author.
3. A covering letter with the following:
   a. Full manuscript title and author listing.
   b. The corresponding author's name, address, and telephone number.
   c. The name(s) and address(es) of three or more people in North America, not at your institution, who are competent to review the manuscript.

PREPARING THE MANUSCRIPT

Weed Technology and *Weed Science* will follow the same general editorial policy. Therefore, *Weed Technology* and *Weed Science* can be used as examples. Except as noted or in the latest reports of the WSSA Terminology Committee, *Weed Technology* follows the CBE Style Manual, 5th ed., Council of Biology Editors, Inc., Bethesda, MD.

Typing instructions. Type manuscripts on 22- by 28-cm paper with the lines numbered on each page. Numbers must be visible on all copies as well as on the original. Number all pages consecutively including the tables and captions on figures. Double space everything, including pages with tables, figure legends, footnotes, and literature citations. Indent three spaces for all footnotes, sentences, or paragraphs that do not begin with words in boldface type or italics.

Order. Assemble the manuscript in the following order: Title (no separate title page), Author(s), Abstract, Additional index words, Text, Literature Cited (begin on a new page), Tables, Figure Captions (begin on a new page), and Figures. The text of research articles commonly is divided into the following main sections: Introduction, Materials and Methods, Results

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and Discussion, Acknowledgments, and Literature Cited. However, the author(s) may use other section titles that are more appropriate for the specific manuscript. Omit a summary or list of conclusions. Place the main section headings in all capitals in the center of the page and four lines below the previous section. Begin subsection headings at the left-hand margin, use a squiggly underline or enter in boldface type, capitalize the first word only, and end with a period. Begin the first sentence on the same line. If sub-subsection headings are needed, begin at the left-hand margin, underline with a straight line or italicize, capitalize the first word only, and end with a period. Begin the first sentence on the same line.

Title. Limit the title to no more than 80 characters. Include key words for a computerized literature search. Use WSSA-approved common and scientific names for weeds. If there is no WSSA-approved common name, use only the scientific name. Omit the author for the scientific name. Use only the common names of herbicides if they are listed on the back cover of *Weed Science*. Capitalize the first letter of the first word and all major words. Footnote the title with a superscript arabic one (1). Footnote one should be: [1]Received for publication __________ and in revised form __________.

Author(s). Place the name(s) of the author(s), in all capital letters except "and" before the last author, two lines below the title, and footnote with a superscript arabic two (2). Use of one given name and initial for each author is encouraged. In footnote two, give job titles of the authors at the institution(s) where the study was conducted, followed by the address(es) of the institution(s). New addresses of the authors should follow. See a recent issue of *Weed Technology* for title abbreviations. Addresses of U.S. authors should include the official two-letter state abbreviation and zip code.

Abstract. Place the abstract on the same page with the title and author(s). Begin with the word 'Abstract' at the left-hand margin, use a squiggly underline or enter in boldface type, and place a period after it. Begin the first sentence on the same line. The abstract body contains two components, the text and the nomenclature. The text should not exceed 3% of the length of the manuscript including tables but not including Literature Cited. It must be written as a single paragraph containing an objective, informative digest of the significant content of the paper, not simply a description of the contents. Use only common names of chemicals and plants in the text. Immediately after the text, type "Nomenclature:" in boldface or use squiggly underline. Then repeat each common name appearing in the title and abstract paired with the appropriate chemical or binomial name, and include the computer code for weeds. List chemical names first in alphabetical order. Example: **Nomenclature:** dalapon, 2,2-dichloropropanoic acid; 2,4-D, (2,4-dichlorophenoxy)acetic acid; corn, *Zea mays* L.; cheat, Bromus secalinus L. #[3] BROSE; wild oat, *Avena fatua* L. # AVEFA.

Note that common and chemical names are separated by commas and semicolons. Omit tables, graphs, long lists of names, literature, or footnotes, except for the computer code for weed names. At the first mention of the herbicide rate, express the rate either on the acid equivalent (ae) basis or active ingredient (ai) basis, e.g., as kg ae ha^{-1} or kg ai ha^{-1}. Do not use a slash (/) or dot (·) between units. Omit trade names for herbicides, surfactants, or pesticides in the abstract.

Additional index words. Immediately after the abstract, begin the phrase, 'Additional index words' at the left-hand margin, use a squiggly underline or enter in boldface type, and follow with a colon. On the same line, list words, word pairs, or phrases (usually not more than five words) not included in the title that further describe the content of the manuscript. List only specific words or phrases that will be useful in indexes and in computerized literature searches. Capitalize only the first letter of the first word of this list. Place a comma after each word or phrase and a period after the last word. List information in the following order: (a) type of study, (b) herbicides or other compounds, (c) Latin binomials for weeds and crop plants (omit common names of plants), and (d) computer codes for weeds (omit # with these codes). Example: **Additional index words:** Selective applicators, glyphosate, *Cyperus rotundus*, *Glycine max*, CYPRO. Alphabetize within each subset.

Herbicide names. At the first mention of a herbicide, except in the title and abstract, give its approved common name or other designation first followed by its full chemical name enclosed by parentheses or by brackets when parentheses occur within the chemical name. Use the chemical names and common names as printed on the back cover of *Weed Science*. Use only the common name or other designation thereafter. Do not repeat in the text chemical names that have been given in the Abstract. The company code name should be used in lieu of the common name if a common name has not been approved by the WSSA Terminology Committee. If the particular commercial formulation of a herbicide used may significantly affect the results, identify the formulation used in a footnote.

When the common name of the herbicide in the text refers to the parent acid, the salt or ester portion of the active ingredient should be identified. This should be at first mention of the herbicide and should be stated as the methyl ester of __________ or the isopropylamine salt of __________. The blank should contain the WSSA-approved common name of the acid equivalent. This should be followed by the chemical name of the parent acid as printed on the back cover of *Weed Science*. Use the approved common name in the remainder of the paper unless there is a need to distinguish between the active ingredient and the parent acid in the text. In such cases, a modifier can be added to the common name, such as 2,4-D-amine or diclofop-methyl, and can be used in the text to identify the active ingredient. Recent issues of *Weed Technology* or Weed Science can be used to determine appropriate modifiers.

When rates of acid herbicides are expressed as weight/volume or weight/area, the author must indicate at first mention of the rates whether weight refers to the acid equivalent (ae) or the active ingredient (ai), as kg ae ha^{-1} or kg ai ha^{-1}, unless this information is included in the abstract.

Soil terminology. Include the soil series with textural classification and the subgroup name, using the terminology of the

U.S. Dep. Agric. Soil Conserv. Serv. publication, Soil Taxonomy, U.S. Gov. Printing Office, Washington, D.C. 1975. For soils outside the United States, use the local official terminology.

Adjuvant names. Where possible, use WSSA-approved terminology as given in the WSSA monograph, Adjuvants for Herbicides, or in *Weed Science* 26:204–205. Otherwise, use the most complete chemical description of the adjuvant available.

Plant and animal names. At the first mention of a plant or animal, give its common name followed by the approved scientific name enclosed by parentheses or by brackets when parentheses occur within the binomial. Give the genus, species, and author(s) for the binomial. Underline or italicize the genus and species. Enclose the cultivated variety of a crop plant if known in single quotes at first mention; thereafter, omit the single quotes. Example: Corn *(Zea mays* L. 'Dixie 18'), but later Dixie 18 corn. For cultivar names that are registered trade names, insert ® after the name. Use the most recent WSSA Terminology Committee Report for approved common and scientific names of weeds. After the scientific name of weeds, except in the title, place the five-letter, WSSA-approved computer code. After the author for the scientific name, follow this sequence: space, #, space, five-letter code in capitals, comma. At first use only, footnote the symbol # to give source of the code. Example: purple nutsedge *(Cyperus rotundus* L. #[3] CYPRO) with footnote as follows–[3]Letters following this symbol are a WSSA-approved computer code from Composite List of Weeds, Revised 1989. Available from WSSA, 309 W. Clark St., Champaign, IL 61820. Use the code only for plant species included in the study; do not use the code for weeds mentioned in literature citations only. After the first mention, use only common names. Do not repeat in the text scientific names of plants or animals or the chemistry of herbicides that have been given in the Abstract. For the scientific and common names of crops, use those listed in the South. Weed Sci. Soc. publication, Research Methods in Weed Science, 3rd ed., or Standardized Plant Names, 2nd ed., prepared for the Joint Committee on Horticultural Nomenclature and the International Code of Nomenclature for Cultivated Plants whenever a more recent, authoritative taxonomic reference is not available.

Enzymes. Use the Enzyme Commission's accepted numbering system.

Abbreviations. Use abbreviations as shown in the CBE Style Manual or as used in *Weed Technology*. Abbreviations that often cause trouble or differ from the Style Manual include the official two-letter abbreviations for states, M for molar, L for liter, ppmw for parts per million by weight, ppmv for parts per million by volume, ae for acid equivalent, and ai for active ingredient. The examples listed are correct abbreviations. See current Directions for Contributors to Weed Science for other acceptable abbreviations commonly used in Weed Science literature. Place a period after all abbreviations in footnote two and in the LITERATURE CITED section. Do not place a period after an abbreviation in the text unless its omission might be confusing. All abbreviations used in the Abstract not shown in the Style Manual, WSSA Herbicide Handbook, *Weed Technology*, or *Weed Science* should be introduced in parentheses immediately after the first use of the word(s); e.g., days after treatment (DAT), thin-layer chromatography (TLC). All new abbreviations introduced in the text must be collected in one abbreviations footnote with the appropriate superscript number. Example: [4]Abbreviations: DAT, days after treatment; TLC, thin-layer chromatography. Avoid excessive use of acronyms.

Numbers. Use arabic numbers for all numbers with two or more digits and for all measurements of time, weight, length, area, quantity, or degrees, except when the number is the first word in a sentence. Spell out numbers if they are the first word in a sentence or if they are less than 10 and not measurements, except in a series in which one number has two or more digits. Do not use a hyphen for the preposition 'to' or an x for the preposition 'by' except in tables and figures. Write 100 by 20 rather than 100 x 20 and 1 to 3 rather than 1–3.

Omit nonsignificant numbers. Herbicide dosages and injury levels often are not known more accurately than to the nearest 10%. Yields, enzyme levels, photosynthetic rates. . . often are not known more accurately than to the nearest 1% (10% of LSD or similar statistic). Therefore report a herbicide rate, for example, as 0.9 kg ha^{-1} rather than 0.89 kg ha^{-1} and a grain yield as 590 kg ha^{-1} rather than 593 kg ha^{-1}.

Measurements and units. Report all measurements in SI units or SI-derived units. Do not use quintals or metric tons. Describe lighting conditions in terms of irradiance (W m^{-2}) of photosynthetically active radiation (PAR) or in terms of photosynthetic photon flux density (PPFD) as $\mu E\ m^{-2}\ s^{-1}$ or mol $m^{-2}\ s^{-1}$. Leave a space between units in a series. Use nanometers (nm) to designate wavelength, and give spectrophotometric readings in absorbance units (A) rather than optical density (OD). In laboratory studies, express concentration of acids and bases in normality (N) and of herbicide and salt solutions in molarity (M) rather than ppm. Express pressure in kPa (kilopascals) rather than kg cm^{-2} or bars. Use kg rather than Mg (megagrams). In field or laboratory studies, indicate whether ppm and percentages are on a w/w, w/v, or v/v basis. Use ml rather than cc for all measurements of volume. Express the makeup of solvent systems as follows: methyl alcohol, water, and kerosene mixture (1:2:1, v/v/v).

Statistical analyses. Data should be analyzed statistically. Include the analyses in tables or figures in which average values are presented. Clearly identify all statistical procedures used, including methods of analysis, numbers of replicates and subsamples, transformations used, and statistical tests performed.

Footnotes. Number all footnotes consecutively throughout the manuscript except for table footnotes which are indicated with superscript letters. Indent the first line of each footnote three spaces. Omit acknowledgments in footnotes. All personal communications should be footnoted.

Trade names. Use trade names only if necessary to describe the materials or methods adequately. If a trade name is necessary, put it as a footnote to the generic name in the text. The footnote should contain the capitalized trade name and the name and address of the manufacturer or supplier.

Acknowledgments. Place all acknowledgments in a separate section immediately following RESULTS AND DISCUSSION.

Literature citations. Literature citations in the text should use the number system (see Literature cited) enclosed in parentheses. Two or more citations within a set of parentheses should be separated by a comma and a space. When referring to the authors of a paper with more than two authors, use et al.

Literature cited. Begin this section on a separate page. List citations alphabetically, and number them consecutively. Each citation should include the names of all authors, year of publication, complete title, publication, volume number, and inclusive pages, in that sequence. Journal names should be abbreviated as shown in the 1985 BioSciences Information Service publication, Serial Sources for the BIOSIS Data Base, and recent issues of *Weed Technology* and *Weed Science*. When two or more authors are listed, initials and a comma should follow the last name for the first author, but the initials should precede the last name of other authors. When two or more authors are listed, place a comma after the next to last name as well as after earlier names in the sequence. Leave a space between the period after each initial and the next initial. In references to a specific portion of a book or similar publication, cite those pages rather than the total pages of the book (Example: Baver, L. D., and W. H. Gardner. 1972. Flow in stratified soil systems. p. 343–345 in L. D. Baver, ed. Soil Physics. Academic Press, New York). Publications not normally available in libraries must appear as text footnotes. Do not cite or footnote abstracts more than 3 years old unless the information contained is of vital importance and has not been reported elsewhere.

Tables. Tables should be no more than 120 character spaces wide. Type each table on a separate sheet. Tables should be numbered with arabic numerals in the sequence of first reference in the text. First reference to tables included primarily to present results should be in the RESULTS AND DISCUSSION section. The caption, column headings, and side headings of each table should be in lower case letters except for the first word and proper nouns which should have initial capitals. Begin the table title at the left-hand margin, underline or italicize the word 'Table' and its number, and follow with a period. Begin the first sentence on the same line. Double-space the caption, the body of the table, and all footnotes. The unit of measurement for a column of figures should be abbreviated at the top of the column below the solid horizontal line. Avoid exponents in column headings. Footnotes to tables should be designated with superscript, lower-case letters. Place the footnote designation at the highest appropriate level. Study the form of Table 1. Leave a space between values and letter(s) used to indicate significant differences.

Captions for figures. Type the list of captions on a separate page. Begin the caption at the left-hand margin, underline or italicize the word 'Figure' and its number, and place a period after it. Begin the first sentence on the same line.

Figures. Experimental data can be presented in graphic or tabular form, but the same data will not be published in both forms. Figures will be published only if they convey an essential concept that cannot be adequately expressed by words or numbers. Number figures consecutively with arabic numerals in the sequence of first reference in the text. Do not

Table 1. Seed weight and germination of downy brome as affected by DPX-Y6202 and fluazifop treatments at three stages of plant growth[a].

Herbicide	Rate	Growth stage	100-seed weight 1984	100-seed weight 1985	Germination 1984	Germination 1985
	kg ha^{-1}		— mg —		— % —	
DPX-Y6202	0.07	Culm elongation	280	–	100	–
		Anthesis	300	270	99	99
		Seed fill	340	290	100	89
	0.28	Culm elongation	–	–	–	–
		Anthesis	310	250	96	71
		Seed fill	340	240	99	63
Fluazifop	0.07	Culm elongation	–	–	–	–
		Anthesis	310	–	93	–
		Seed fill	360	240	99	85
	0.28	Culm elongation	–	–	–	–
		Anthesis	–	–	–	–
		Seed fill	360	200	99	33
None			360	300	99	99
LSD (0.05)			25	35	2	10

[a]Dashes indicate that no seeds were produced.

CONVERSION FACTORS FOR ENGLISH AND SI UNITS

To convert English to SI units, multiply by	English units	SI units	To convert SI to English units, multiply by
Length:			
2.540	Inches	Centimeters (cm)	0.3937
0.3048	Feet	Meters (m)	3.281
1.609	Miles (statute)	Kilometers (km)	0.6214
30.48	Feet	Centimeters (cm)	0.0328
0.9144	Yards	Meters (m)	1.094
Area:			
0.4047	Acres	Hectares (ha)	2.471
6.452	Square inches	Square cm (cm^2)	0.1550
Volume:			
0.9463	Quart, liquid, U.S.	Liters (L)	1.057
1.136	Quart, imperial	Liters (L)	0.8799
3.785	Gallon, U.S.	Liters (L)	0.2642
4.546	Gallon, imperial	Liters (L)	0.2200
28.41	Ounce (British fluid)	Milliliters (ml)	0.0352
29.57	Ounce (U.S. fluid)	Milliliters (ml)	0.0338
Weight:			
28.35	Ounces (avoirdupois)	Grams (g)	0.0353
0.4536	Pounds (avoirdupois)	Kilograms (kg)	2.205
907.2	Tons (short)	Kilograms (kg)	0.0011
Pressure:			
98.0665	Kg/cm^2	Kilopascals (kPa)	0.0102
6.8941	Pounds per square inch	Kilopascals (kPa)	0.1450
0.100	Bars	Megapascals (MPa)	10.000
Other conversions:			
1.12	Pounds/acre	Kilograms/hectare (kg ha^{-1})	0.892
9.35	Gallons/acre	Liters/hectare (L ha^{-1})	0.107
0.120	Pounds/gallon	Kilograms/liter (kg L^{-1})	8.33
0.3937	Mesh size (wires/in)	Mesh size (wires cm)	2.54
37.000	Microcuries	Kilobecquereis (kBq)	0.0270

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