GOLF

McLoughlin named GCSAA exec director

James E. McLoughlin has been chosen as the new Executive Director of the Golf Course Superintendents of America, said GCSAA President Melvin B. Lucas Jr.

McLoughlin is well known in the national golf community, having served as executive director of the prestigious Metropolitan Golf Association since 1966. He will begin his duties with GCSAA this September.

Lucas said, "The future welfare of the golf, club, and turf industries will require greater communications among all golf-related organizations in the years ahead, and often, a common effort. Jim McLoughlin's diversified background will facilitate GCSAA's support of this concept."

McLoughlin has served on the board of governors and is currently a member of the National Club Association's long range planning committee. He is a past president of the International Association of Golf Administrators and is chairman of its national liaison planning committee. He cofounded and served on the faculty of the Manhattanville College Club Management Program, a continuing education program designed specifically for the golf club community, which has been attended by many golf course superintendents.

IRRIGATION

Symposium planned for Nebraska Center

The Second National Irrigation Symposium has been scheduled at the Nebraska Center for Continuing Education (NCCE), University of Nebraska, Lincoln for October 20-23.

The program will include presentations on current irrigation practices, irrigation development during the 70's, current significant research, and potential future developments.

HONORS

Chemical Association elects new chairman

The Chemical Manufacturers Association (CMA) recently elected H. Barclay Morley, chairman of the board and chief executive officer of

LANDSCAPE CONTRACTOR NEWS

Interior Landscape will meet in Denver

"Prospering in an Uncertain Economy" is the theme of the 1980 Interior Landscape Conference scheduled for the Fairmont Hotel in Denver, Sept. 10-13.

A wide range of speakers will discuss the economic climate's impact on interior landscape firms, foliage technology, personnel administration, promotion, and selling. The conference will also feature a business meeting and presentation luncheon, at which exhibiting firms will show new developments in their products and/or services.

At least 50 leading suppliers and manufacturers will display their products and services for the industry at the trade exhibit on Thursday. Program chairmen are expecting a record turnout, possibly 400 people.

Complete information and registration materials for the 1980 Interior Landscape Conference of ALCA is available from: Interior Landscape Div., 1750 Old Meadow Road, McLean, VA 22102, 703/821-8611.

Author to address California landscapers

Author William Whyte will keynote the 1980 California Council of Landscape Architects annual conference scheduled for October 19-21 at the Asilomar Conference Center on the Monterey Peninsula.

White, who wrote "The Social Life of Small Urban Spaces," will show a film he made of New York street life which analyzes public places and why people do or don't use them.

Panels will provide discussion on resource conservation and licensing and legislation. Other topics include microclimate modification for human comfort and a presentation by Sunset Magazine on problems landscape architects have preparing photos for publication.

For more information, contact conference chairpersons Leah Haygood (415/841-5154) or Deb Mitchell (415/821-3500).

Productivity marks ASLA board meeting

The American Society of Landscape Architects' Board of Trustees covered a multitude of items at its mid-year meeting held in Kansas City during May.

The discussion included the new headquarters building, membership, unification with the American Institute of Landscape Architects and changes in the constitution and "Emeritus Status" bylaw. Executive Director Ed Able reported that in the past 12 months, ASLA membership has increased 14.2 percent, and the current number of dues-paying members stands at 4,876.

ALCA's Interior Div. names chairman

The Associated Landscape Contractors Interior Landscape Division installed a new chairman and embarked on its first full year of operation as an independent arm of ALCA at the group's 1980 annual meeting in San Diego.

Laine Craft, owner/manager of Living Interiors, Lake Park, FL, was installed as chairman of the I.L. for 1980.

According to Craft, I.L.D. programs for the year include: several one-day interior Maintenance Technicians Short Courses, management-oriented seminars, and the first annual Interiorscape Conference this fall in Denver.

GOVERNMENT UPDATE

Senate panel votes for chemical cleanup

The Senate Environment Committee recently approved a tough hazardous waste bill which would force chemical companies to annually contribute $700 million to a new federal superfund.

The bill would open chemical companies and their customers to a new round of government and private lawsuits over damage caused by toxic waste spills around the country. It is much tougher than an earlier bill proposed by the House Commerce Committee.

The measure would impose "strict liability" for damages—which means that plaintiffs wouldn't have to prove that negligence was involved in a waste spill—on companies that contributed to a hazardous emission. Such suits could be filed against the owners or operators of dump sites, the companies that generated the waste or contracted for its disposal, or the concerns that transported it.

A spokesman for the Chemical Manufacturers Association said that the Senate is asking the chemical industry to cover for 17 industries, such as hospitals, and steel mills, and others involved with chemicals. A new company would have to contribute to cleanup of pre-existing spills.

Mondale, Bergland dedicate herb garden

Joan Mondale, honorary chairwoman of the Federal Council on the Arts and Humanities, and Secretary of Agriculture Bob Bergland dedicated the new National Herb Garden at the U.S. Department of Agriculture's National Arboretum in Washington, D.C.

In the dedication, Mondale placed the final plant, a dwarf blue cypress, into an intricately patterned knot garden, one of the major features of the garden. The herb garden covers about two acres in a meadow of the 444-acre arboretum.

Bergland said the Herb Society of America raised over $300,000 for the garden, which was then supplemented by $200,000 in federal funds.

Senate acts to perk interest in patents

To stimulate both production and innovation, the Senate recently passed a measure that would allow small businesses to retain title to inventions they develop using federal research funds.

Under current law, the government owns more than 28,000 patents, but of that number, only 4% have been commercially exploited. Business owners complain that investments in new product developments are unattractive without exclusive rights to the patents. While some government agencies award exclusive licenses, others do not.

EPA asks ban on most uses of lindane

The Environmental Protection Agency has proposed to ban most uses of lindane, a pesticide used in a number of household products, in agriculture, and for treating hardwood logs and lumber.

The agency has invited Hooker Chemicals and Plastics Corp. of Niagara Falls, NY, the only U.S. manufacturer of lindane, and other interested parties to comment on the proposal.

Some of the areas EPA would ban lindane use are: all seed tr eatments, Christmas trees, home applications on ornamental plants and trees, in forestry, and on hardwood logs, lumber, and in structures.

Stauffer Chemical Co., as its new chairman of the board. It also honored The Dow Chemical Company, Midland, MI, and Virginia Chemicals, Inc., Portsmouth, VA, for the 1980 Safety Awards at its annual meeting in White Sulphur Springs, WV.

William G. Simeral, senior vice president of E.I. du Pont de Nemours & Company, was elected vice chairman of the board.

Paul F. Oreffice, president and chief executive officer of the The Dow Chemical Company, was elected chairman of the executive committee.

Robert A. Roland was re-elected president of the association, and 19 members were newly elected to the board of directors.

The awards are made to CMA member companies that show the greatest percentage reduction rates of occupational injuries, deaths, and illnesses in a five year span. The Dow Chemical Company led the larger company category with 57 percent injury reduction, and Virginia Chemicals had 38 percent reduction in the smaller company category.

CMA is also presently planning for the 1981 awards to high school, two-year and four-year college chemistry and chemical engineering teachers. United States and Canadian teachers with a minimum of 10 years teaching experience are eligible for the national awards.

Nominations must be received by CMA by Feb. 1, 1981. For further information contact Dr. Robert E. Varnerin, CMA, 1825 Connecticut Ave., N.W., Washington D.C. 20009.

PLANTS

GCA Survey shows foliage plant sales up

Overall sales of foliage plants increased last year, according to the 70 firms responding to a management survey taken by Garden Centers of America (GCA) in February.

Thirty-seven percent of these firms showed increases between 10 and 25 percent; however, 59 percent of the respondents said such sales represent 10 percent or less of their total 1979 sales.

When asked by GCA members what size plants make better sales items, the retailers' response was: plants in 6-10 inch pots are 26 percent; 3-6 inch pots 21 percent; 3 inch

Continues on page 63

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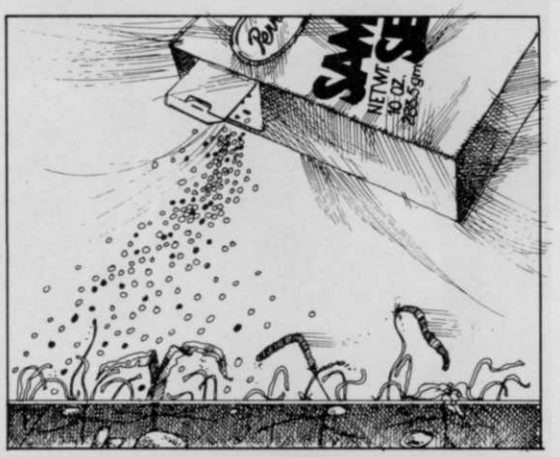

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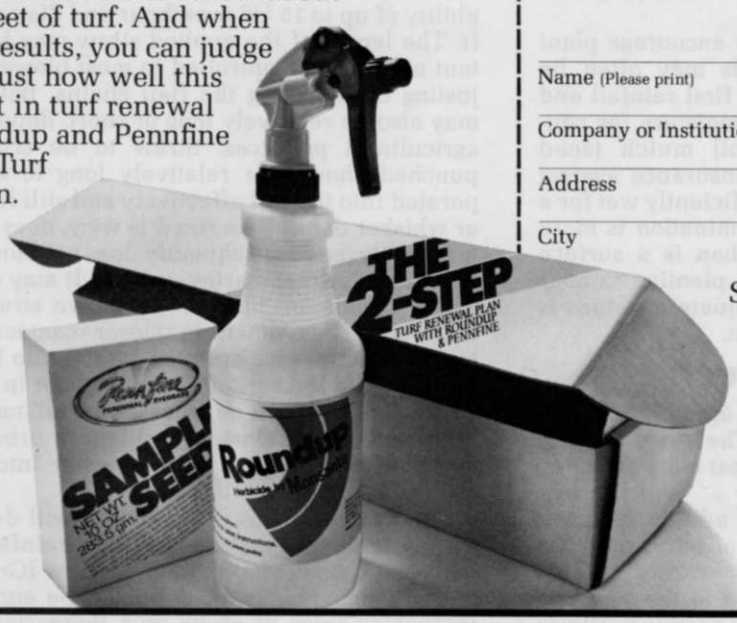

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MULCH CHOICES FOR EROSION CONTROL AND PLANT ESTABLISHMENT

By Burgess L. Kay, Department of Agronomy and Range Science, University of California, Davis

Reprinted with permission from the Associated Landscape Contractors of America Revegetation Report, 1978. This highly informative collection of papers on erosion control is available from ALCA, 1750 Old Meadow Rd., McLean, Virginia, 22102 for the price of $14 (members price less).

Mulching nearly always shortens the time needed to establish a suitable plant cover. The conventional mulches of agricultural or industrial residues have recently encountered competition from many chemical stabilizers or mulches introduced largely as supplements to the increasingly popular hydraulic methods (hydroseeding — application of a water slurry of seed, fertilizer, mulch, etc.).

Seed coverage with soil to the proper depth is essential in dry regions. Mulch, particularly hydromulching, is sometimes substituted for seed coverage when moisture is adequate. Showing the most promise in excessively dry areas are mulches applied after seed has been covered to the proper depth with soil, as with a grain drill (Springfield 1971).

Mulches can both protect soil and enhance plant establishment. The soil is protected by shielding it from raindrop impact, retarding water flow and soil movement by trapping silt on the sites, increasing water penetration, and sometimes shedding water. Properly anchored, mulches may reduce wind velocity. They enhance plant establishment by holding seed and fertilizer in place, retaining moisture, preventing crusting, and modifying temperatures.

Mulches on dry sites may also encourage plant suicide! Properly mulched seeds may often be fooled into germinating with the first rainfall and soon die from lack of sufficient moisture for continued growth. The use of soil mulch (seed coverage) is probably the best insurance against such a calamity. Soil which is sufficiently wet for a long enough period to effect germination is more likely to sustain plant growth than is a surface organic mulch or chemical. Also, planting as near as practical to a date when adequate moisture is expected may avoid this problem.

ORGANIC MULCHES

Organic mulches are often an agricultural crop residue or industrial product. The price usually reflects transport and handling cost more than any intrinsic value of the product.

Most organic mulches require additional nitrogen to compensate for the tie-up of nitrogen in the decomposition process.

Effectiveness is roughly related to the size and shape of the mulch particles. Long narrow particles are superior to finely ground products. Following is a discussion of the organic mulches commonly used.

Straw and Hay

Straw and hay are the mulches used most often in the West. Cereals are a major crop in dry regions of the United States, and straw left on the site of production is often considered a liability because its decomposition ties up nitrogen needed for the next crop. Straw availability should be increased by current restrictions on removing this crop residue by burning in place. Clean grain straw, free of noxious weeds, is preferred. The straw can be expected to contain 0.5 to 5.0% cereal seed by weight, which may result in considerable plant cover in the first year. This provides additional erosion protection but may also be prohibitively competitive with the planted erosion-control or beautification mixture. Rice straw is sometimes used because neither the rice nor associated weeds can be expected to grow on most unirrigated disturbed lands. In areas where cereal crops are not common, hay is sometimes used but is normally more expensive than straw. Wild Grass hay may be a valuable source of native plant material if cut when the seeds are ripe but not shattered.

The mulch effect of straw can be expected to increase plant establishment. Meyer et al. (1971) obtained fescue-bluegrass establishment of 3, 28, and 42% with respective surface straw mulch treatments of 0, 1, and 2 tons/acre. Comparisons of straw with hydromulch show that straw mulch produced the best grass stands (Kay, 1974; Perry et al., 1975).

Straw can be applied with specially designed straw blowers or spread by hand. Commercial mulch spreaders or straw blowers advertise a capability of up to 15 US tons/hour and distances to 85 ft. The length of the applied straw may be important and can be controlled in most blowers by adjusting or removing the flail chains. Baled straw may also be relatively long or short, depending on agricultural practices. Straw to be crimped or punched should be relatively long to be incorporated into the soil effectively and still leave tufts or whisker dams. Rice straw is wiry, does not shatter readily, and consequently does not blow as well as straw of wheat, barley, or oats. It may come out of the blower in 'bird nests'. Blown straw (other than rice) lies down in closer contact with a tackifier (substance sprayed on straw to hold it in place). Wind is a serious limiting factor in applying straw, though it can be an asset in making applications downwind. Dust, a problem in urban areas, can be overcome by injecting water into the airstream used to blow the straw.

The amount of straw to be used will depend on the erodability of the site (soil type, rainfall, length and steepness of slope), kind of straw (Grib, 1967), and whether plant growth should be encouraged. Increasing rates of straw give increasing protection. Meyer et al. (1970) show that as little as 1,000 lb/acre reduced soil losses by two-thirds, while 4 US tons/acre reduced losses by 95%. Straw to be

crimped is commonly used at 2 US tons/acre, while straw punched into fill slopes in California is at 4 US tons/acre each. Straw to be held down with net should be limited to 1.5-2 US tons/acre, and straw held with a tackifier at 1-1.5 US tons/acre if plant growth is important. Too much straw may smother seedlings by intercepting all light or forming a physical barrier. Also, some grass straw (notably annual ryegrass, *Lolium multiflorum)* may contain inhibitors that have a toxic effect if used in excess. A good rule of thumb is that some soil should be visible if plant growth is wanted. Higher rates of straw may still satisfy these requirements if the straws are vertically oriented (like tufts) by crimping or punching. Excessive straw on the surface may be a fire hazard.

Straw or hay usually needs to be held in place until plant growth starts. The problem is wind, not water. Water puddles the soil around the straw and helps hold it in place. Also, methods of holding straw in place are crimping, disking, or rolling into the soil; covering with a net or wire; or spraying with a chemical tackifier. Swanson et al. (1967) found similar protection from prairie hay applied as a loose mulch or anchored with a disk packer (crimper).

Crimping is accomplished with commercial machines which utilize blunt notched disks which are forced into the soil by a weighted tractor-drawn carriage. They will not penetrate hard soils and cannot be pulled on steep slopes.

Rolling or "punching" is done with a specially designed roller. A sheepsfoot roller, commonly used in soil compaction, is not satisfactory for incorporating straw. Specifications of the California Department of Transportation contain the following provisions (State of Calif. 1975): "Roller shall be equipped with straight studs, made of approximately 7/8 inch steel plate, placed approximately 8 inches apart, and staggered. The studs shall not be less than 6 inches long nor more than 6 inches wide and shall be rounded to prevent withdrawing the straw from the soil. The roller shall be of such weight as to incorporate the straw sufficiently into the soil so that the straw will not support combustion, and will have a uniform surface."

The roller may be tractor-drawn on flat areas or gentle slopes, whereas on steeper slopes with top-of-slope access the roller may be lowered by gravity and raised by a winch in yo-yo fashion, commonly from a flat-bed truck. Requirements are soil soft enough for the roller teeth to penetrate, and access to the top of the slope. This is a common treatment of highway fill slopes in California. It can be used on much steeper slopes than a crimper. Punched straw may not be as effective as contour crimped straw, because of the staggered arrangement of tucked straw instead of the "whisker dams" made by crimping (Barnett et al., 1967).

A variety of nets have been used to hold straw in place: twisted-woven kraft paper, plastic fabric, poultry netting, concrete reinforcing wire, and even jute. Price and the length of service required should determine the product used. These should be anchored at enough points to prevent the net from whipping in the wind, which rearranges the straw.

Perhaps the most common method of holding straw, particularly in the eastern U.S., is use of a tackifier. This method may be used on relatively steep slopes which have limited access and soil too hard for crimping or punching. Asphalt emulsion, the tackifier used most commonly, is applied at 200-500 gal/acre—either over the top of the straw or applied simultaneously with the straw blowing operation. Recent tests (Kay, 1976) have shown that 600 gallons is superior to 400 gallons, and that 200 gal/acre is not satisfactory. Wood fiber, or new products used in combination with wood fiber, have been demonstrated to be equally effective, similar in cost, and environmentally more acceptable. Terratack I is a gum derived from guar, Terratack II is semi-refined seaweed extract, and Ecology Controls M Binder is a gum from plantain, *Plantago insularis.* The remaining products are emulsions used in making adhesives, paints, and other products. Though wood fiber alone is effective as a short-term tackifier, glue must be added to give protection beyond a few weeks. Increasing the rate/acre of any of the materials will increase their effectiveness.

Hydraulic mulching

Hydraulic mulching, or hydromulching, is a mulch applied in a water slurry. This same slurry may also contain seed, fertilizer, erosion-control compounds, growth regulators, soil amendments, etc., and is increasingly popular because of low labor requirements. Mulches must have a particle size small enough for ready pumping through 0.5-inch nozzles, and must not be too buoyant to remain in suspension with moderate agitation. Used most commonly are specially manufactured fibers of alder and aspen. Hemlock, also used, is more difficult to pump. Many recycled paper and agricultural products have been marketed or tested. Among those marketed are office waste, corrugated boxes (PFM), chopped newspaper, and seed screenings. Also tested by the author were whole and ground rice hulls, ground cereal straw, and washed dairy waste.

The most important quality of a hydromulching material is that it must adhere to the soil even on steep slopes and hold the seed in place during heavy rainfall impact and wind. If it fails in those functions, other characteristics (water-holding capacity, appearance, cost, etc.) are not important.

Hydromulching materials have been tested (by the author) by applying them to the surface of greenhouse flats of 13 x 19 in. filled with decomposed granite. The flats were inclined at 45° (1:1 slope) and subjected to artificial rainfall of 3-mm drops falling 15 feet from a 1-inch grid at 6 in. of water/hr. Virgin wood fibers of aspen and alder offered considerable soil protection and were consistently superior to all other products. The only recycled products to approach their effectiveness were the PFM products made from corrugated boxes. One lot of these fibers had been separated on the basis of length, with the shorter fibers being recycled into other paper products. These longest fibers were at least equal to the virgin wood fibers. Tests of commercial PFM products, however, do not always produce such satisfactory results, apparently because they contain a high proportion of short fibers. Commercial materials made of office waste, newsprint, and seed screenings are vastly inferior. These and other recycled materials wash from the slope with the first raindrops. A satisfactory material could probably be made from

Mulches *from page 17*

recycled material if more attention were paid to fiber length.

Working with Mr. Tom Miles of the Oregon Field Sanitation Committee, we found that a satisfactory hydromulch can be made from fibers of grass or cereal straw. Fibrated straw is manufactured by presteaming chopped straw and refining this through rotating close-tolerance discs and drying. Tests show that the process effectively eliminated the allelopathic (germination-depressing) characteristics of ryegrass straw. Fibrated rice straw also makes a satisfactory hydromulch, more resistant to raindrop impact than fiber made from ryegrass.

Fiber testing has been for characteristics which protect the soil surface and hold the seed in place. However, these same characteristics may hold the seed and prevent them from readily falling into natural depressions in the soil where they can become covered with soil. Under these soil conditions it may be better to use very little fiber, or even no fiber. The unsatisfactory products mentioned above may, under these circumstances, result in a better grass stand than using a quality fiber. The best choice would be to broadcast seed or drill first and then cover with a quality hydromulch.

Another important property of mulch is its moisture-holding characteristics. A standard procedure for measuring this characteristic has been developed by the California Department of Transportation (Hoover 1976). In general, products with the longest fibers and best slope-adhering characteristics also have the highest moisture-holding capacity.

Commercial fibers are usually dyed with a fugitive green dye which lasts only a few hours or days. This visual aid assists in obtaining an even distribution on the slope.

Rates of hydromulch vary from 500 to 3,000 lb/acre. The rate of 500 lb/1,500 gal. water is suggested as necessary to disperse seeds evenly in the slurry, and to protect seed in passing through the centrifugal pumps commonly used in hydraulic seeders (Kay, 1976). This would cover one to three acres, with best coverage on one acre and possible distribution problems if used on three acres. A minimum of 1,000 lb/acre is necessary to hold the seed on a slope. An inconsistent "mulch effect" has been observed with less than 1,500 lb/acre. Currier (1970) expressed some concern that "60-70% of the seed hangs up in the mulch and has little or no chance to get its primary roots into mineral soil." Studies with wood fiber (Kay, 1973) showed that under conditions of adequate moisture, small grass seeds such as Durar hard fescue could emerge through as much as 9,000 lb and readily emerge from between two 1,000-lb layers. Placing the seed on top of 2,000 lb speeded emergence and total ger-

Summary of methods and costs of common erosion-control practices.

Treatment	Comments	Pregermination erosion effectiveness*	Effectiveness on plant establishment*	Approx. cost per acre $**
1. Seed and fertilizer broadcast on the surface, no soil coverage or mulch.	Inexpensive and fast. Most effective on rough seedbeds with minimum slope and erodability where seed will cover naturally with soil. Suitable for remote or critical areas where machinery cannot be taken.	1	1-4	250
2. Hydroseeding or hydromulching (seed + fertilizer) with 500 lb. wood fiber, 1,500 gal. water/3 acres.	Similar effectiveness to broadcasting seed and fertilizer. Not enough fiber to hold seed in place or produce a mulch effect. Seed distribution would be improved by increased volume of water.	1	1-4	250
3. Seed and fertilizer broadcast and covered with soil (raking or dragging a chain, etc.).	Does not require special equipment. Generally a very effective treatment. Labor cost is high on areas not accessible by equipment.	1	3-4	320
4. Hydromulching with 1,500 lb./acre wood fiber (plus seed and fertilizer).	Most common hydromulch mix in California. Advantages include holding seed and fertilizer in place on steep and smooth slopes where there may not be an alternative method. Only a minimal mulch effect. Cost is much higher than 2.	2	3-5	425-520
5. Hydromulching with 1,500 lb. woodfiber plus an organic glue: Ecology Control, Terra-tack III etc. plus seed and fertilizer.	The addition of an organic glue will sometimes improve fiber holding and germination. Does not increase labor or machinery cost.	2 +	3-6	550-650
6. Hydromulching with 2,000-3,000 lb./acre wood fiber plus seed and fertilizer.	Produces a true mulch effect and some erosion protection. Commonly better results than 1,000 lb. fiber or fiber plus glue.	2-3	4-7	530-750
7. Seed and fertilizer broadcast and covered with soil as in 3 above, but followed with hydromulch of wood fiber at 2,000-3,000 lb./acre.	Very effective, combine advantages of seed coverage and mulching.	2-3	6-8	680-865
All of the above treatments offer only minimal protection from the impact of raindrops and water flowing over the surface, but are all weed free.				
8. Straw or hay broadcast with straw blower on the surface at 3,000 lb./acre and tacked down (asphalt emulsion, Terratack II, etc.). Seed and fertilizer broadcast with hydroseeder or by hand.	Common elsewhere in U.S. Very effective as energy absorber, mulch; and straw forms small dams to hold some soil. May be weedy depending on straw source. Not for cut slopes steeper than 2:1. Cost would increase significantly if slopes over 50 feet from access, or application is uphill.	5-7	8-10	650
9. Straw broadcast 4,000 lb./acre rolled to incorporate (punched) another 4,000 lb. straw broadcast and rolled, seeded and fertilized. Seed and fertilizer broadcast with hydroseeder or by hand.	Common on difficult fill slopes in California. Very effective. Not possible on most cut slopes. Very weedy. Cost would increase significantly if slopes over 50 feet from access.	6-8	8-10	877-1070
10. Roll-out mats (jute, excelsior, etc.). Held in place with wire staples. Seed and fertilize as in 1 or 2.	Some are a good mulch, weed free, adapted to small areas. Can be installed any season, cuts or fills. Unsightly. Difficult to install on rocky soils.	5-7	5-10	2400-2700
11. Polyethylene sheets. (4 mil) Seed and fertilize as in 1 or 2, use clear plastic, black if no seed is used.	Useful for temporary control. Can be installed any season. Unsightly, wind is a problem in installation and maintenance. May be difficult to establish plants.	10	?	2400-2700
12. Seed and fertilizer broadcast, or hydromulched with fiber (treatment 2 or 4), followed by erosion control chemical such as polyvinyl acetate at 6:1 dilution (6 parts water) at 1,000 lb. solid/acre (approx. 200 gal. PVA).	Very expensive, but will hold soil and seed in some very difficult conditions. May restrict penetration of water into soil. Will not cure below 55°F. Not effective on soils which crack. Will not support animal or vehicle traffic.	10+	?	1070-1370

* 1 = minimal, 10 = excellent.

** Assumes seed plus fertilizer $150.00, fiber $150/con. Ecology Control $1.25/lb., PVA $3.00/gal., 1,500 gal. hydroseeder with 2 man crew $55.00/hr., labor $13/hr., straw $50/T, straw mulcher with 4 man crew $64/hr. (applies 2 T/hr.) and markup of 30% for overhead (including equipment depreciation), and profit. Cost figures were derived from conversations with contractors, and by review of recent Caltrans contracts.

From: Kay, B. L. 1976. Hydroseeding, straw, and chemicals for erosion control. Agronomy Progress Report No. 77. Agronomy and Range Science Department, UCO. Mimeo. 14 p. June.

mination of orchardgrass and did not reduce emergence of any of the other five species tested.

Under conditions of limited moisture, created by applying the mulch over seed broadcast on greenhouse flats filled with various problem soils, inclining the flats at slopes of 1:1, 1.5:1, or 2:1 (horizontal to vertical measurement) and exposing them to natural rainfall yielded the data in Table 2. On the steepest slopes (1:1 and 1.5:1), 1,000-2,000 lb of fiber was necessary to hold the seed in place. Without that amount, no seedlings were established. On the flatter 2:1 slope, the 1,000-lb rate did not improve the stand whereas 2,000 lb did. Increasing the rate to 3,000 lb increased the number of seedlings on the most severe test with either decomposed granite or fine sand. In recent tests by the author near Lake Tahoe, California, 4,500 lb resulted in good grass stands, while 3,000 lb produced only a few seedlings, because of excessive frost heaving.

Wood fiber is an essential addition to most hydraulically applied chemicals, including straw tackifiers. Many soil-binding chemicals will not hold seed, fertilizer, or straw to a slope unless wood fiber is included.

Wood Residues

Wood residues (woodchips and bark) can be used effectively if locally available as a waste from the forest-products industry or chipped on the site during land clearance. Smaller wood-residue particles, such as shavings or sawdust, would be subject to wind loss. Woodchips and bark can be applied with a conventional straw-blower to a distance of 18 m. (Emanuel 1971). The rate must be twice that of straw to obtain the same soil protection (Meyer et al., 1972) or even as much as 6 times the straw rate (Swanson et al. 1965). Observations in California indicate that uneven distribution often results in poor or no plant establishment in the heavier (100% ground cover) applications.

Fabric or Mats

Fabric or mats, including jute, exelsior, and woven paper or plastic fibers, are provided in rolls to be fastened to the soil with wire staples. Fiberglass roving (which is blown on with compressed air and tacked with asphalt and emulsion) is also available as a nonbiodegradable substitute. Use of these products is limited by their cost and effectiveness. The rolls require high labor inputs for installation, cost at least four times as much as tacked straw, and are not adapted to fitting to rough surfaces or rocky areas. Erosion from beneath these products is common because they do not have intimate contact with the soil. They must be heavy enough or anchored in enough spots to prevent wind whipping. Several reports indicate they are not as effective as straw (Springfield, 1971). They have the advantage of being weed-free but may be unsightly, a fire hazard, or (in some cases) nonbiodegradable or too rapidly biodegradable to be effective. Dudeck et al. (1970) found excelsior mat or jute to yield the best seedling grass of eleven mulch treatments tested. Swanson et al. (1967) found jute, excelsior, and prairie hay or fiberglass anchored with asphalt emulsion to be the best of all treatments.

Mats would be used only on small areas, such as to repair failures of other treatments, where time and cost factors are of secondary importance. They should be maintained, repairing tears, etc., before wind or water can cause extensive damage.

CHEMICALS

Chemicals to be used as a mulch, humectant (a substance that absorbs or helps another substance retain moisture), or soil binder are usually applied in a water carrier or as part of a hydraulic seeding slurry. They are expensive and very specialized, and must be used correctly for maximum effectiveness. They are not substitutes for sound agricultural or engineering practices, regardless of glowing advertisements. Products are discussed here as either fiber tackifiers (including humectants) to be used as part of a seeding, or plastic emulsions which may be used with a seeding or alone as a soil binder.

Fiber Tackifiers

Fiber tackifiers are generally advertised to hold fiber in place, promote germination, hold moisture, and retard erosion. Most sales literature acknowledges that fiber should be used with the product. Within this group we have tested Ecology Controls M-Binder, Kelgum, Terratack I, Terratack III, Styrene butadiene, Super Slurper, PVA, and Verdylo Super.

Although virgin wood fibers as a hydraulic mulch adhere well to slopes without the addition of glues or tackifiers, interest continues in products which would improve their resistance to wind or rain. Of the variety of products previously tested, only a few improved the fiber characteristics, and then only slightly or inconsistently. Most products do make the slurry easier to pump, allowing the addition of more fiber/load.

Most existing products are sensitive to fertilizer. Adding 16-20-0 ammonium phosphate-sulfate at 500 lb/acre to 1,500 lb of wood fiber greatly reduced the effectiveness of Terratack III (an alginase), Ecology Controls M Binder (husk of *Plantago insularis*), PVA (polyvinyl acetate homopolymers or vinyl acrylic copolymers), Super Slurper, and SBR (styrene butadiene). These and all following tests involved applying treatments to greenhouse flats, inclining the flats at 1:1 after curing, and exposing them to artificial rainfall of 3-mm drops at 6 inches/hour.

Two new products promise to be much more effective than those previously tested. The two products are of very different composition, an improved SBR (styrene butadiene), and Super Slurper, an absorbent polymer made from starch. Several SBR Products are sold for erosion control. The available SBR products differ considerably in pH (acidity) and can therefore be expected to perform quite differently. The product tested in the current studies is XFS 4163-L Dow mulch binder, a liquid which utilizes a dry powder modifying agent (methyl cellulose). Super Slurper, a USDA patent, promises to have many uses. This dry powder is reported to be able to absorb up to 1,000 times its weight in water. The sample tested is SGP absorbent polymer from General Mills.