Ground Covers for Louisiana Highways

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ABSTRACT

More than 200 different plants were investigated during 8 years for their adaptability; hardiness; propagation; maintenance; and general suitability for use as ground covers on slopes, medians, and flat areas along highways in Louisiana. Eight different plantings were made. Ratings for overall appearance, weed presence, and establishment over a 13-month period indicated that the liriope rated highest by far. Lonicera japonica 'Pupurea', Trachelospermum asiaticum, and Wedelia trilobata also rated high.

Because limited information on the use of ground covers along highways in the South was available, this research requested by the Louisiana Highway Department was conducted by the Department of Horticulture at Louisiana State University, Baton Rouge, Louisiana. The primary purpose was to learn about and observe low-growing plant materials that could enhance safety, give beauty, prevent erosion, and reduce maintenance costs on problem areas.

The objectives were

1. To research literature on ground covers and their use and adaptability to Louisiana;
2. To obtain, select, propagate, and learn of sources of plants for trials in the immediate area;
3. To learn best propagation and production methods for selected types and determine their availability commercially;
4. To set up field trials, screen plant materials, and then replicate trials to learn about establishment and performance;
5. To meet problems such as drought or weeds and learn how to cope with them; and
6. To make recommendations for future plantings based on information obtained.

DISCUSSION

Phase 1 (1974) gave a review of the literature on the use of ground covers with emphasis on highway use (1). Low-growing plants of 60 cm or less that tended to propagate readily were stressed. Original plants were grown under 50 percent shade in a lath house. Bugleweed (Ajuga reptans L.), mock strawberry [Duchesnia indica (Andr.) Focke], and moneywort (Lysimmachia nummularia L.) completely covered plots within a 3-month period. In a previous report (2) the 32 plants that showed the most promise are listed and remarks given about their performance.

Most trial plants were transferred to 0.003 m^3 containers from 7.6 cm pots after they were well established but before they were pot bound. The medium was composed of 85 percent shredded pine bark, 4.72 percent washed builder's sand, 9.4 percent gravelite, 0.472 percent 18-6-12 osmocote, 0.201 percent dolomitic lime, 0.08 percent hydrated lime, and 0.007 percent fritted trace elements.

Liners and plants that were divided and placed in containers for finishing were fertilized with soluble 20-20-20 fertilizer at 100 ppm every 2 weeks while in the lath house. About 5 weeks later they were moved to full sunlight until they were planted along the highways. Osmocote (18-6-12) at 42 g per container was applied after 4 weeks and thereafter every 12 weeks.

In an unreplicated trial along LA-415 underneath the US-190 overpass at Lobdell, Algerian ivy (Hedera canariensis Willd.) and trailing lantana [Lantana montevidensis (K. Spreng.) Briq.] spread rapidly and made a dense cover. The heavy shade also seemed best for the cast-iron plant (Aspidistra elatior Blume).

The first planting was made in November-December 1973; the second in March 1974; the third in March 1975; the fourth, on the Hill Farm of Louisiana State University (LSU), in June 1975; the fifth in August 1975 on Florida-Airline property; the sixth on the Essen Lane median in March 1976; the seventh, an extension of the Florida-Airline planting, in March 1977; and the eighth on Dalrymple, Fuqua, and Bluebonnet sites on April 20, 1980. Early spring plantings were considered best because plants need an entire growing season to become well established. Many species showed no growth late in the season, whereas asparagus fern [Asparagus densiflorus (Konth) Jessop], lantana hybrids, and wedelia [Wedelia trilobata (L.) A.S. Hitchc.] were killed by frosts and regrowth did not recur until soils warmed up again the following spring.

In the first planting, most rapid covering occurred with bronze bugleweed, moneywort, and mock strawberry. In the next growing season, the dwarf Confederate jasmine [Trachelospermum asiaticum (Siebold & Zucc.) Nakai], big blue liriope [Liriope muscari (Decne.) L.H. Bailey], bronze wintercreeper [Euonymus fortunei (Turcz.) Hand-Mazz. 'Colorata'], memorial rose (Rosa wichuriana Crep.], stonecrop (Sedum acre L.), and variegated eulalia (Miscanthus sinensis Anderss. 'Variegatus') covered the areas well. Bugleweed and moneywort were susceptible to southern wilt. The bugleweed was very susceptible to root-knot nematodes. In the second planting in full shade, Algerian ivy and trailing lantana made the best cover. Other plants that persisted included the cast-iron plant, creeping liriope (Liriope spicata Lour.), mondo grass [Ophiopogon japonicus (Thunb.) Ker-Gawl], and ground ivy (Glechoma hederacea L.).

None of these except ground ivy spread to any extent. The ground ivy grew best when temperatures were below 50°F. An extended hot, dry period in 1975 severely damaged plants in full sunlight; however, the next winter the area was covered and plants had spread along the embankment. Weed growth was excessive in the third planting at Lobdell. Inability to get labor until June and frequent rains in early spring allowed weeds to become excessively established. More aggressive species also infiltrated. Moneywort, mock strawberry, big periwinkle (Vinca major L.), ground ivy, and wedelia, because of long vines, tolerated hand weeding only. Pilferage was extensive at this site especially of the narrow-leaf evergreens, liriope, and roses. The entire area was mowed on October 25, 1975, which caused considerable damage to the woody plants; however the memorial rose, dwarf Confederate jasmine, and Algerian ivy plants tended to branch more and thus covered the area more rapidly.

Bermuda and Johnson grasses were the two main weeds. Because there were so many missing plants, no statistical analyses were made. Species remaining to date were day lilies (Hemerocallis fulva L.) and sunproof liriope on the southern exposure and day lilies, big periwinkle, Algerian ivy, and dwarf Confederate jasmine on the northern side. Liriope and day lilies persisted in full sunlight under annual highway department mowings and herbicide sprayings. The fourth planting was made in June 1975 on the Hill Farm, LSU campus, in full sunlight on raised rows that could be cultivated. Plants that grow best under full sunlight were tried. Those that rated excellent included dwarf bamboo [Arundinaria pygmaea (Miq.) Asch. & Graebn, 'Nana'], dwarf coreopsis (Coreopsis auriculata L.), variegated eulalia, lantanas, dwarf rosemary (Rosmarinus officinalis L.), St. Paul Verbena [Verbena pervriana (L.) Britt], dwarf Confederate jasmine, purple-leaved honeysuckle (Lonicera japonica, Thunb. 'Purpurea'), liriope, and mondo. The planting was discontinued in 1976 to allow develop- ment of a rose garden.

The Florida-Airline planting was made in August 1975. Glyphosate was applied twice at 2-week intervals and all existing vegetation appeared to be dead before planting. Spot treatment with 2,4-D was made on dewberries to kill those in the plots. Plantings were replicated on either side of the bridge with two exposures, one a slope with more sunlight and the other a north-facing slope where direct sunlight hit only a short time during the day. Wedelia and lantanas made the fastest coverage. The lantana, wedelia, stonecrop, yarrow (Achillea millefolium L.), and day lilies gave attractive flowers. The lantana bloomed for months. On the north-facing slope, the big perwinkle, dwarf Confederate jasmine, memorial rose, variegated liriope, and variegated eulalia looked best. On the south slope, stonecrop, lantana, mondo, wedelia, and lantanas gave the best coverage in the first year.

Two replications were made on a median strip on Essen Lane in early March 1977. Unfortunately underlying this area was a hardpan because cement had been mixed here when the road was paved. The only plants that grew well were the liriopes, mondo, and dwarf Confederate jasmine. This planting was mowed frequently, thus most plants except liriope never became well established.

A seventh planting was completed on March 18, 1977, and was an extension of the previous Florida-Airline planting. The akebia [Akebia quinata (Houtt.) Decne.], bronze wintercreeper, dwarf bamboo, and thimbleberry (Rubus parviflorus Nutt.) grew well. Unfortunately the entire planting was run over by a rotary mower on October 4, 1978, and many plants were uprooted. Heavy clippings caused smothering and rotting of plants. Duff was removed by lifting with forks and by raking, but heavy damage had occurred. An inadvertent herbicide spraying occurred the same fall. The next spring, the wedelia had not survived, but the day lilies, lantana, yarrow, and wintercreeper came back well on the south side and the big periwinkle, thimbleberry, memorial rose, and ground ivy on the north side. Verbena was substituted for the wedelias.

Stock was increased in the summer of 1979 for three replicated trials along the Interstate including dwarf Confederate jasmine, purple-leaved honeysuckle, bronze wintercreeper, dwarf coreopsis, dwarf compact sprengeri fern, St. Paul verbena, and wedelia.

Highway department glyphosate sprayings were to be made at the rate of 16 cm^3/L over the three areas at least twice in the fall. If a third spraying had been necessary it was to have been made 2 weeks after the second spraying. The first and only spraying was made in October. To learn what weed growth to expect, sod was taken from each site and placed in flats in a greenhouse. The Bluebonnet sample showed regrowth of Bermuda grass but the Johnson grass, which has just about 2 cm of root, did not grow. The Dalrymple area showed primarily Bermuda grass. The Fuqua area showed growth of dallis grass and winter annuals. A second spraying was made on February 21, 1980, but temperatures at this time were too low and weeds were not actively growing.

Soil tests indicated low phosphate so treble superphosphate was applied to all plots at 4.5 kg/ha before planting. Because finished plants were available, planting could not be delayed and was started in late February. Many weeds were present; the worst were Bermuda and Johnson grass.

A complete randomized planting was made at each location with individual plantings from top to bottom of the slope. Individual plantings varied in size depending on available plant materials and spacings required. Spacings were from center to center of the plants. The smallest plots were of asparagus fern that were almost 141 m^2. Plantings, starting with Fuqua and ending on Bluebonnet, were completed on April 20, 1980.

Approximately 1,440 man-hours were required to plant about 35,000 plants in the 0.64-ha area. Weed control started as soon as plantings were completed. Ratings were made monthly by six judges starting in June 1980 for overall crop appearance, weed presence, and crop establishment. An extended period of drought from May 20 to June 19, 1980, and in August took its toll on plants. Most of the dwarf coreopsis and verbena were lost and were replanted. The asparagus fern on Fuqua were planted in February before plants could be checked to see if they were alive and many were dead. Both asparagus fern and wedelia will kill in containers if the medium freezes. Roughly 70 percent never came up in spring. Replanting, which was done from December through February, took about 900 man-hours for all replications. Weed control began in April 1980 and continued thereafter. Directed sprays and hand weeding around plants were used initially. Glyphosate was used at the rate of 10 mL/L over the dwarf Confederate jasmine after plants became established and at the rate of 5 mL/L over the honeysuckle and wintercreeper. No visible damage occurred to the crop plants and the jasmine exhibited an increased number of shoots per plant. Terminal buds were killed and axillary buds were induced to break. Glyphosate could not be used on the asparagus fern, coreopsis, eulalia, or verbena, all of which are highly susceptible to injury. Glyphosate at 5 mL/L over liriope did not appear to damage the plants. When plants were small, covering with plastic containers and spraying between and within rows prevented the plants being touched. Paraquat was used in the two first sprayings. Thereafter glyphosate (4 sprayings) was used in the first growing season and subsequently. Crops that were not treated with herbicides were hand weeded.

In 1981 glyphosate was used twice over tolerant crops and a quickbar was used overall once. Quickdraw, a liquid application from a bar containing glyphosate solution, was used to control tall weeds, mainly Johnson grass. Crops were considerably shorter than many weeds. Honeysuckle, a vine, crawled up the weeds; thus the bar could not be used on it. The bar had a solution of 2 parts glyphosate to 1 part water on a volume basis. It was used three times during the growing season.

To estimate what yearly maintenance would cost, a

record of man-hours was kept from April 1, 1980, through March 31, 1981. The project took 1,400 man-hours of labor. A commercial lawn maintenance company charged $180 to put 46 kL water over the 0.64-ha area. Four waterings were made; however, double that number should have been made. About 26.5 L of glyphosate and 15 L of paraquat were used to control weeds. Fertilizer costs were roughly $300. Service station charges averaged $50 per month, and miscellaneous expenses totaled about $350. The total expense was $10,680 for the 0.64-ha planting.

Irrigation, when needed, was always a problem. In May and June just 3.35 cm of rain was recorded. Plants suffered immensely and added moisture seemed necessary at least once every 2 weeks. Average temperatures were 13°C with full sunlight and more wind than usual; many plants died.

The first frost occurred on November 19, 1980; however, the wedelia was not killed until a low of -16.5°C was recorded. The lantana showed injury; however, they were not killed until the temperature dropped to -18°C. All plantings made excellent recovery the next spring. The lowest recorded temperature was -22°C on January 13, 1981.

SUMMARY

Ratings were made monthly by six judges on the three replicated plots for overall appearance of the crop, presence of weeds, and crop establishment using a scale of 1-9 with 9 indicating the largest number of plants. Analyses of variance were run monthly and for the 13-month period. Duncan's multiple range tests were run on the means (Table 1). Only six species were rated because the dwarf coreopsis and St. Paul verbena were severely damaged by drought in May, June, and August.

On the first date, liriope had the best rating followed by wedelia and honeysuckle. Closer spacing in liriope contributed to the high rating because fewer weeds were present. The same relative order was shown in crop establishment.

Considering the summary analysis of variance (2), the overall ratings were highest for the Dalrymple site. Weeds were easier to control here because much less Bermuda and Johnson grass was present. Plots here were more protected from winds. A pH closer to neutral might also have favored the crop plants. The same order was shown in crop establishment and significantly fewer weeds were present.

The overall rating for liriope was significantly better than that for all other species. The honeysuckle, wedelia, and jasmine were not significantly different, yet they were better than the wintercreeper. In previous trials wintercreeper was slower to become established but in time made a dense cover.

For crop establishment the same general pattern was exhibited among species means. Significantly more weeds were found in the wintercreeper than in all other species. The honeysuckle and wedelia had significantly more weeds than the jasmine and liriope. No herbicides were applied to the wedelia plots, and the reduced rate and more open nature of honeysuckle gave the appearance of more weeds. The honeysuckle at Bluebonnet had the greatest amount of Johnson grass. Tall grasses in the wedelia at Fuqua tended to compete with the crop. The fern was hand weeded at Dalrymple but herbicides were used between plants that could be covered to avoid contact with herbicides. Weed kill was greater among this species because a higher concentration of herbicide could be used. In general, the fewest weeds were found in liriope; however weed populations were not significantly less than in the jasmine, which had periodic herbicide applications over the entire plots. Whether these sprays will have a long-term effect on the crop was not determined.

In conclusion, the liriope appeared to be the best species for highway plantings followed by honeysuckle, jasmine, and wedelia. Wintercreeper and fern required more time for establishment.

RECOMMENDATIONS FOR IMPLEMENTATION

1. All vegetation should be killed before planting is started. Fumigants that can be watered down into the ground might be used. If glyphosate and 2,4-D are used, at least three sprayings spaced a minimum of 2 weeks apart should be made to kill all grasses and weeds. Weeds should be in active growth when herbicides are applied, and temperatures should be 70°F or above. Soil tests should be run and fertilizers added as needed. The pH should be close to 6.5. If a big adjustment is needed in pH, tests and lime or sulfur additions should be made 6 months before planting.

2. If the area to be planted is bare, soil tests should be made, fertilizers added as needed, and the area rototilled to 20 to 30 cm before fumigation. On slopes, erosion control would be necessary. Using established plants in 0.003-m^3 or larger containers for planting and staggering plants from row to row would reduce erosion considerably. Straw might possibly be used between plants on very steep sites. Shredded bark such as used in nursery media is too coarse and will float or be carried away by rains. Erosion net could be used between rows where erosion might be a problem but only after plantings were completed. The netting would make using a post-hole digger difficult. A mulching anchoring tool or tracking with a tracked-type vehicle with cleats penetrating to about 6 cm might be used to

TABLE 1 Duncan Multiple Range Tests for Rating Means for Overall Appearance[a]

	Overall Appearance		Crop Establishment		Weed Presence	
Species	$\bar{X}$[b]	Letters[c]	$\bar{X}$	Letters	$\bar{X}$	Letters
Liriope	7.21	a	8.23	a	3.65	d
Honeysuckle	6.34	b	7.75	b	4.76	b
Jasmine	6.11	b	7.56	b	3.89	cd
Wedelia	6.16	b	7.43	b	4.60	b
Fern	5.55	c	6.68	c	4.38	bc
Creeper	3.91	d	5.86	d	6.82	a

[a]Crop establishment and weed presence for six ground cover species on three sites during 13 months rated by six judges.

[b]$\bar{X}$ = Mean.

[c]All with the same letter are not significantly different.

prevent erosion on very steep slopes. Straw and fertilizers could be incorporated into the soil by this method.

3. Obtaining finished plants in containers in the numbers needed will be difficult unless plants are grown on consignment. This would mean that at least one growing season would be necessary to produce most plants except the very fast-growing herbaceous types. Using two or three rooted cuttings per container would also speed maturity. Most of the woody plants, with the exception of akebia, grow relatively slowly from liners. Although many nurseries grow ground covers, few produce them in quantity unless assured they will have a market when plants are well established. The dwarf Confederate jasmine was sold by most of the nurseries consulted, but usually in numbers not exceeding a few thousand plants. The liriopes could be obtained best as liners; however, getting the creeping liriope was difficult. A number of nurseries carried the purple-leaved honeysuckle but finished stock was very limited. Other materials were in exceedingly short supply.

4. Stock produced in the same hardiness zone in which it will be used would be best; however, for asparagus fern, wedelia, and lantana, or those plants that are injured by freezing temperatures during the winter if they are in containers, only plants produced and planted before freezing temperatures occur would be reliable. Some problems also occurred with plants in containers in which a very fine medium with very poor internal drainage was used especially during very rainy periods. The only solution to obtaining large numbers of finished plants when needed is to buy on consignment and this must be done at least a year before the plants are wanted.

5. Plants should be maintained by the planter at least through the first growing season. If weeds are not controlled before planting, maintenance should be contracted for at least two growing seasons. Irrigation when necessary would be essential to establishment. Possibly at least 2.54 cm of water per week might be necessary during periods of drought when plants are newly planted and before they have become well established. When plants are established, bimonthly checking might be sufficient and irrigation used only if needed. Plantings should be made from mid-November through February.

6. Fertilization, using a slow-release nitrogen carrier like urea-formaldehyde, should be done shortly after planting at the rate of at least 48 kg of actual nitrogen per hectare. After the first year, fertilization at the rate of 1,465-2,000 kg/ha of 8-8-8 would be suggested to keep plants growing well.

7. Herbicides might be used in the first season after plants become established although certain herbicides can be used when the plants are planted. Systemic herbicides like glyphosate have affected growth of certain woody crop plants for several seasons after applications. Long-range effects would have to be learned as well as effects of repeated applications of small concentrations.

FURTHER INVESTIGATIONS

Peculiar problems encountered in conducting this research and time limitations made full investigation of certain practices impossible. Further work would be of great value in the following areas.

1. More extended tests over at least 3 years of many different plant materials are needed. Certain plants that showed promise were unobtainable or could not be produced in sufficient numbers for trials (e.g., akebia, dwarf bamboo, and kumasaca). Testing of more native materials like *Coreopsis lanceolata* L., *Achillea millefolium* L., *Rudbeckia* sp., and others is needed. Many of these plants have wide adaptability and persist with no care along highways.

2. Companion plantings should be tried. For example, ground ivy grew rampantly when temperatures were cool and soil was moist; thus it could be planted with memorial rose. Memorial rose is slow establishing and has strong apical dominance in the shoots. Planting ground ivy with memorial rose would give a fast cover to prevent weed infiltration and erosion stresses. Leaf drop, which often occurs in the roses due to diseases or low temperatures in winter, would permit the ground ivy to grow because it tolerates full sunlight well at this time of year. The big periwinkle, with other plants giving a good cover at the Florida-Airline site, is another example of plant partners. Native dewberries make an excellent solid cover; however, their thorniness is objectionable. There is a thornless selection that is not available. Although a dwarf form of the pampas grass [*Cortaderia selloana* (Schult & Schult. f.) Asch. & Graebn.], which is an ornamental grass used along highways and which has very low maintenance and excellent persistence, has been reported, efforts to obtain it were futile. Such a selection could be invaluable for highway use if it were very dwarf.

3. Use of smaller plants in tube-type containers, liners as in sprigging, and mats developed from planting liners to develop like sod should be tried to ascertain if a quicker cover could be obtained without erosion and with reductions in cost. Equipment developed to facilitate mechanical planting of these plants might greatly reduce costs for labor needed in planting, which was next to plant costs in amount.

4. Further studies are needed on ways to kill existing vegetation before ground covers are planted. Maintenance costs are prohibitive and weed competition is excessive and detrimental to establishment if weed kill is not completed before planting. Fumigants and herbicides that can be used to achieve this need to be researched. A thorough testing of new material is needed.

5. High mowing, at least annually until a solid stand occurs, is needed to improve appearance of the plants by removing dead stems and seedheads. Tall weeds, if present, might be weakened enough to allow crop plants to take over. Only the narrow-leaf evergreens did not tolerate inadvertent mowings over trial plantings. Possibly for herbaceous materials, which have tall seedheads that become unattractive, mowing could be done at least once annually. Plants that exceeded 60 cm might be kept down by an annual mowing.

6. For those plants that have annual tops, herbicides might be tried to control weeds without danger of injury to the crop when tops have died back.

7. Research to determine best fertilizer rates and formulations to maintain excellent growth for each species should be initiated.

8. Chemicals to induce lateral buds to break are needed for those plants that show strong apical dominance (e.g., dwarf Confederate jasmine, Algerian and English ivies, and memorial rose). This would mean a faster complete coverage of an area. Growth-retarding chemicals might also be tried.

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Roadside Deicing Chemical Accumulation After 10 Years

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ABSTRACT

Soil and plant samples were collected along the northbound lane of I-95 between Alton and Howland, Maine, from sites identical to those used in a similar study in 1972-1973. The sodium and chloride content of the samples was determined; the values were averaged and treated statistically. The mean values were then compared with values obtained in 1972- 1973. The following conclusions could be drawn. Sodium ion concentration exhibited a general cumulative trend due to application of road salt, sodium chloride (NaCl). However, accumulation was far below exchangeable sodium levels that are considered damaging. The chloride ions leached out of the soil fairly rapidly and had no pronounced accumulative effect. The effect of deicing salt on the sodium and chloride content of hemlock needle tissues was insignificant. The NaCl content of accumulated snow, which is caused by snow plow and blow action during the application of the road salt in the winter season, diminished as the distance from the highway increased. The alkalinity (or acidity) of soil appeared to have a direct relationship with the sodium content of the soil. The present study is generally applicable to areas adjacent to four-lane divided Interstate highways in the northeastern United States.

The use of deicing salt, sodium chloride (NaCl), to remove snow and ice from highways during the winter months has been an environmental concern for more than two decades. Highway maintenance agencies struggle constantly to balance the benefit of highway safety versus the possible harm of the salt to nearby soil and plants. Numerous studies have been carried out to determine the extent of the contamination including the effect of deicing chemicals on soil and plants (1,2) and the effect of deicing chemicals on groundwater (3). The economic aspects of highway snow and ice control are also a subject of much concern (4,5); the cost of damage to the environment and automobiles is compared with the financial benefit derived from road safety and travel convenience. Studies of alternative deicing methods for winter maintenance have also been carried out by many researchers (6,7).

It is generally agreed that most salt vacates the roadside environment via surface runoff and leaching after the winter season. In particular, chloride ions leach out quite rapidly. However, the interaction between the salt and the soil is of great complexity, depending on weather conditions, amount of snowfall, depth of the water table, soil texture, and soil chemistry (8). Therefore, it requires a considerable amount of data to reach a conclusion.

A recent publication by Hudler (9) summarized the effect of salt injury to roadside plants by listing various plants according to their tolerance of deicing salt. Among the highly tolerant plants were Norway maple, yellow birch, mulberry, and mountain ash. Some plants of low tolerance, among others, were balsam fir, red maple, black walnut, Norway spruce, and eastern hemlock.

As early as 1965 concern over pollution caused by deicing chemicals along Maine highways prompted the investigation of soil and water in areas contiguous to the highway under the direction of F.E. Hutchinson of the University of Maine at Orono (10,11). It was found that there was no significant increase in sodium or chloride content of river water during the spring when snowmelt was at its maximum. However,