Grass Species Growth on a Volcanic Ash-Derived Soil Cleared of Forest[1]

F. V. PUMPHREY[2]

Associate Professor of Agronomy, Eastern Oregon Experiment Station, Union, Oregon.

Highlight

Grasses producing high forage yields in a 20 to 28 inch precipitation zone of northeastern Oregon on volcanic ash soil (Tolo silt loam) cleared of a stagnant forest were Greenar intermediate wheatgrass, Sherman big bluegrass, and Regar bromegrass. Tall oatgrass, meadow foxtail, and creeping meadow foxtail were high yielding when fertilized. Annually fertilizing with 60 lbs. N, 10 lbs. P, and 11 lbs. S/acre increased the mean annual forage yield 1800 lbs./acre. Fertilizing increased downy brome in species not well adapted. Fertilized forage contained a slightly lower nitrogen concentration than non-fertilized forage.

[1] Contribution of the Oregon Agricultural Experiment Station as Technical Paper number 2852. Received February 27, 1970; accepted for publication November 7, 1970.

[2] Present address is Associate Professor, Pendleton Experiment Station, Pendleton, Oregon 97801.

Range managers and foresters readily agree that high priority must be given to revegetating forest land which has been denuded of vegetation either purposely or accidentally. A properly managed cover of grasses reduces erosion, provides grazing and income for several years, allows for the return to timber, and aids in eliminating "doghair" stands of trees (Rummell and Holscher, 1955). Adaptation and characteristics of the species seeded affect the success of the seeding and successional patterns during the gradual replacement of herbaceous plants by shrubs and trees. This paper reports forage and fertilizing results obtained from a grass nursery grown on a soil derived from volcanic ash which had been cleared of forest.

Study Area and Methods

This study was conducted in the ponderosa pine (*Pinus ponderosa*)—Douglas fir (*Pseudotsuga menziesii*)—grand fir (*Abies grandis*) forest-range zone of the Wallowa Mountains in northeast Oregon. Mean annual precipitation of this zone is 20 to 28 inches. The bulk of the precipitation occurs as rain or snow from October through June. July and August are warm and dry but summer showers do occur.

The particular site was a north slope at 3500 feet elevation with a mean annual precipitation of 26 inches. The site had been cleared of a stagnant forest stand dominated

Table 1. Forage yields (lbs./acre, oven dry) of non-fertilized and fertilized grasses growing on volcanic ash soil cleared of forest.

Species	Variety	Mean annual forage yield[1] Non-fertilized	Fertilized[2]
Intermediate wheatgrass (*Agropyron intermedium*)	Greenar	2940	4980
Intermediate wheatgrass (*Agropyron intermedium*)	Amur	1850	3290
Tall wheatgrass (*Agropyron elongatum*)	Alkar	1250	3980
Pubescent wheatgrass (*Agropyron trichophorum*)	Topar	2150	3880
Pubescent wheatgrass (*Agropyron trichophorum*)	P-14942	1280	2670
Beardless wheatgrass (*Agropyron inerme*)	Whitmar	1840	3360
Crested wheatgrass (*Agropyron desertorum*)	Nordan	1250	3110
Crested wheatgrass (*Agropyron desertorum*)	P-13333	1090	2200
Siberian wheatgrass (*Agropyron sibiricum*)	P-27	1200	2430
Big bluegrass (*Poa ampla*)	Sherman	1580	4360
Tall oatgrass (*Arrhenatherum elatius*)	Common	1310	4080
Bromegrass (*Bromus biebersteinii*)	Regar	1950	3940
Red bromegrass (*Bromus tomentellus*)	P-2447	1120	3140
Smooth bromegrass (*Bromus inermis*)	Manchar	1770	3080
Mountain bromegrass (*Bromus marginatus*)	Bromar	1460	3010
Meadow foxtail (*Alopecurus pratensis*)	"HESA"	1250	3930
Meadow foxtail (*Alopecurus pratensis*)	P-5903	1360	3540
Creeping meadow foxtail (*Alopecurus arundinaceus*)	P-14762	1160	3650
Timothy (*Phleum pratense*)	Common	1250	3490
Timothy (*Phleum pratense*)	Drummond	990	2830
Orchardgrass (*Dactylis glomerata*)	Pennlate	1390	2550
Orchardgrass (*Dactylis glomerata*)	Latar	1280	3120
Orchardgrass (*Dactylis glomerata*)	Sterling	1360	2440
Hard fescue (*Festuca ovina* var. *duriuscula*)	Durar	1460	3340
Chewings fescue (*Festuca rubra* var. *commutata*)	Chewings	1250	3140
Tall fescue (*Festuca arundinacea*)	Alta	1140	2740
Tall fescue (*Festuca arundinacea*)	Fawn	940	1890
Blue wildrye (*Elymus glaucus*)	P-2662	1430	3270
5% L.S.D. (Varieties)		339	742

[1] Mean annual yields for the years 1966–69.

[2] Fertilized annually with 60 lbs. N, 10 lbs. P, and 11 lbs. S per acre. Highly significant difference (P = .01) between non-fertilized and fertilized occurred each year.

by grand fir. Soil test values for available P were very high (86 and 83 ppm by the bicarbonate method for the 0–8 and the 8–20 inch soil depths). The site was also high in available potassium; the soil test showed over 1500 pounds of exchangeable K per acre to a depth of 8 inches. The surface soil had a pH of 6.1. The deep (40+ inches) soil derived from volcanic ash is classified as Tolo silt loam. In the comprehensive soil classification system the Tolo series is a member of the ashy over loamy, mixed, frigid family of Typic Vitrandepts.

Volcanic ash is one of the major soil parent materials in the Pacific Northwest. The ash originated in the Cascade Mountains from northern California to central British Columbia with the bulk of the ash coming from Mt. Mazama (Crater Lake, 6600 years ago) and Glacier Peak (12,000 to 13,000 years ago) (Powers and Wilcox, 1964; Fryxell, 1965). Unique features of soils from volcanic ash in northeast Oregon are weak structural development, a narrow range of particle size which is dominantly silt, and high particle-size surface area. These features generally enhance water retention and the amount of water available for plant use.

The 28 grasses[3] listed in Table 1 were seeded individually in plots 8 by 20 feet. One-half of each plot received an annual application of N-P-S at the rate of 60 lbs. N, 10 lbs. P, and 11 lbs. S per acre. Plots and sub-plots were arranged to allow a randomized block split-plot analysis of the yield data. The nursery, containing two replications, was seeded in August following clear-cut logging and slash burning. Showers occurred soon after seeding providing moisture for immediate germination and seedling establishment. Bull thistles (*Cirsium vulgare*) were removed by hand hoeing in the spring following grass seeding as the primary objective of the nursery was comparing forage production of the grasses planted.

Forage yields were determined when intermediate wheatgrass, which was the latest maturing grass, reached the hay stage (early flowering) of growth in late July. Sub-samples

[3] Seed of most entries was obtained through John L. Schwendiman, Plant Materials Center, Soil Conservation Service, Pullman, Washington.

of the harvested forage of key species were taken for N analysis. Total N was determined by the modified micro-Kjeldahl method (Jackson, 1958). Aftermath growth was not sufficient to warrant an additional harvest in early fall.

The nursery was fenced to exclude cattle, deer, and elk. Rodents were controlled by poisoning.

Results and Discussion

Forage yields were affected by species, varieties, and the fertilizer applied (Table 1).

Greenar intermediate wheatgrass was the outstanding forage producer. Amur intermediate wheatgrass did not exhibit the outstanding yielding ability of Greenar. Differences in productivity between varieties are also expressed in the two pubescent wheatgrasses grown. Intermediate, pubescent, and tall wheatgrasses remained green and succulent longer than many of the other grasses in this nursery. Moisture at this site was in excess of what is needed by the drought tolerant, long-lived, bunchgrass types of wheatgrasses—crested, Siberian, and Whitmar. Thus, they did not demonstrate superior productiveness over most of the other species as is observed in the more arid areas of Oregon (Hafenrichter et al., 1968).

Many grasses beside the wheatgrasses produced high yields of forage. Results in Table 1 and observations of Sherman big bluegrass support other results that this grass is widely adapted, productive, starts growth early in the spring, and remains green into the summer (Currie, 1969; Hyder and Sneva, 1963; Lavin and Springfield, 1955). A recently introduced and released grass, Regar bromegrass, was among the high forage producers (Foster et al., 1966). This species produced sufficient cover to suggest it is a weak sod former under these conditions. Its regrowth after cutting and fall growth were not superior to other grasses. Tall fescue on a comparative basis performed poorly on this site. Stands were deteriorating and giving evidence that the planting will be short-lived on this site. Fourteen miles away on alluvial soil at the Eastern Oregon Experiment Station tall fescue is one of the most productive grasses (Richards and Hawk, 1945). Pure stands of timothy were deteriorating into mixed stands by the fifth year after establishment which is in agreement with other local observations. Pocket gophers, because of their apparent relish for the swollen base of the stem, are a serious menace to pure stands of timothy (Garrison and Moore, 1956).

Several grasses as timothy, tall oatgrass, and meadow foxtail were reseeding themselves in areas where plant competition was not severe. Little or no reseeding by other species occurred in intermediate wheatgrass, hard fescue, and big bluegrass plots. No observations were possible on the potential reseeding of intermediate wheatgrass as this species was harvested before seed matured.

Table 2. Fertilizer effect on nitrogen (%) in the forage and nitrogen uptake (lbs./acre).[1]

Species	Fertilizer[2]	Nitrogen	Annual N uptake
Intermediate wheatgrass	None	0.66	18
	Fertilized	0.62	34
Creeping meadow foxtail	None	0.73	15
	Fertilized	0.46	19
Manchar smooth bromegrass	None	0.85	15
	Fertilized	0.66	23
Blue wildrye	None	0.93	11
	Fertilized	0.81	24

[1]Data obtained from two replications for two consecutive years.
[2]Annual application of 60 lbs. N, 10 lbs. P, and 11 lbs. S per acre.

Fertilized grass started growth earlier in the spring and remained green longer in the summer. Fertilizing increased the density of stands but did not prevent stands of tall fescue and timothy from deteriorating. Density and growth of downy brome (*Bromus tectorum*) were increased several fold by fertilizing species not well adapted to this site as tall fescue and crested wheatgrass.

Mean annual increase in forage produced by all grasses fertilized each year was over 1800 lbs./acre (Table 1). Two early maturing grasses—tall oatgrass and meadow foxtail—and Sherman big bluegrass were among the outstanding responders to fertilization. Each averaged over 2500 lbs./acre increase in forage from fertilizing. The additional forage produced by fertilization, unless removed by grazing or as hay, would be a serious menace as a fire hazard during the dry summer months.

A nitrogen-sulfur interaction response may have occurred as large responses from nitrogen and sulfur applied to wheat and sulfur applied to legumes have been obtained in eastern Oregon (Pumphrey, 1961, 1963) and in the Palouse Country of Washington and Idaho. It is not likely that the grasses responded to the applied P since the soil test values for available P were very high. These results from fertilizing on this site support observations that forest soils developed on volcanic ash are low in organic matter and some nutrients essential to plant growth.

Fertilized forage of the four species analyzed contained a lower nitrogen content at harvest time than did non-fertilized forage (Table 2). The forage yield increase from fertilizing was larger proportionally than the increase in nitrogen uptake from fertilizing. This resulted in a slight decrease in nitrogen concentration within the plant but an increase in nitrogen uptake. Percent uptake of the applied nitrogen was low from fertilizing pure grass stands where moisture is not a dominant limiting factor for growth.

Literature Cited

CURRIE, PAT O. 1969. Plant response and cattle gains on Sherman big bluegrass. J. Range Manage. 22:258–261.

FOSTER, RONALD B., HUGH C. MCKAY, AND EDWARD W. OWENS. 1966. Regar bromegrass. Idaho Agr. Exp. Sta. Bull. 470. 7 p.

FRYXELL, R. 1965. Mazama and Glacier Peak volcanic ash layers, relative age. Science 147:1288–1290.

GARRISON, GEORGE A., AND A. W. MOORE. 1956. Relation of the Dalles pocket gopher to establishment and maintenance of range grass plantings. J. Range Manage. 9:181–184.

HAFENRICHTER, A. L., JOHN L. SCHWENDIMAN, HAROLD L. HARRIS, ROBERT S. MACLAUCHLAN, AND HAROLD W. MILLER. 1968. Grasses and legumes for soil conservation in the Pacific Northwest and Great Basin States. U. S. Dep. Agr., Agr. Handbook 229. 69 p.

HYDER, D. N., AND FORREST A. SNEVA. 1963. Studies of six grasses on sagebrush bunchgrass range. Ore. Agr. Exp. Sta. Tech. Bull. 71. 20 p.

JACKSON, M. L. 1958. Soil chemical analysis. Prentice-Hall, Inc., Englewood Cliffs, N. J.

LAVIN, F., AND H. W. SPRINGFIELD. 1955. Seeding in the Southwestern pine zone. U. S. Dep. Agr., Agr. Handbook 89. 52 p.

POWERS, H. A., AND R. E. WILCOX. 1964. Volcanic ash from Mount Mazama (Crater Lake) and from Glacier Peak. Science 144:1334–1336.

PUMPHREY, F. V. 1961. Winter wheat fertilization in northeast Oregon. Ore. Agr. Exp. Sta. Cir. of Info. 610. 8 p.

PUMPHREY, F. V. 1963. Sulfur and phosphorus fertilization of alfalfa and clover in northeast Oregon. Ore. Agr. Exp. Sta. Cir. of Information 619. 10 p.

RICHARDS, D. E., AND V. B. HAWK. 1945. Palatability for sheep and yield of hay and pasture grasses at Union, Oregon. Ore. Agr. Exp. Sta. Bull. 431. 51 p.

RUMMELL, ROBERT S., AND CLARK E. HOLSCHER. 1955. Seeding summer ranges in eastern Oregon and Washington. U. S. Dep. Agr. Bull. 2091. 34 p.