distinguished from taste. The perception of particular tastes is restricted to definite areas of the tongue surface and epiglottis, whereas astringency is perceived over all the oral mucous membrane. Astringency differs from taste in that the threshold for perception is much greater. Previous investigators had reported that the relative astringency of substances could be determined more easily by the use of powdered preparations rather than a solution of these compounds. This is substantiated by the high concentrations of tannin (100 mg and over/100 mls) required to be detectable in wines and fruits. In contrast, leucodelphinidin from the carob bean and persimmon was astringent at 20 mg per 100 mls. Astringency again differs from taste in the time lag for perception; a longer delay than in the perception of taste and considerably longer than the familiar autonomic reflex.

Combination

Many investigators have suggested that the astringency caused by the ingestion of unripe fruit is due to the combination or binding of their phenolic compounds with the protein or mucopolysaccharide of the mucous membranes or saliva. This suggestion was made by analogy between the relative astringency of vegetable tannins and the ability of these compounds to convert animal hide into leather. The physico-chemical basis for the tanning reaction is the cross-linking of the keto-imide group of adjacent protein chains by the aromatic hydroxyl groups of the tannin, due to hydrogen bonding. For this reaction to occur, the tannin must be of the correct molecular size to cross-link adjacent collagen fibers, and there must be a sufficient number of free phenolic hydroxyl groups to achieve attachment at several points. Ionic bonds may be formed between any charged substituent, in addition to hydrogen bonds, for example between a carboxyl group and an amino group, such as occurs in lysine.

Sensation

It has not been demonstrated that the sensation of astringency perceived in the mouth is due to the combination of plant phenolic compounds with the oral mucopolysaccharides or proteins. The degree of astringency of pharmacological preparations, however, is traditionally determined by tests depending on the ability of astringents to bind or shrink protein, for example, inhibition of haemolysis of erythrocytes, permeability changes, and changes in elasticity or volume.

The dry puckery sensation perceived in the mouth is not an isolated sensation but is part of a more general syndrome. It is experienced by people suffering from *diabetes insipidus*, it occurs in conditions of severe thirst, alcoholism, or it can be induced by the action of certain drugs, for example, atropine. These observations make it likely that the sensation of astringency is part of a general physiological reaction, perhaps similar in mechanism to pain.

The tongue and oral cavity are innervated by the andrenergic nerves of the sympathetic nervous system and the cholegenic nerves of the parasympathetic system. The sympathetic nerves secrete the catecholamines, adrenaline and nor-adrenaline. These catecholamines are known to be methylated in the 3^1 position on liberation into the cytoplasm, and their biological function is thus modified. The enzyme involved is an O-methyl transferase which requires S-adenyl methionine as the methyl donor and Mg^{++}. It was found that *in vivo* pyrogallol acted as a competitive inhibitor to this system. Phenolic compounds of a leucoanthocyanin nature, containing catechol or pyrogallol nuclei, are believed to be responsible for astringency in unripe fruit. It is likely that astringency is caused by the build-up of the catecholamines in the cytoplasm because the extraneous phenolic compounds have been preferentially methylated.

Aqueous extract

It was found that the dry puckery sensation caused by an aqueous extract from persimmon, *Diospyros kaki* L. and carob bean, *Ceratonia siliqua* L. (containing 0.5 mg/ml leucodelphinidin) could be removed by rinsing the mouth out with a methionine solution (5 mg/ml) whereas water or glycine was without effect. However, if the astringent solution was mixed with methionine prior to tasting, the degree of astringency was only depressed by one unit on an arbitrary one-to-five scale.

These observations are in agreement with the hypothesis that astringency is a general physiological phenomenon similar to pain, and hence may involve an adrenergic mechanism.

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CHEMICAL

Perennial

C. M. MC KELL • B. L. KAY

Results of this study indicate that certain herbicides may be used to reduce soil-moisture depletion by weedy plant species and thus insure good stands of grasses, even when seeded in seasons of low rainfall. Vigorous grass plants are more likely to result if soil-moisture reserves are high at the time of seeding.

ONE OF THE most crucial factors limiting the establishment of perennial grasses in areas of low precipitation is the competition for soil moisture from competing vegetation at the time of seeding. After removal of sagebrush by fire or mechanical means, weedy annual grasses offer such intense competition that attempts to establish seeded species may be unsuccessful. Most of the weedy annual grasses, including such species as cheatgrass (*Bromus tectorum* L.) and medusahead (*Taeniatherum asperum* (Simk.) Nevski), are low in desirability as forage species during some periods of the year.

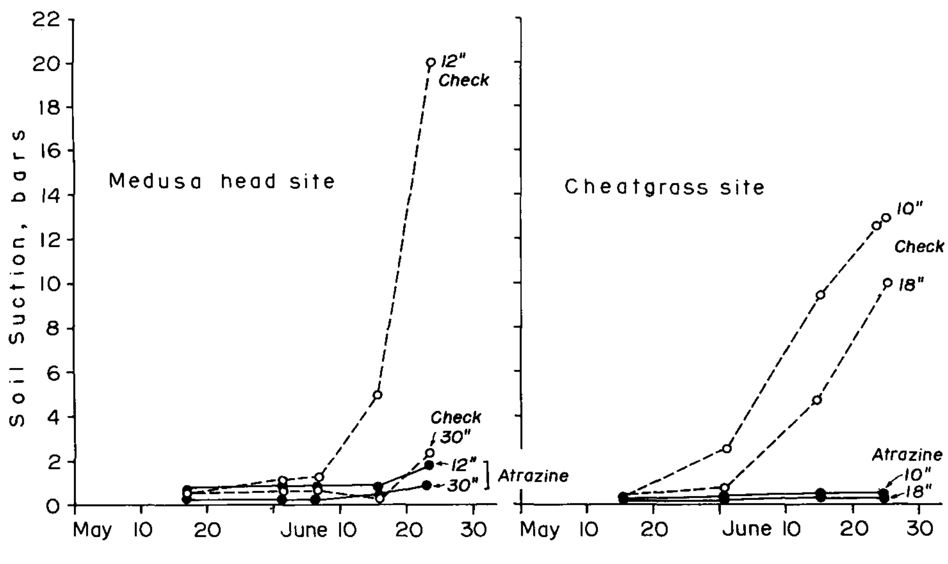
From earlier work with herbicides to reduce competition during seedling establishment, three materials were chosen for these tests: ethyl *N*, *N*-di-*n*-propylthiolcarbamate (EPTC), 2-chloro-4, 6-bis (ethylamino)-*s*-triazine (simazine), and 2-chloro-4-ethylamino-6-isopropylamino-*s*-triazine (atrazine). This field study was conducted in 1959–60 in Modoc County in two locations formerly occupied by sagebrush (*Artemisia* sp), but presently dominated by medusahead in one and cheatgrass in the other. Three rates of each herbicide, replicated four times, were applied as a water spray to 10×20 ft plots on September 3. A rain of 0.64 inch had occurred on August 20.

In the medusahead location, the number of replications was doubled and half the treatment areas were harrowed to incorporate the herbicides as a comparison with surface application. Gypsum electrical-resistance blocks were buried at 12 and 30 inches (in the cheatgrass site, blocks were buried at 10 and 18 inches)

FALLOW AIDS

Grass Establishment

SOIL-MOISTURE DEPLETION ON PLOTS TREATED WITH PREEMERGENCE HERBICIDE ATRAZINE



in the plots treated with high rates of EPTC and atrazine to allow a check on soil-moisture depletion. Plots were drill-seeded with Topar pubescent wheatgrass (*Agropyron trichophorum* (Link.) Richt.) on March 4 in the cheatgrass location and April 18 in the medusahead location. Accumulated rainfall during the season prior to seeding was 3.99 and 9.44 inches, respectively.

The seeding in the medusahead location was unsuccessful and was attributed to the lack of rainfall after seeding (only 1.73 inches). Plots were reseeded the next fall but broad-leaf weeds dominated the plots to such an extent that the location was given up. However, first-year weed-control results were satisfactory, as shown in table 1. Incorporation appeared to give better weed control than surface application, but at the higher rates of the chemicals either method was effective. At all rates the incorporated materials significantly reduced the ground cover of medusahead, and all but the 3-lb-per-acre rate of EPTC reduced the total ground cover. Of the non-incorporated materials, all rates of EPTC, the 2-lb rate of simazine, and the 1- and 2-lb rate of atrazine reduced medusahead. However, the total ground cover was reduced only by the 2-lb rate of simazine and the 1- and 2-lb rate of atrazine.

TABLE 1.—EFFECTS OF PREEMERGENCE HERBICIDES ON PER CENT OF GROUND COVERED BY LIVE PLANTS—MEDUSAHEAD SITE, MODOC COUNTY, JUNE 17, 1960.*

Chemical	Rate (lb/A)	Incorporated: Ground Cover (%) Medusahead	Incorporated: Ground Cover (%) Total	Surface Applied: Ground Cover (%) Medusahead	Surface Applied: Ground Cover (%) Total
EPTC	1.5	2	16	6	16
	3.0	1	25	3	27
	6.0	0	8	1	26
Simazine	.5	5	10	14	20
	1.0	1	5	10	18
	2.0	0	1	0	1
Atrazine	.25	13	17	16	30
	1.0	0	3	4	10
	2.0	0	0	0	0
(None)		18	33	16	25
	LSD .05	5	10	5	10

* Herbicides were applied on September 3, 1959 and plots were seeded on April 18, 1960.

Soil-moisture conservation was good on plots treated with atrazine at the high rate, as shown on the graph. Plots treated with the high rate of EPTC were no better than the control plot, possibly because of the abundant broad-leaf weeds, and for clarity, the lines were not included on the graph.

The ground cover of competing vegetation on the cheatgrass site was significantly reduced by the 2-lb-per-acre application of atrazine, as shown in table 2. This reduction was reflected in the conservation of soil moisture on the atrazine plots, as compared with untreated or EPTC plots (see graph). By the middle of May very little soil moisture had been used from plots treated with the high rate of atrazine. Since the reduction of ground cover on the simazine plots was essentially the same as on the atrazine plots, it would be expected that the pattern of soil moisture depletion would also be similar.

The resulting stands of Topar wheatgrass in the cheatgrass site were only fair, because of the very dry season. Best stands were obtained with 1- and 2-lb per acre rates of simazine and with 1/4 lb per acre applications of atrazine. The possibility of a chemical residue persisting in the soil may have reduced the density of the perennial grass stand. Further work with materials of varying solubility should be undertaken.

Plants with the greatest vigor appeared where treatments gave the best control of weedy vegetation and soil moisture reserves were high before spring seeding.

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TABLE 2.—EFFECT OF PREEMERGENCE HERBICIDES ON PER CENT OF GROUND COVERED BY WEEDS AND SUBSEQUENT TOPAR WHEATGRASS ESTABLISHMENT ON A CHEATGRASS SITE.
Figures are average of 4 replications.

Chemical	Rate (lb/A)	Ground Cover (%) June 1960: Cheatgrass	Ground Cover (%) June 1960: Other	Ground Cover (%) June 1960: Total	Wheatgrass Stand June 1961: Vigor rating*	Wheatgrass Stand June 1961: Establishment Index†
EPTC	1.5	6.8	1.5	8.3	1.5	3.8
	3.0	5.0	2.3	7.3	2.0	5.0
	6.0	2.6	3.1	5.7	1.8	5.3
Simazine	.5	8.0	1.8	9.8	3.3	8.5
	1.0	2.3	2.5	4.8	4.3	14.0
	2.0	.7	.6	1.3	5.0	12.5
Atrazine	.25	2.4	4.3	6.7	3.3	11.5
	1.0	.4	.6	1.0	4.5	6.0
	2.0	.4	.8	1.2	4.8	4.8
(None)		3.9	2.3	6.2	2.3	6.8
	LSD .05	3.3	--	2.3	.9	4.7

* A rating scale of 1 = poor to 5 = good based on visual estimates. Rating was made on June 29, 1961. Herbicides were applied September 4, 1959 and plots were seeded March 4, 1960.

† An index of relative stand establishment as reported in Western Weed Control Conference 1963, P.9.