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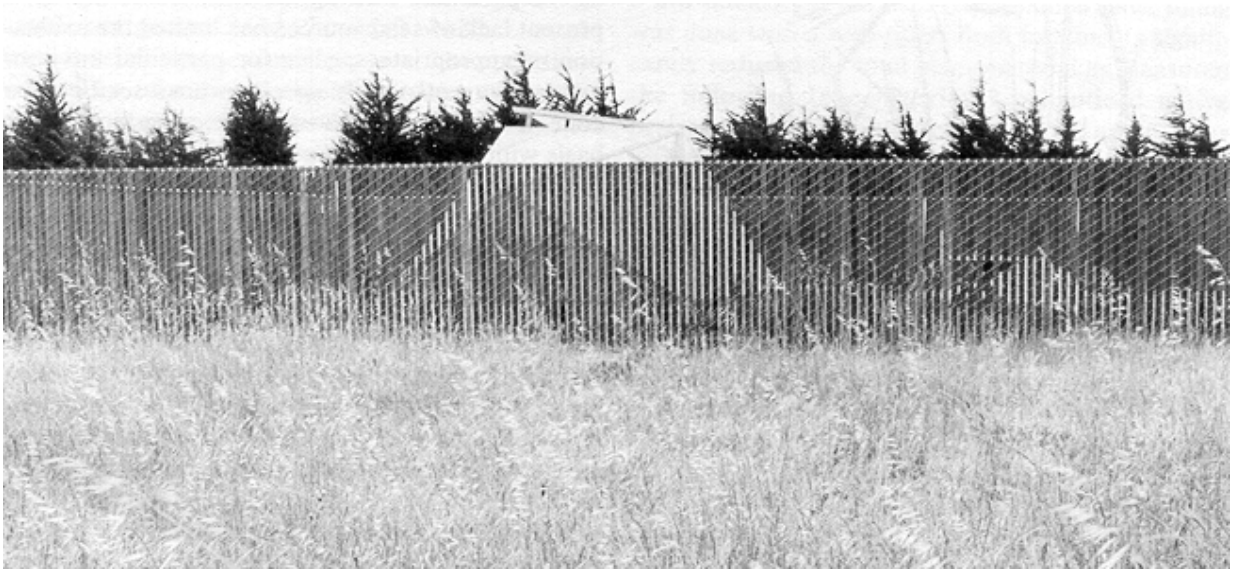
NOTES ON PLANTING AND MAINTENANCE OF BUNCHGRASSES

by Dennis Rogers

The organization I am associated with, Design Associates Working with Nature (D.A.W.N.), became involved with native perennial bunchgrases as a solution to landscape design problems for the City of Berkeley's ninety-acre North Waterfront Park converted from a city dump. After being awarded a contract for propagating native plants that are hard to obtain in the landscape trade, we became concerned with their ability to compete with conventional groundcovers. People of the community had expressed a demand for both native plant communities and recreational activities within the same park. My experience in turf maintenance with Berkeley's Park and Recreation Department showed me that aggressive grasses like Kikuyu (*Pennisetum clandestinum*), carried by mowing equipment, could overrun nearly the entire city parks system. We knew that we had to keep Kikuyu out of the North Waterfront Park, but we needed a tough substitute that would stand up under at lease a moderate amount of traffic, while at the same time not overrunning the restored native plant communities. This substitute grass also had to do a good job of resisting weed invasion and be cheap to install and maintain.

My own ten years experience in growing both exotic and native grasses and an intensive period of research in 1979 convinced me that native bunchgrasses could be the buffer between recreational grasses and native plant communities. Preliminary maintenance studies and cost analyses suggested that careful selection of high-use recreational turfgrasses for compatibility with native bunchgrasses, along with adaptation of range-management techniques, could lower the usually exorbitant park development and maintenance costs to agricultural levels. For example, we found in 1979 that a popular groundcover like ice-plant (*Mesembryanthemum* spp.), compete with the required underground irrigation system, costs $23,180 per acre (on any site) to install, but that native bunchgasses with temporary portable aluminum irrigation cost from $630 to $3000 per acre to install (depending on site conditions and the acreage involved). Maintenance costs for ice-plant were $1000 per acre per year compared to $410 for bunchgrasses.



The growing compound of D.A.W.N. in Berkeley surrounded by a sea of wild oats and other Mediterranean annuals. Photographs by David Amme

We began growing native bunchgrasses for the City of Berkeley at our growing grounds and greenhouse compound at the Berkeley Marina in early 1980. After starting them indoors in flats, we transplanted the seedlings to experimental beds where we are currently monitoring both weeds and bunchgrasses. This year we will expand our experimental efforts to an acre site at the Marina so that we may test various techniques of establishment and maintenance. The City of Berkeley park design staff is interested in the possible application of techniques to large areas in the North Waterfront Park.

Principles of Bunchgrass Establishment

Like exotic turfgrasses and groundcovers, native bunchgrasses require specific techniques of establishment and maintenance and careful and detailed planning. Detail is the crux of the matter. The better we know the site, the better our chances of success will be. The "rules" must be bent or even broken at times. But the principles upon which the rules are based remain constant.

Success in establishing bunchgrasses requires a working knowledge of the basics of seed germination and seedling survival that are common to all groundcovers. Assuming sufficient seed supply, the main factors to be considered are: 1. rainfall and temperature, 2. light, and 3. soil-surface or seedbed conditions. In respect to seedbed conditions, the important factors are: a. moisture retention, b. hardness or compaction, and c. available nitrogen.

The combination of these factors determines which plants will become established on a site most easily and which will have the advantage in competition with other. Thus, as a general rule, forbs (broadleaf herbs) germinate best when soil surface is hard, bare, and infertile, with lots of light—what could be described as the "poor seedbed" side of a scale of variables. There is reason for this. Forb seeds are often small in comparison what most grass seeds; lumps of soil or heavy litter that afford good cover and moisture-retention for grasses may bury forb seeds too deeply. Since most forbs that associated with grasses are more or less intolerant of shade, they survive better where there are few competing faster-growing and taller plants. Thus when soils are "disturbed" by the removal of vegetation, forbs are among the first invaders-or pioneers. Because bare soil lacks good surface litter or mulch, there may be little available nitrogen in the seedbed, as in infertile, sandy soils. Therefore nitrogen-producing legumes—lupine or clover, for example-often invade these areas first.

Annual Grasses

On the other end of the scale are conditions favoring the annual grasses. They are usually heavy nitrogen users and do not easily establish themselves on hard or sandy, bare areas devoid of decomposing litter (i.e.. nitrate form of nitrogen). Without adequate cover their larger seeds dry out or are eaten by rodents and birds. They require mulch or small-clod cover for good moisture retention. These requirements describe the "good seedbed" extreme of the scale—soft, with a large amount of surface mulch, and high content of available nitrogen, allowing the rapid establishment of fibrous-rooted annual grasses with the first inch or so of fall rains. Annual grass seeds prefer relatively warm temperatures for germination, and if rain doesn't come until late November or early December, cooler temperatures will favor establishment of broadleaf forbs. But if rains are early (and they usually are) and there is a good seedbed, the annual grasses will quickly overtop most forbs and shade them out.

Native perennial bunchgrasses occupy a middle position on the seedbed spectrum, but this may not have always been the case in California. As in the Great Plains, native bunchgrass prairies probably occupied deep and fertile valley soils. But with the dominance of Mediterranean annuals, the competitive situation is running against native perennials. Careful manipulation of seedbed conditions will be necessary to turn the tide on any given site. Seedbeds should be neither too good nor too poor, so as to allow the perennial native grasses to compete successfully.

Pre-seeding Weed Control — Tilling

The obvious first step is the elimination of as many undesired forbs and grasses as possible before the planting of seeds. The means we select to accomplish this should leave the seedbed in a state which will discourage further weed invasion. We will consider 1. tilling or cultivation 2. herbicides 3. fire and mowing or grazing.

Cultivation destroys annual weeds before they go to seed, but in the process exposes a whole new crop of seeds to light and germination with the first moisture. Repeated shallow cultivation (no deeper than four inches) over the entire rainy season would be necessary to bring up most of the weeds in the soil. This method is highly inefficient for large areas since it requires year-long intensive weed control work, and on sloping sites it exposes good topsoil to severe erosion. Operating heavy equipment on moist soils creates soil compaction problems just below the surface (plough-layer), which may favor broadleaf forb invasion later. Tilling is best left to small backyards, vacant lots or experimental test plots. The major disadvantage of tilling is that it leaves a seedbed with plenty of light for broadleaf invasion, while it provides a fallowed, soft, cloddy surface (with more available nitrogen), favoring annual grasses. In fact, grain farmers have found a year-long fallow period to be useful in boosting grain (i.e. annual grass) production. Tilling is especially not recommended where perennial weeds are dominant. The perennials simply come back from roots and rhizomes, and worse, they may be spread by the cultivating equipment to new areas on the site.

Herbicides

While herbicides are a faster and cheaper means of weed control than tilling (especially on perennials), most must be ruled out because of high residual toxicity. It should be noted that cultivation practices can lead to increased use of phenoxy herbicides like 2,4-D if the increased light assists establishment of broadleaf weeds within the following season's bunchgrass crop. By contrast, pre-seeding treatment with a far less toxic herbicide like Glyphosate will leave natural mulches and litter on the soil surface, and so retard broadleaf invasion. Selective herbicide use may be the only practical answer for medium-to-large sites where perennials like Kikuyu, Bermuda, or Johnson grass are in dominance. The only relatively safe herbicide that I have found to be effective on both annuals and perennials (especially grasses) is Glyphosate ("Roundup" by Monsanto; "Kleen-up" by Ortho). It is inactivated within a few days. I have seeded within forty-eight hours after applying Glyphosate with no resulting mortality. There are risks here too, but on balance, it seems to me that it is better to use Glyphosate once or twice and get most weeds before seeding than to use the wrong cultural alternative (tilling), which may encourage weed increase after seeding, and lead either to project failure or repeated dosages of more toxic

phenoxy herbicides later. If there already are bunchgrasses on the site, rake away dead thatch of annuals in late fall or early winter and cover temporarily while spraying. The main advantage of herbicide use is that it leaves the seedbed undisturbed and thus improves our ability to control the seedbed so that perennial bunchgrasses will be favored.

Mowing or Grazing

Where the competition is mainly from annuals, mowing or grazing may afford adequate pre-seeding weed control. The object is to prevent the current season's weed crop from setting seed. Repeated mowings at low heights (or close grazing by herbivores) may be necessary because many annual grasses and forbs produce seedheads very close to ground level. The disadvantage of mowing controlled grazing is that many seeds already on the ground will germinate the following season, and low-growing light-lovers like Poa annua, foxtail, and purslane will continue producing prodigious amounts of seeds anyway. This drawback may be partly offset by leaving a heavy litter of clippings on the ground' thereby reducing light. If there are relatively few annual grasses already on the site, this approach may favor the bunchgrasses because of increased surface mulch. If annual grasses are the weeds, clippings should be picked up. Mowing is highly dependent on the nature of the competition. And, as with tilling, use of heavy equipment may create soil compaction problems and new weed species later.

Stipa pulchra plants in gallon cans in the greenhouse

Fire

Controlled burning overcomes some of the limitations of mowing because fire destroys seeds on the ground as well as weeds of all heights. In addition, adequate weed control may be accomplished with only one burn in late summer or early fall (or later if amounts of combustible materials are dangerously high). Large acreages can be handled cheaply and safely. Moreover, if there are already a lot of perennial bunchgrasses on the site, fertile tillering (the production of flowering culms or stems) will be stimulated by the burn and will result in increased seed production the following season. The major disadvantage of fire is that the seedbed is modified. Surface litter, which burns up along with weed seeds, benefits bunchgrasses as well as annual grasses; and increased light favors broadleaf weed establishment. Thus, while fire benefits already established bunchgrasses, it is a mixed blessing.

We could recommend burning as a pre-seeding weed control technique (where it is allowed) on predominantly annual-grass sites, especially where there are already a large number of native bunchgrasses or desirable native forbs and wildflowers. The complete burning of the surface litter and consequent reduction in the amount of available nitrogen on the soil surface should check annual grass reinvasion and favor the spread of native bunchgrasses. Also, on soils heavily disturbed by rodent tunneling, fire may be the only practical way of controlling constant weed invasion. D.A.W.N. recently received permission in principle from the San Francisco Parks and Recreation Department to use controlled burns at Bernal Heights hilltop as a management tool in a heavily rodent-infested annual grassland which also supports a large number of perennial bunchgrasses and native wildflowers.

One or more of theses pre-seeding weed control measures may be necessary, depending on the nature of the competition. For example, treatment with Glyphosate maybe required after a fall burn has germinated a new crop of perennial broadleaf weeds that a temporary seeding with tall annual grasses will not control. Or, mowing may have to substitute for burning if fires are illegal. Then, on sites where there is a good general mix of annuals and perennials, grasses and forbs (without many native perennials), we could proceed thus: Allow enough time for both winter and summer annuals to germinate and spray with Glyphosate, probably up to three spaying; when temperatures are still moderate in late fall or early spring; in mid-late spring; and in early summer. Then in late summer mow down to three- to four-inch stubble and pick up all clippings, leaving just enough old mulch on the surface to cover the bunchgrass seeds adequately; and finally, allow the first one inch of rain in the fall to bring up any remaining slow-to-germinate weed seeds or new ones since blown into the seedbed, and spray once more with Glyphosate before seeding the bunchgrasses.

Seeding

When and how to seed? Seeding time and method will vary according to the weather, size, and slope of the site, whether or not artificial irrigation is available, what means of pre-seeding weed control was used, and the nature of the competition. The important thing to remember is that the seedbed should be left in a condition after seeding which will favor bunchgrasses over their competitors. Here are the essentials:

1. The germination period for perennial bunchgrasses is usually long and irregular, with seedlings coming up after annuals are already established. Late spring water (rains may fail) may

be critical for establishment the first year, especially in sites away from the immediate coast and at lower elevations. Therefore, seed late enough for adequate weed control, but not so late that there won't be warm enough temperatures for germination or enough time for establishment before the beginning of our summer drought (probably October-December).

2. The seeding method chosen should not disturb the seedbed any more than is necessary to imbed the seed firmly in the top inch or less of soil. Good soil-seed contact with a tight, firm (but not compacted) soil surface will ensure adequate moisture retention over the long germination and establishment period of the bunchgrass. Where large acreages are involved, range-drilling is probably closest to an ideal situation. Range drills can be used on even very rough terrain to drill seed into the soil at very precise depths and intervals, thus ensuring good seed cover with minimum seedbed disturbance. It costs about $100 per acre, including seed and fertilizer. Because of the precise placement of seed, seeding rates are very low compared with hand broadcasting or hydroseeding. Nitrogen fertilizer may be used to increase bunchgrass growth avoid cultivation that loosens dry soils in order to receive the drills, seeding should be done when there is just enough moisture to soften soils for drilling, but not so much that compaction problems may develop. If any cultivation is required, then the range drill should be used with a cultipacker to firm up the soil surface. This is particularly important where annual grasses are the main competition.

Hydroseeding is the next cheaper seeding method (1,500 per acre with a $500 minimum for small areas). A slurry of wood-cellulose fiber, chemical stabilizing agent for holding on steep slopes, seed, and fertilizer is shot at high pressures onto the ground. The main disadvantage is that the wood-cellulose-fiber mulch created an excellent seedbed for all seeds on the soil surface by holding moisture and nitrogen throughout the growing season. Thus the competition—especially annual grasses—benefits as much as the desired plant species. Also, this mulch breaks down slowly, so that it is often still on the ground at the beginning of the next growing season, creating a barrier which prevents good seed-soil contact. The germinating seed then dries out and dies. Recommended seeding rates should be doubled for hydroseeding because up to 50% of the seeds can be stranded, and dry out, on the outside surface of the mulch, or be lost in the mixing tank.

The most expensive seeding method for large areas is hand-brodcasting. It is expensive mainly because hand-labor is required to rake in and cover the seed. But it may be the only practical way to seed bunchgrasses in small areas. To minimize soil disturbance, seed should be broadcast into three-to-four-inch stubble with a light mulch left on the soil surface. About 30% to 40% of the soil surface should be opened by raking away stubble and litter, taking care not to rake any deeper than about half an inch. Time should be allowed for the first rains to bring up and kill weeds that have germinated because of the increased light. After the seed has been broadcast on the surface, it should be lightly raked in. Then the soil surface should be firmed by pressing the seed in with the feet. Finally, cover the seeds lightly with the same litter which you previously raked away. Add a little more for steep areas. Don't use any nitrogen fertilizer on the ground with the seed. Later you can use a foliar nitrogen spray on just the bunchgrasses. Remember that recommended seeding rates are often geared to the economics of large-scale seeding projects. For small areas always double or triple the recommended rates. Add still more seed for steep areas. Don't let the seedbed dry out once germination begins.

The First Year

Weed control techniques during the establishment period—roughly the first year after seeding—have to be coordinated with the natural growth cycle of the bunchgrasses. Fertile tillering (the production of culms or stems for later seed production) occurs in the fall, while vegetative tillering (growth of the individual bunchgrasses) happens in the early spring. Grazing to promote vegetative tillering cannot be used at this point because the bunchgrasses are still too young to stand even moderate clipping. Fire for fertile tillering must be ruled out until there is enough dry fuel to carry it. Also, the young plants may be too sensitive to survive fire the first year. Herbicides have a limited use, mainly for spot treatments of hard-to-kill perennials or brush, but care should be taken to protect the young sensitive plants from spray drift.

Mowing is probably the best means of weed control during the first year after seeding. Mowing (unlike grazing) can be controlled and timed to fit in with the natural growth cycle of native bunchgrasses. The first mowing after seeding should be done in early spring when soil moisture conditions allow. It should be just low enough to cut the tips of the young bunchgrasses, which will start to respond with new growth a littler earlier and fill up space which would otherwise be occupied by the competition. If the terrain is too rough for this kind of fine-tuned mowing, the first cutting should be done a little higher. In either case, the object is to clip off the taller annual weeds so that the bunchgrasses will have the necessary light to grow rapidly. All subsequent spring mowings should leave the bunchgrasses unclipped. Clipping height should be adjusted so that as many seedheads and rank growth of annual weeds as possible can be cut, but enough high stubble left to shade the soil surface and provide some late-spring moisture for the bunchgrasses. The bunchgrasses will need good top growth to make enough root growth to survive their first five-month drought.

Since the bunchgrasses will remain low throughout their first growing season, the first year is about the only time that repeated spring mowings can be made low enough to put a dent in the annuals' seed production and still high enough to spare the bunchgrasses after their one first light clipping. During the second spring the perennials will be too high to allow more than one required early growth-stimulating mowing. Fertile tillering will be well along by spring and any mowings done too late may retard bunchgrass seed production. This is why the pre-seeding weed control program is usually critical to project success. This is especially true in very fertile soils which favor rapid annual grass growth.

If good spring rains fail, and if seeding was late in the season, artificial irrigation may be necessary to ensure establishment. For larger areas this may mean the use of temporary portable aluminum agricultural-type irrigation systems($350 per acre per month rented). For medium-sized areas, quick-couplers may have to be installed for easy hose impact-head hookup. Late spring water will also benefit other perennials as well as summer annuals. Therefore further spot weed-control may be required.

The second bunchgrass mowing of the establishment period should be made in late summer, and should be timed to clip summer annuals before they go to seed. The main reason for this late mowing is to stimulate fertile tillering and knock off any persistent bunchgrass seedheads. This mowing simulates the natural grass fire of late summer or early fall which regenerates the bunchgrass population. Later on in the maintenance period (second growing season or later), when broadleafs are under control and fuel buildup is occurring on the soil surface, fire may be used from time to time to stimulate seed production.

Whether or not we pick up the mowing clippings the first year depends mainly on the competition. If broadleafs are in predominance, then the clippings should be left on the ground; if annual grasses, then the clippings should be picked up. For large areas this can be done with a hay-mower swather combination. A vacuum-sweeper or bristle-sweeper may be used the first season but not the second because it will also pick up bunch grass seeds.

Maintenance Period

The two mowings mentioned above, or fire and mowing combination, may be used annually for growth, seed production, and weed control. Clipping pickup may be necessary. The object is to maintain an intermediate level of surface litter or mulch (1000-3000 lbs. per acre)—enough to cover seed and retain moisture and nitrogen for establishment and suppress broadleaf invasion; but not enough to generate too much nitrate nitrogen which will favor annual grasses (3000-6000 lbs. per or more).

Fire and mowing or grazing are complementary management tools, and all may be used in one season. After the first year or two, bunchgrasses may be grazed moderately in early spring and later in early summer after seeds have set. This will substitute for mowing and picking up of clippings. Fire will destroy the most mulch, and for this reason is especially useful on annual grass sites. Fire on broadleaf and brush sites may require a long follow-up period of spot herbicide treatment or hand-weeding. Annual re-seeding with bunchgrasses will probably be necessary for the first few years.

It has always been encouraging to me to observe how well perennial bunchgrasses, once established, resist further weed and brush invasion. Although better soils will produce better growth and better resistance to weeds once the annual competition has been controlled, bunchgrasses will also do good weed control work on low fertility of droughty sites. This is probably due to a very extensive and efficient root system which forms a formidable barrier to seedling establishment. Perennial bunchgrasses have a longer growing season than most of the competition. They start growth with the first ¼”- ¾” of moisture ahead of winter annuals and stay green long after most weeds have set seed and died. And they maintain themselves for decades with no additional fertilizer or water, supplying their own nutrients from decomposing roots, and maintaining good tilth and long-term nitrogen reserves through build-up of organic matter in the soil.