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MANAGEMENT and PRODUCTIVITY of PERENNIAL GRASSES in the NORTHEAST III. ORCHARDGRASS

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Management and Productivity of Perennial Grasses in the Northeast: III. Orchardgrass

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Contents

Preface

This publication describes experiments conducted by several experiment stations in the Northeastern Region of the United States, under the auspices of Northeastern Regional Technical Committee NE-29. A. M. Decker, Maryland Agricultural Experiment Station; G. A. Jung, West Virginia Agricultural Experiment Station; R. C. Wakefield, Rhode Island Agricultural Experiment Station; J. B. Washko, Pennsylvania Agricultural Experiment Station; D. D. Wolf, Connecticut, Storrs, Agricultural Experiment Station; and M. J. Wright, New York, Cornell University Agricultural Experiment Station were responsible for the collection, statistical analyses, and interpretation of data. A manuscript was then prepared from these station summaries by J. B. Washko. Preparation and organization of the final manuscript was the responsibility of G. A. Jung.

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SUMMARY

Experiments were conducted in six Northeastern states to test the effects of harvesting at several stages of growth, fertilizing with nitrogen at two rates, and cutting the aftermath at two heights on yield, persistence, and forage quality.

1. Dry matter weed-free yields of orchardgrass exceeded 5 tons per acre at every location when moisture was ample and cool temperatures prevailed. Yields were reduced 35 per cent during a droughty year. Late maturing varieties were less productive than was an early maturing variety.

2. Nitrogen fertilization at rates between 100 and 450 pounds per acre had a greater influence on yields than did cutting at different stages of growth each spring. Total seasonal yields were generally greatest when the first harvest was taken at late stages of maturity, but little yield advantage was gained by delaying harvest later than early bloom.

3. With favorable cutting management practices, high rates of nitrogen fertilizer, and adequate moisture, aftermath yields of dry matter exceeded 3 tons per acre at every location. Aftermath production was greatest when first harvests were removed at the early head stage of growth.

4. Clipping orchardgrass to different stubble heights did not influence forage production in a consistent manner. Higher forage yields were generally obtained when the aftermath stubble was cut to a height of 1½ rather than 3½ inches.

5. Stands of orchardgrass were not affected adversely at any location by taking the first harvest at different stages of maturity. The high rate of nitrogen fertilization thinned stands at all locations. Cutting the aftermath stubble to different heights had only a small effect on stand density. Better stands were maintained at Connecticut with the 3½-inch stubble height, whereas the 1½-inch stubble height was best at Pennsylvania. Two stands of orchardgrass were winter-killed during the four-year period.

6. The quantity of reserves remaining in the stubble of orchardgrass, as measured by etiolated growth, was not affected in a consistent manner by any of the treatments imposed.

7. The nutritive value of orchardgrass decreased markedly over a two-month period in the spring. Nutritive value of orchardgrass forage in spring was related more to stage of growth than date of harvest. Orchardgrass cut after early bloom provides little more than maintenance energy to livestock. Aftermath forage had high nutritional values irrespective of when the first harvest was taken.

Management and Productivity of Perennial Grasses in the Northeast: III. Orchardgrass

FARMERS OF THE NORTHEASTERN United States have favored legumes or grass-legume combinations to provide forage for their livestock. However, existing conditions in the Northeast are frequently unfavorable for legume culture and better suited for grass species. Several developments within the past few years have also focused attention on grasses in pure stands as a source of forage for livestock. These are (a) spread of the alfalfa weevil; (b) development of several improved, high-yielding grass varieties for the Northeast; (c) availability of nitrogen fertilizer at economical prices; (d) new evidence that grasses adequately fertilized and harvested early are equivalent to legumes in feeding quality; and (e) new harvesting and storage techniques, making it possible to remove forage earlier to preserve its higher nutritive value for livestock feeding.

Among the several grasses adapted to the Northeast is orchardgrass (**Dactylis glomerata** L.) which is utilized alone and in legume mixtures for pasture, green chop, silage, and hay. During the period 1963-64, approximately 600,000 pounds of seed of this species were used annually within the Northeast Region (12). This quantity of seed, if used alone at a seeding rate of 8 pounds per acre, would have seeded 75,000 acres, or twice that acreage if seeded with legumes. Since orchardgrass is a perennial with an expected longevity of five or more years, the seed usage figures justify an estimate of the total Northeast acreage of this species in any one year at 500,000 or more acres. Seed usage figures probably lead to an underestimate, however, because orchardgrass volunteers readily when soil fertility is adequate.

Although widely adapted within the Region, this grass is of greater importance in the southern than in the northern part. Based on seed usage data of 1963-64, Pennsylvania, Maryland, and West Virginia, in that order, grew the largest acreage of orchardgrass.

Orchardgrass is indigenous to Europe and was first cultivated in this country in 1760. Its persistence, leafiness, productivity, ability to withstand relatively adverse soil and climatic conditions and to stand up well under grazing make it a desirable forage grass. The availability of seed at reasonable prices and ease of establishment also have contributed to the wide acceptance of orchardgrass. While it is commonly believed that orchardgrass is less palatable than smooth bromegrass or timothy, comparisons are biased by the fact that it matures early and is often undergrazed early in the spring or cut at a late stage of maturity for hay.

It appeared appropriate to study the relationship between the physiological development and management of orchardgrass stands in order to determine practices most conducive to stand maintenance, persistence, and the production and removal of quality forage. This bulletin presents the results of experiments in which stands of orchardgrass at Storrs, Connecticut; College Park, Maryland; Ithaca, New York; Centre Hall, Pennsylvania; Kingston, Rhode Island; and Morgantown, West Virginia were subjected to nearly identical management for the three-year period from 1960 to 1962.

LITERATURE REVIEW

Orchardgrass (**Dactylis glomerata** L.) is a typical bunch-type grass which forms dense circular tufts and has folded leaf blades and compressed sheaths. The shape of the inflorescence is unusual and has resulted in orchardgrass being called "cocksfoot" in Europe. It is a long-lived perennial where winters are not too severe. Orchardgrass is more shade tolerant than most perennial forage grasses and this characteristic also has given rise to one of its common names. Two other characteristics of orchardgrass which were recognized early by investigators are its early spring growth and its abundant leafy aftermath production (31, 55). Moreover, in comparison with many species, orchardgrass yields better in summer and it is affected less by weather conditions (2, 30).

Although orchardgrass has been grown in the Northeast since 1760, little information was available on the performance of this species in the region until 1954. In that year, a three-year study was published (52) reporting the performance of seven varieties or strains of orchardgrass grown alone and with ladino clover under a pasture and a silage management in seven northeastern states. All varieties and strains gave satisfactory yields, but the early maturing types produced greater yields than the late maturing types. Differences in yield between the pasture and silage managements were small. Higher yields were obtained in the northern than in the southern part of the region.

It has been reported by three investigators (9, 47, 64) that the optimum temperature for the topgrowth of orchardgrass is approximately 70 F. This, in part, explains why orchardgrass is well adapted to the climatic conditions of the Northeast. Plant breeders have developed varieties with superior performance in the Region. These varieties are "Potomac," "Pennmead," "Pennlate," and "Masshardy" (25). Additional new strains are presently being tested (51) throughout the region.

Stage of Maturity at First Harvest

First cutting yields of orchardgrass were found by Austenson (2) to increase rapidly in the spring until the plants reached full bloom and then no further increase was noted. Reports are conflicting as to whether time of first harvest affects seasonal and/or aftermath yields. Spurrier (67) and Darke **et al.** (18) reported that highest seasonal yields were obtained when the first cutting of orchardgrass was taken at early heading. Wagner (74), on the other hand, found that time of cutting in the spring had little effect on seasonal yields, but did affect seasonal distribution of yield. Spurrier's results differ again from those of Wagner because he found first harvest management to have little effect on aftermath yields. Differences in range of plant maturity and variations in growing conditions may account for these variable results. Austenson's studies showed that time of first harvest **per se** determined whether or not this cutting treatment affected aftermath yields. When first harvest date was delayed from April 21 to May 31, aftermath yields declined. Further postponement of the first harvest had no additional effect on aftermath yield.

Nitrogen Fertilization

The yield of most grasses increases with nitrogen fertilization. Orchardgrass, however, has proved to be more responsive than several bromegrass varieties (19, 26, 41, 61), reed canarygrass (19, 41), red fescue (38), meadow fescue (30), meadow foxtail (41), perennial and Italian ryegrass (30, 83), timothy (26, 30, 41, 61, 83), and intermediate and tall wheatgrass (16, 41). Recent studies (44) in Pennsylvania, however, showed that at low rates of nitrogen fertilization (50 pounds per acre) timothy was more responsive than orchardgrass or bluegrass, whereas this was not so at higher rates.

Nitrogen fertilization has been shown by Wilson (83) in New Zealand and Auda **et al.** (1) in Virginia to increase tillering of orchardgrass. Henderlong **et al.** (28) found the competitiveness of orchardgrass to be greatly increased with adequate nitrogen and potassium fertilization. When these elements were at low concentrations or not in the proper ratio, bluegrass and tall fescue were more competitive than was orchardgrass. With adequate nitrogen and potassium the reverse was true.

Nitrogen has been reported to decrease root growth of grasses in relation to top growth. Plants grown under conditions where available nitrogen is a factor limiting growth, have a well developed root system but a relatively poorly developed shoot (topgrowth) system, according to Troughton's review of the literature on nitrogen nutrition (73). When nitrogen is added to plants lacking this nutrient there is an increased growth of both roots and shoots, with the increase in shoots being greater. Additional increments of nitrogen produce smaller and smaller increases in root growth until a point is reached where root growth decreases. This principle was demonstrated with orchardgrass in studies by Sprague and Sullivan (65) and by Mitchell (48, 49). Several investigators (23, 28, 29, 37, 40, 44) have also shown that orchardgrass will not continue to respond to high rates of nitrogen fertilizer unless the soil potassium content is high.

Evidence that orchardgrass responds to high rates of nitrogen fertilizer is provided by Marriott (44), Mitchell (49), and Drake **et al.** (18), who found that the highest yields produced by this species under their conditions were with 200, 300, and 400 pounds of nitrogen per acre, respectively. However, dry matter produced per pound of nitrogen was greater at a lower rate of fertilization. At rates of 50 or 100 pounds of nitrogen per acre, Marriott found that orchardgrass produced 21 pounds of dry matter per pound of nitrogen and that this amount declined with increasing increments of nitrogen. Ramage **et al.** (58) fertilized orchardgrass for three years with ammonium nitrate at the annual rate of 50, 100, 200 and 400 pounds of nitrogen per acre. Nitrogen recovery by orchardgrass at the four fertilizer rates was 60, 74, 62, and 59 per cent, respectively. Dotzenko (16) also concluded that the growing of orchardgrass under high rates of nitrogen resulted in lower percentages of nitrogen being recovered from the fertilizer. In England, Kernick (38) showed little reduction in the uptake of nitrogen by orchardgrass and red fescue when the fertilizer was placed at depths of 12 inches to 2 feet. He concluded that, on a weight basis, orchardgrass roots are probably more efficient absorbers of nitrogen than are those of fescue.

From studies with orchardgrass grown alone and with ladino clover, Wagner (74) concluded that the legume provided the equivalent of approximately 150 pounds of nitrogen per acre. However, Washko and Pennington (82) obtained higher forage yields from orchardgrass fertilized with 100 pounds of nitrogen annually than they did when the grass was grown in association with ladino clover, alfalfa, or birdsfoot trefoil under a hay management system.

Height and Frequency of Clipping

In 1930, Stapledon and Milton (69) reported that orchardgrass was responsive to height of cut. They found that orchardgrass cut to a 6-inch stubble yielded more per year than similar swards cut to the soil surface. High cutting also favored better root and tiller development. Similarly, progressively higher yields of dry matter were reported by Harrison and Hodgson (27) for orchardgrass cut every week to 1, 3, and 6-inch heights, respectively. Drake **et al.** (18) substantiated these findings by reporting that orchardgrass cut to a 3-inch stubble height was more productive than orchardgrass cut to a 1½-inch stubble height. Recently, though, Mitchell (49) reported higher yields in two out of three seasons for orchardgrass cut to a 1-inch than to a 3-inch stubble. He found that this response was associated with high soil moisture. In a different type of defoliation study, Ward and Blaser (80) showed that orchardgrass tillers with two leafblades (5.5 cm long) remaining after clipping grew faster than tillers with all blades removed. Considerable evidence is available to show that rate of regrowth is a function of energy obtained from photosynthetic activity, from stored reserves or both. When little stubble is left after plants are cut, energy for plant growth must come almost entirely from reserves for several days (13). On the other hand, leaving considerable stubble, especially with leaves, results in the direct utilization of much energy from photosynthate (13,80).

The lower portion of orchardgrass tillers may contain up to 36 per cent carbohydrate reserve on a dry weight basis (65). Reserves may be lost, therefore, by harvesting these stem bases.

Jantti and Heinonen (33) point out that close defoliation may affect the drought sensitivity of grasses. They theorized that roots attached to a transpiring shoot can absorb more water from drier soil than can the roots of closely clipped plants.

Most grasses become less productive as frequency of harvest is increased. However, Wagner (74) observed that orchardgrass grown with ladino clover was as productive when cut at two-to-three-week intervals as when cut at five-to-seven-week intervals. Similar results were reported by Brown and Munsell (8); under their conditions, mediocre stands of orchardgrass were maintained for five years when the grass was cut to a 1-inch height at 10-to 14-day intervals. Both Wagner and Brown and Munsell concluded that frequent clipping was less harmful to orchardgrass than to bromegrass. Klapp (39) has postulated that growth of orchardgrass is neither enhanced nor inhibited by frequent mowing or grazing because of a preponderance of basal leaves. Root weight was not affected by frequency of cutting in studies by Baker and Garwood (3) in England, whereas stubble weight was considerably higher in the autumn on less frequently cut plots.

Orchardgrass and bromegrass grown in mixtures with alfalfa and ladino clover were subjected to 12 cutting systems for two years by Sprague **et al.** (63). The cutting systems had no residual effect on total yields harvested the third season but did influence persistence of the species. When grown with alfalfa the grasses persisted best when most of the cuttings were taken at immature growth stages of alfalfa, and particularly so for the last cut of the season. When grown with ladino clover, both grasses persisted best when first harvests of the season were taken at early stages of growth and when late summer harvests were delayed. This suggests that competition from the legume partner influences the performance of the grass. Orchardgrass was clearly the most competitive species in their studies.

Carbohydrate Reserves

Many factors have been shown to influence the concentration of organic reserves in orchardgrass. The concentration of carbohydrate reserves in orchardgrass was considered by Davidson and Milthorpe (13) to be dependent on rate of photosynthesis, respiration, translocation, and synthesis of structural compounds. Higher levels of non-reducing sugars, fructosan, and sucrose have been observed (65, 76) in orchardgrass plants fertilized at low, as compared to high, rates of nitrogen. Jones **et al.** (35) concluded from several experiments in Wales that the level of soluble carbohyrate in grass will depend on the species and variety, the time of fertilizer application, the amount applied, and the date of sampling. Colby **et al.** (10) considered that the reduction of fructosan reserves by nitrogen fertilization rendered the plants susceptible to injury under conditions of stress from high temperature and low moisture. In contrast to these investigations, Drake **et al.** (18) found that the reserves of orchardgrass, as indicated by regrowth in the dark, were greater in plants that had received 400 pounds of nitrogen per acre than in plants fertilized with 200 pounds of nitrogen. Etiolated growth, however, is a measure of carbohydrate and nitrogenous reserves.

That other variables may influence the content of carbohydrate reserves is illustrated by the results of MacLeod (43) and of Mitchell (49). MacLeod found that the potassium-nitrogen ratio influenced the total available (reserve) carbohydrate content of orchardgrass. Using two techniques, Mitchell reported that reserves of irrigated orchardgrass were higher when the orchardgrass was cut to a 3-inch stubble than when it was cut to a 1-inch stubble. This difference was not apparent, however, for orchardgrass that was not irrigated.

The level of carbohydrate reserves in orchardgrass has been shown to be temperature dependent (1). The fact that the carbohydrate content is higher at lower temperatures probably can be attributed to rapid carbohydrate utilization at higher temperatures.

It is not clear how dependent the new growth of orchardgrass is on previously stored reserves. Davidson and Milthorpe (13) concluded that, although rates of leaf and root extension immediately following defoliation are related to the concentration of labile carbohydrates and other substances present, it does not necessarily follow that these substances influence rate of regrowth directly as sources of substrate. Sullivan and Sprague (71) also indicated that aftermath production was not solely dependent on the level of stored carbohydrates. More recently, though, Sprague (personal communication) postulated that high rates of nitrogen fertilization stimulate extensions of new leaves and other plant parts as well as increased vigor and growth, all at the expense of the carbohydrate reserves. Ward and Blaser (80) made observations on the utilization of carbohydrates for respiration and/or synthesis of new tissue. Tillers with high levels of carbohydrate reserves produced more dry matter than did tillers with lower levels of reserves; however, the reserve status was much less important for dry matter production than was degree of defoliation.

Both Wagner (74) and Baker **et al.** (4) reported that spring yields of orchardgrass were not influenced by cutting management the previous fall. These results are unlike those from many studies with legumes and therefore raise the question of whether the fall cutting managements influenced the reserve status of the plants.

Sprague and Sullivan (65) found up to 36 per cent fructosans in the lower one-half of orchardgrass stems. While Waite and Boyd (78, 79) found a higher fructosan content in orchardgrass stems than in leaves, they reported a maximum fructosan content of only 13 per cent for the stems. This difference in fructosan content probably can be explained by the particular portion of the plant organs examined and by differences in climate. Taylor and Templeton (72) found leaf sheaths of old leaves to have a higher reserve carbohydrate content than sheaths of younger leaves. Moreover, the lower half of the sheaths of old leaves was higher in reserves than the upper portion of the sheaths, whereas, the content of reserves was similar for the sheath parts of new leaves. In recent studies, Okajima and Smith (53) fractionated the carbohydrate reserves of several grasses. When sampled at near seed maturity, the stem bases of Potomac orchardgrass contained 3 per cent glucose and fructose, 3.5 per cent sucrose, 25.3 per cent fructosan, and 2.8 per cent starch on a dry weight basis. In another study, Smith and Grotelueschen (62) found that the fructosan chain length of orchardgrass was quite variable.

Nutritive Value

Chemical composition, digestibility of certain plant constituents, and animal consumption of orchardgrass forage have been used by investigators when evaluating the nutritional value of the forage. A group of papers by Waite (75, 77) and Waite and Boyd (78, 79) contains much information about factors associated with the variations in content of water-soluble carbohydrates in grasses. It is apparent from their studies that the water-soluble carbohydrate content of grasses varies for different tissues and fluctuates at different stages of growth. In addition, species vary in their seasonal fluctuations associated with stages of growth; **e.g.** fructosan concentrations in orchardgrass forage decreased during heading, whereas similar reductions in fructosan concentrations in ryegrass forage did not occur until after flowering. After several years of investigation it was concluded that under conditions in Scotland, orchardgrass forage is never likely to contain large quantities of fructosan.

Stallcup **et al.** (68) reported that the crude protein content of orchardgrass, rye, and crimson clover declined over a four-week spring harvesting period. The protein content was maintained at a higher level in orchardgrass and crimson clover than in rye. During the same period, crude fiber content increased at a slower rate in orchardgrass and crimson clover forage than in rye forage. In contrast to these noted changes, the chemical composition of ladino clover changed little during the sampling period. Haenlein **et al.** (24) also found the crude protein content in hays of three orchardgrass varieties cut on three dates in spring to decline as the season progressed. Moreover, the varieties ranked in protein content according to rate of maturation, with the slowest maturing variety ranking highest. On the other hand, they found the crude fiber and gross energy contents for the varieties to be similar on each cutting date. Examination of the lignification process in orchardgrass during the spring growth period led Johnston and Waite (34) to conclude that thickened cells of the pericycle formed the major region of lignification in the stems and that this lignification increased up to anthesis. After anthesis, larger cells connecting vascular bundles also became lignified. The carotene content of orchardgrass was reported by Evans **et al.** (21) to decline 60 per cent from May 3 to June 6 in New Jersey.

After considering the content of protein, lignin, fiber, cellulose, nitrogen-free extract, fructosan, and soluble ash of eight grass species at different growth stages, Phillips **et al.** (54) concluded that orchardgrass was intermediate in feeding value when compared with the other species. Bromegrass and tall oatgrass were considered to have feeding values similar to orchardgrass, whereas reed canarygrass, "Alta" fescue, and Kentucky bluegrass were thought to have higher feeding values, and timothy and redtop lower feeding values. Sullivan (70) found the content of crude fiber in orchardgrass to be less than that in bromegrass or timothy.

Ramage **et al.** (58) observed that increasing the rate of nitrogen fertilization decreased the crude fiber content of orchardgrass but increased its crude protein content. Increases in crude protein content with nitrogen fertilization were observed by Lewis and Lang (41) to be greater for orchardgrass than for eight other grass species. Both rate and source of nitrogen fertilizer were found by Reid **et al.** (59) to alter the content of structural components of orchardgrass such as acid-detergent fiber, cell wall components, and lignin in fall-produced aftermath but not in aftermath produced in summer. It has been reported by several investigators (6, 23, 35, 76, 77) that nitrogen fertilization results in a reduction of sugar content of orchardgrass forage.

Crawford **et al.** (11) reported nitrate accumulation by orchardgrass to be insignificant even with rates to 200 pounds of nitrogen per acre, whereas Gordon **et al.** (22) reported that fertilization with rates of 400 to 1,200 pounds of ammonium nitrate per acre increased the nitrate content of orchardgrass forage appreciably. Even so, Gordon **et al.** pointed out that the nitrate concentrations would probably not be toxic. Dotzenko and Henderson (17) compared nitrogen uptake of five orchardgrass varieties and found that "Latar" accumulated higher concentrations of nitrate than did other varieties. Under conditions in Virginia, Lutz **et al.** (42) found that nitrogen, phosphorus, and potassium fertilization increased the content of N, P, and K in orchardgrass forage produced with and without irrigation.

There is much information to document the decrease in dry matter digestibility associated with maturation of the first crop. Minson **et al.** (45, 46), working in Britain, reported that digestibility of "S 37" and "Germinal" orchardgrass fell slowly up to the time of head emergence and then fell more rapidly with further advance in maturity. Mowat **et al.** (50) found the **in vitro** dry matter digestibility of orchardgrass stems to be greater than leaves at immature growth stages. At head emergence the digestibility of the leaves of orchardgrass was similar to that of the stems; and at later growth stages, leaves were more digestible than stems. Evidence of a strong inverse linear relationship between **in vitro** digestibility and lignification in orchardgrass was reported by Johnston and Waite (34). Digestibility of energy, protein, and dry matter was associated with varietal differences in rate of maturation, with the slowest maturing variety ranking highest in studies at Delaware (24). Ely **et al.** (20) have shown that "apparent digestibility" coefficients of three cellulose fractions, and of pentosans, total carbohydrates, and organic acid fractions decreased with advancing maturity of orchardgrass. On the other hand, digestion coefficients of the starch and sugar fractions were high at all growth stages.

Richards **et al.** (60) reported that under a rotational grazing system the dry matter digestibility of orchardgrass was significantly greater than for bromegrass at each of eight grazing periods throughout the grazing season. But under Canadian conditions, Pritchard **et al.** (57) found the **in vitro** digestibility of "Lincoln" bromegrass and "Frontier" reed canarygrass to be greater than for "Frode" orchardgrass, "Climax" timothy, tall fescue and mountain rye at the flowering stage of growth. They also pointed out, however, that early maturing species were less digestible than late maturing species when both groups were cut at the time the late maturing species were beginning to bloom.

In nitrogen fertilization studies with the second crop of orchardgrass, Poulton **et al.** (56) found the crude protein of orchardgrass hays fertilized with 100, 200, and 400 pounds of nitrogen per acre to be less digestible than the crude protein of alfalfa hay cut at 50 per cent bloom. Digestibility of the fiber of orchardgrass, however, was greater than for alfalfa fiber. The orchardgrass hays had digestible nutrient and energy values approximately 10 per cent higher than that of alfalfa. Level of nitrogen fertilizer had little effect on the total digestible nutrient value of these orchardgrass hays or those in a study at Pennsylvania (6).

Haenlein **et al.** (24) concluded that voluntary consumption of orchardgrass hays by sheep was more accurately predicted by date of cut than by chemical composition of the hays or by data from rabbit feeding trials. The nutritive value of the orchardgrass decreased approximately 50 per cent over a harvesting period of two-and-a-half weeks. They found the nutritive value index (N. V. I.) for hays of three orchardgrass varieties cut on each of three dates in spring to rank according to rate of maturation, with the slowest maturing variety ranking highest. Sugar content of orchardgrass forage was found by Bland and Dent (5) to be positively correlated with animal preference.

Reid **et al.** (59) reported that rate and source of nitrogen had little effect on **ad libitum** consumption of orchardgrass hays by sheep. Animal preference for the hays, however, declined with increasing rates of nitrogen fertilization. In contrast, the preference ranking of orchardgrass fertilized at several rates of nitrogen was the opposite under grazing conditions. Use of different sources of nitrogen affected the attractiveness of the hays but did not significantly modify selection of forage by grazing sheep. Sheep and rabbits exhibited differences in preference in these studies. Blaser **et al.** (7) found that steers grazing orchardgrass fertilized with 216 pounds of nitrogen per acre gained less per day than steers grazing orchardgrass grown with ladino clover and not fertilized with nitrogen. On the other hand, carrying capacity of orchardgrass pastures fertilized with nitrogen was higher than for grass grown with ladino clover. Live weight gains per acre over a five-year period were 9 per cent higher for orchardgrass fertilized with nitrogen than for that grown with ladino clover. Washko and Marriott (81) have concluded that beef production was similar for nitrogen fertilized grass (including orchardgrass) and legume-grass pastures. Dressing percentage of animals grazing the nitrogen fertilized grass was lower than for animals on the legume-grass pastures, but this difference was not apparent when animals on these pastures were fed a grain supplement. It is important to note that the per cent clover associated with orchardgrass in studies such as those mentioned may have been a very critical factor in determining animal performance. Decker (14) found little difference in beef cattle preference for orchardgrass and reed canarygrass when the clover content was high, whereas orchardgrass was preferred over reed canarygrass when the clover content was low.

Orchardgrass has demonstrated its superior productivity, responsiveness, and competitiveness in many trials, but its nutritive value continues to rank below that of some other popular grasses. The resolution of the managerial problem this presents is a challenge to the agronomist and may require the assistance of other specialists.

MATERIALS AND METHODS

The experimental area at each station was located on a well-or moderately-well-drained soil of medium to good fertility that had been uniformly fertilized in previous years. Approximately

TABLE 1

Site Characteristics, Fertilizer Applied, Varieties Grown, and Seeding Date and Method

Location	Connecticut (Storrs)	Rhode Island (Kingston)	New York (Ithaca)	Pennsylvania (Centre Hall)	Maryland (College Park)	West Virginia (Morgantown)
Elevation (ft.)	600	100	950	1175	415	1240
Latitude	41° 48′	41° 29′	42° 27′	40° 48′	38° 59′	39° 39′
Growing degree days[1]	3825	3849	3952	4366	5046	5060
Soil series and type	Paxton loam	Bridgehampton silt loam	Williamson and Kibbie silt loams	Hublersburg silt loam	Sassafras silt loam	Cavode silt loam
Limestone applied pounds per acre	6700	4000	6000	4000	3000	8000
Varieties grown	Potomac S-37	Potomac	Potomac Pennlate	Potomac Pennlate	Potomac Pennlate	Potomac Pennmead Pennlate
Date of seeding (1959)	May 5	May 7	April 23 and 24	April 23	August 27	May 15 overseeded Sept. 10
Seeding method	Broadcast	Corrugated roller-seeder	Corrugated roller-seeder	Corrugated roller-seeder	Broadcast cultipacked	Broadcast

[1]March 1 to September 26 with base of 40 F (15).

six months prior to seeding, each area was treated with herbicides to eliminate volunteer grasses. The area was limed to raise the soil pH to at least 6.5. Soil tests in subsequent years indicated no additional limestone was required. Eighty pounds of N, 70 pounds of P, and 133 pounds of K were worked into the soil just prior to seeding. The seedings were made at all locations in 1959 (Table 1) using one seed source, and satisfactory stands were obtained at each location. After the grass was established, broadleaf weeds were controlled with 2,4-D. Uniform applications of 66 pounds of P and 240 pounds of K were made during 1960, 1961, and 1962 with half applied in midsummer and half after the last fall harvest.

The experimental design was a randomized complete block with three replications. All yield data, plant notes, and chemical data were taken from a basic plot of 6 x 20 feet. Adjacent plots treated in exactly the same manner as the basic plot were used for food reserve studies at Pennsylvania and West Virginia.

Cutting Management. First harvests were made each spring at the following maturity stages: (a) pre-joint, when most unemerged heads were less than 2½ inches above the soil surface; (b) early head, when the tips of the heads were beginning to emerge on not over 10 per cent of the plants; (c) early bloom, when anthers were visible on not more than 10 per cent of the heads; and (d) past bloom, arbitrarily set at two weeks after the early bloom harvest date. Plots receiving the high rate of nitrogen were used as the index for determining time of harvest for all plots. All first harvests were cut uniformly to a 2½-inch stubble height.

In the first harvest season the second aftermath of the pre-joint treatment and the first aftermath of all other stage of growth treatments were cut either at 3½ or at 1½ inches above the soil surface. All other aftermath harvests were taken at a height of 2½ inches. In the second and third harvest seasons the two cutting heights were used on all aftermath cuttings except for the first aftermath of plants cut at pre-joint. The treatment was intensified because it was felt that imposing a differential cutting height on one aftermath cutting was not severe enough. Aftermath harvests were made when the extended leaf length was 12 to 18 inches. Regrowth periods of three-and-a-half-week minimum and six-week maxium were observed on all aftermath harvests with the exception of the first aftermath of the pre-joint treatment. This cut was made when the grass was at the early head growth stage. Therefore, aftermath yields reported for the pre-joint treatment are totals for the third and any subsequent harvests, whereas the yields listed under other stages are totals for the second and subsequent harvests. This distinction was adopted for the pre-joint treatment because the differential height of cut, which was the principal method in attempted redistribution was necessarily delayed to the third cutting.

All plots received a final cut for the season on a common date in the fall which approximated the average killing frost date for the area.

Nitrogen Fertilization. In the first year "low nitrogen" plots received 15 pounds per acre in early spring, 30 pounds per acre after each of the first two harvests, and 25 pounds per acre after the final fall harvest. The "high nitrogen" rates were 55, 110, and 25 pounds respectively. Rates of nitrogen fertilization were increased the second and third years because of nitrogen deficiency symptoms observed on the "high nitrogen" plants late in the season. For the second and third years, the low N treatments received 25 pounds of nitrogen shortly after growth began and after each harvest throughout the growing season. For the high rate the time of application was the same but 75 pounds of N were used, except following the final fall harvest when only 25 pounds were applied.

Yields. Weed-free yields of the seeded species were calculated from mower strips approximately 3 feet wide harvested from each plot, after which the remainder of the plot was cut to the same height. Cutter-bar mowers equipped with adjustable skids to control cutting height were used for all mowing operations. The yield samples were weighed and a subsample of approximately 1½ pounds was dried in forced air driers at 140 to 150 F for dry matter determinations and yield calculations.

Persistence Evaluation. Stands were rated twice annually: (a) in early spring as soon as plants of the pre-joint treatment showed two exposed ligules; and (b) in mid-fall within one month after the common harvest. Stand ratings were assigned to each treatment based on estimated percentage of ground cover of the seeded variety. A rating of "1" indicated 10 per cent, whereas a rating of "10" indicated 100 per cent cover.

Reserves. Recovery potential based on tiller growth from stored food reserves was determined on "Potomac" orchardgrass at Pennsylvania and at West Virginia. Core samples 3 inches in diameter to a 3-inch depth were removed after the first harvest at West Virginia and in the fall at Pennsylvania from the extra plots for measurement of recovery potential. The cores were placed in plastic cups, fine potting soil was firmed around the roots to a quarter-inch below the top of the container, and the sample was watered. Nitrogen as KNO_3 was then added at a 50-pound per acre rate to the surface of each container. The containers were then kept in dark cabinets at temperatures of 70 to 75 F. The etiolated leaf growth was cut to the established baseline at 10-day to 2-week intervals until recovery growth ceased. The number of tillers per sample were counted at each harvest. The etiolated growth was dried at 160 to 170 F to a constant weight. Dry weight in milligrams per tiller was then used as a measure of plant reserves or regrowth potential (66).

In vitro digestibility determinations of selected field samples from Pennsylvania and West Virginia were made at West Virginia University according to the method described by Jung **et al.** (36).

EXPERIMENTAL RESULTS

Total Yields of Dry Matter

Yields were markedly influenced by weather conditions. Both precipitation and temperatures during the first harvest season varied within the region (Appendix Tables 2A, 2B). Except for Pennsylvania and New York which experienced a 7-week mid-summer drought, weather conditions in the other states cooperating on this experiment were near normal. The second harvest season was most favorable for grass production. Cool, moist conditions were prevalent, generally, throughout the growing season, which resulted in the highest forage production of the three years at all locations. Yields in excess of 5 tons of dry matter per acre were obtained at all locations. The third harvest season was droughty. Regional average yields fell 35 per cent below those of the previous season. Connecticut and Rhode Island received more precipitation than the other cooperating states. Therefore, performance of the orchardgrass varieties grown in these states was not affected as adversely in the third harvest season as at the other locations. The influence of this drought should be taken into account when varietal performance is compared from site to site on a regional basis.

Potomac. The number of harvests per season (Appendix Table 1A) ranged from only two harvests in Pennsylvania during the severe drought of 1962, to seven at West Virginia during the first year. A greater number of harvests was made each year at each site when early spring harvests were made. The first harvest date ranged from April 15 at West Virginia to May 18 at Connecticut and Rhode Island. In the two southernmost states, Maryland and West Virginia, average first harvest dates for this variety were April 22 and April 24, respectively, over the three-year period. First harvests in the remaining cooperating states, generally, were taken during the first two weeks of May.

Over the three-year period, annual yields of weed-free dry matter at the six locations ranged from 1.05 to 6.57 tons of dry matter per acre per season with an average of 3.66 (Tables 2-4, Appendix Table 5A). Forage yields were increased at all locations when first harvests were delayed until early bloom or past bloom. Yield differences between these two harvest management treatments were generally quite small. Forage yields for the three-year period averaged higher for New York than elsewhere, irrespective of first harvest cutting management.

High nitrogen fertilization produced more forage than low nitrogen fertilization in all six states. An average of 1.30 tons more dry matter per acre was produced under high nitrogen, as compared with low nitrogen, throughout the region. Greater response to nitrogen fertilization for the Potomac variety was obtained at Rhode Island and the smallest at West Virginia. This was related to low nitrogen availability in the soil at Rhode Island. Forage production at Rhode Island was not comparable to that obtained at other locations unless high rates of nitrogen were applied.

Cutting the aftermath to either 1½ or 3½ inches had variable effects on seasonal production depending upon the harvest season and location, but cutting at 1½ inches usually produced higher yields than cutting at 3½ inches.

Numerous observations were made of interacting effects of cutting at various growth stages and nitrogen fertilization. The yield increase attributed to the additional nitrogen was generally greatest when the first cutting was taken at early bloom although some inconsistency in this response was noted. In a few instances, rate of nitrogen fertilization differentially affected the response from cutting the aftermath at two heights. When cutting height did affect seasonal total yields of orchardgrass, the 3½-inch cutting height was the more productive management at the high rate of nitrogen, whereas the 1½-inch height was more productive at the low rate of nitrogen.

Late Maturing Varieties. From two to six harvests of Pennlate were taken within the region (Appendix Table 1B). Generally, one less harvest per season was taken for Pennlate than was taken for Potomac. The pre-joint harvest treatments of Pennlate were generally cut a week after the same treatments of Potomac. Heading of Pennlate, however, occurred two weeks later than heading of Potomac.

Yields of Pennlate at four locations were approximately 10 per cent lower than those of Potomac (Tables 5-7, Appendix Table 5B). The response of Pennlate to stage of maturity at which the first harvest was taken, was similar to that of Potomac. Cutting the first crop at early bloom or past bloom generally resulted in the production of higher seasonal yields than when the first crop was cut earlier. A notable exception to this occurred at Maryland in the third harvest season. Under droughty conditions at Maryland, delaying the time of first harvest had no effect on total yields.

Total yields were increased 38 per cent by applying the additional nitrogen. Height of cutting Pennlate aftermath influenced season yields under dry conditions at New York and Pennsylvania. In both instances, cutting after-

TABLE 2

Dry Matter Produced by Potomac Orchardgrass in the First Harvest Year (1960)

Treatment			Total Yield T/A						Aftermath Yield T/A					
Stage at First Harvest	**N**	**Aftermath Cut**	**Conn.**	**R. I.**	**N. Y.**	**Pa.**	**Md.**	**W. Va.**	**Conn.**	**R. I.**	**N.Y.**	**Pa.**	**Md.**	**W. Va.**
Pre-joint	High	High	4.07de[1]	3.36b	4.91cd	3.46c	4.37def	4.01def	2.17e	2.88a	3.04c	1.25fg	2.84ab	3.45a
	High	Low	4.42cd	3.15b	5.28bc	3.53c	4.81bcd	3.78ef	2.38de	2.65b	3.33bc	1.15fg	3.13a	3.32a
	Low	High	2.70h	1.34e	3.60f	2.33e	3.03jk	2.50hi	1.06i	1.09cd	2.01g	.67hi	1.80de	2.04b-f
	Low	Low	2.71h	1.41e	3.67f	2.41d	3.12jk	2.52hi	1.17i	1.19c	2.04g	.55i	1.93de	2.09b-f
Early head	High	High	4.61c	3.38b	5.76b	3.66c	3.75ghi	4.14cde	3.27a	2.63b	4.16a	2.55a	2.70ab	3.66a
	High	Low	4.64c	3.23b	5.60b	3.88bc	4.34d-g[2]	3.69ef	3.22a	2.52b	4.01a	2.71a	3.09a	3.29a
	Low	High	3.08gh	1.34e	3.68f	2.40d	2.90k	2.34i	1.87fg	.94d	2.39f	1.68d	2.16cd	1.98c-f
	Low	Low	3.00gh	1.47e	3.87f	2.89d	3.47ij	2.62hi	1.90f	1.06cd	2.55ef	1.80cde	2.41bc	2.21b-e
Early bloom	High	High	5.21ab	4.24a	6.49a	4.60a	5.17abc	5.31a	2.94b	2.48b	3.43b	2.40ab	2.82ab	3.75a
	High	Low	5.08b	4.12a	6.48a	4.31ab	5.47a	5.00ab	2.76bc	2.54b	3.33bc	2.35ab	2.77ab	3.61a
	Low	High	3.37fg	1.87d	4.82cde	2.69d	3.73hi	2.97gh	1.90gh	1.07cd	1.80gh	1.32efg	1.71e	1.89def
	Low	Low	3.73ef	1.97cd	5.00cd	2.80d	3.87f-i	3.62ef	1.62fgh	1.08cd	1.99g	1.42ef	1.90de	2.35bcd
Past bloom	High	High	5.23ab	4.27a	5.65b	4.42a	4.68cde	4.57bcd	2.56cd	2.56b	2.64def	2.04bcd	1.93de	2.42bc
	High	Low	5.49a	4.10a	5.68b	4.43a	5.31ab	4.65bc	2.66c	2.30b	2.72de	2.10bc	2.50bc	2.50b
	Low	High	4.05de	2.01cd	4.42e	2.76d	3.89f-i	2.84ef	1.65fgh	1.06cd	1.47i	1.13fg	1.58e	1.86ef
	Low	Low	4.15d	2.28c	4.60de	2.65d	4.14e-h	3.50fg	1.52h	1.25c	1.65hi	.97gh	1.67e	1.65f
Averages:														
PJ			3.48u	2.32t	4.37s	2.93t	3.83s	3.20s	1.70u	1.95r	2.61s	.91u	2.42rs	2.73r
EH			3.83t	2.36t	4.73s	3.22s	3.61t	3.20s	2.56r	1.79r	3.28r	2.24r	2.59r	2.79r
EB			4.35s	3.05s	5.70r	3.61r	4.56r	4.23r	2.30s	1.79r	2.64s	1.94s	1.92t	2.90r
PB			4.73r	3.16r	5.09rs	3.56r	4.51r	4.14r	2.10t	1.84r	2.12t	1.57t	2.30s	2.11s
	High		4.84w	3.73w	5.73w	4.08w	4.74w	4.39w	2.74w	2.60w	3.33w	2.12w	2.72w	3.25w
	Low		3.35x	1.71x	4.21x	2.59x	3.52x	2.99x	1.59x	1.09x	1.99x	1.21x	1.90x	2.01x
		High	4.04y	2.73y	4.92y	3.30y	3.94z	3.71y	2.18y	1.86y	2.62y	1.62y	2.19z	2.63y
		Low	4.15y	2.72y	5.02y	3.38y	4.32y	3.67y	2.15y	1.85y	2.70y	1.70y	2.42y	2.63y
C. V. %				6.0	5.3	8.8	7.4	8.3		6.5	6.3	13.4	9.5	9.2

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.

[2](d-g) indicates the inclusion of d, e, f, g

TABLE 3

Dry Matter Produced by Potomac Orchardgrass in the Second Harvest Year (1961)

Treatment			Total Yield T/A						Aftermath Yield T/A					
Stage at First Harvest	N	Aftermath Cut	Conn.	R.I.	N.Y.	Pa.	Md.	W. Va.	Conn.	R. I.	N. Y.	Pa.	Md.	W. Va.
Pre-joint	High	High	4.63bc[1]	3.59c	5.49c	4.36cde	4.63b	4.20de	3.28a	2.64ab	3.32a	3.11ab	2.24cde	2.43b-e[2]
	High	Low	3.37d	3.88bc	5.27c	4.82abc	4.76b	4.31d	1.97bcd	2.87a	2.77bc	3.29a	2.30cd	2.21def
	Low	High	3.01d	1.63f	4.05d	3.38f	3.24f	3.43e	2.09bc	1.23f	2.38ef	2.53cd	1.83f	1.59gh
	Low	Low	2.60d	2.01e	3.70d	3.39f	3.49def	3.29e	1.76cd	1.58e	2.19fg	2.33def	1.84f	1.33h
Early head	High	High	4.19c	4.08b	5.31c	4.62bc	4.70b	5.45abc	2.70a	2.67a	3.31a	2.70bcd	3.10a	3.24a
	High	Low	3.53d	4.19b	5.13c	4.74bc	4.50b	4.90bcd	1.79cd	2.79a	3.21a	2.99ab	2.74ab	2.87abc
	Low	High	3.13d	1.91f	4.06d	3.27f	3.33f	4.72cd	1.83bcd	1.24f	2.62cde	1.87efg	2.34cd	2.99ab
	Low	Low	3.17d	2.55d	3.92d	3.67ef	3.56def	4.30d	1.80cd	1.77c	2.43def	2.28def	2.54bc	2.64a-d
Early bloom	High	High	5.59a	5.06a	6.05d	4.48cd	5.33a	5.95a	2.66a	2.23cd	2.81bc	2.25def	1.92ef	2.89abc
	High	Low	5.18ab	5.25a	6.26ab	5.60a	5.24a	5.63ab	2.19bc	2.42bc	2.94b	2.98abc	1.84f	2.63a-d
	Low	High	3.36d	2.37de	5.01c	3.66ef	3.48ef	4.78cd	1.65de	1.04f	2.10fg	1.08h	1.73f	2.26cde
	Low	Low	3.49d	2.42d	5.41c	4.28cde	4.05c	4.28d	1.65de	1.24f	2.20fg	1.82fg	1.99def	1.62fgh
Past bloom	High	High	5.77a	5.16a	6.57a	4.87abc	5.28a	5.78a	2.26b	2.27cd	2.72bc	2.39de	1.74f	2.69a-d
	High	Low	5.17ab	5.22a	6.27ab	5.31ab	5.23a	5.86a	1.85bcd	2.13d	2.67cd	2.57bcd	1.68fg	2.65a-d
	Low	High	3.09d	2.69d	5.24c	3.63ef	3.89cde	5.20abc	1.34e	1.23f	2.01gh	1.37gh	1.39g	2.15d-g
	Low	Low	3.38d	2.60d	5.03e	3.75def	3.91cd	5.26abc	1.36e	1.21f	1.91h	1.26h	1.64fg	1.96efg
Averages:														
PJ			3.40s	2.78s	4.63s	3.99t	4.03s	3.81t	2.28r	2.08r	2.67s	2.81r	2.05s	1.89t
EH			3.50s	3.18s	4.60s	4.08st	4.02s	4.84s	2.03s	2.12r	2.89r	2.46s	2.68r	2.94r
EB			4.40r	3.78r	5.68r	4.50r	4.53r	5.16s	2.04s	1.73s	2.51t	2.03t	1.87t	2.35s
PB			4.36r	3.92r	5.78r	4.39rs	4.58r	5.53r	1.70t	1.71s	2.33u	1.90t	1.61u	2.36s
	High		4.68w	4.55w	5.79w	4.85w	4.96w	5.26w	2.34w	2.50w	2.97w	2.78w	2.20w	2.70w
	Low		3.15x	2.27x	4.55x	3.63x	3.62x	4.41x	1.68x	1.32x	2.23x	1.82x	1.91x	2.07x
		High	4.10y	3.31z	5.22y	4.03z	4.23y	4.94y	2.23y	1.82z	2.66y	2.16z	2.04y	2.53y
		Low	3.74z	3.52y	5.12y	4.44y	4.34y	4.73y	1.80y	2.00y	2.54z	2.44y	2.07y	2.24z
C. V. %				5.8	5.6	10.2	5.3	8.0		6.7	5.4	13.3	8.8	13.7

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.
[2](b-e) indicates the inclusion of b, c, d, e

TABLE 4

Dry Matter Produced by Potomac Orchardgrass in the Third Harvest Year (1962)

Treatment			Total Yield T/A						Aftermath Yield T/A					
Stage at First Harvest	N	Aftermath Cut	Conn.	R. I.	N.Y.	Pa.	Md.	W. Va.	Conn.	R. I.	N. Y.	Pa.	Md.	W. Va.
Pre-joint	High	High	3.86de[1]	3.64b	2.87def	1.44bcd	2.88a-d	3.06d-h	2.88ab	2.65b	1.83abc	.50ab	1.08ab	1.97abc
	High	Low	3.86de	3.96ab	2.79ef	1.15de	2.61b-f	3.02e-h	2.68abc	3.02a	1.81abc	.48abc	.77cd	1.77bcd
	Low	High	2.27i	1.54a	2.50f	1.17de	1.86fg	2.56h	1.31gh	1.18f	1.32efg	.31def	.91bc	1.61c-f
	Low	Low	2.56hi	1.96cd	2.59f	1.05e	2.20d-g	2.86fgh	2.25bcd	1.65d	1.49def	.32def	.94bc	1.62cde
Early head	High	High	4.70bc	3.57b	3.32bcd	1.63abc	2.69b-e	3.37c-f	3.12a	2.61b	1.93ab	.57a	1.02ab	2.21a
	High	Low	3.77e	3.77b	3.26b-e[2]	1.51abc	2.79a-e	3.06d-h	2.17cd	2.69b	1.99a	.52ab	1.01ab	2.08ab
	Low	High	2.68hi	1.52d	2.52f	1.31cde	1.79g	2.77gh	1.52efg	1.17f	1.24g	.35cde	1.09ab	1.95abc
	Low	Low	3.58ef	2.09c	2.56f	1.17de	2.04efg	2.74gh	2.24bcd	1.72d	1.28fg	.29def	1.19a	2.04ab
Early bloom	High	High	4.36c	4.34a	3.97a	1.63abc	3.10abc	4.43a	2.41bcd	2.53b	1.67cd	.47abc	.93bc	1.50d-g
	High	Low	4.26cd	4.33a	3.63abc	1.50abc	3.37ab	3.49cde	1.96def	2.49b	1.71bcd	.49abc	.97abc	1.03hi
	Low	High	2.95gh	2.07c	3.15cde	1.36cde	1.84fg	3.27c-g	1.01gh	1.18f	1.20gh	.22efg	.63e	1.17ghi
	Low	Low	3.22fg	2.11c	3.18cde	1.11de	2.20d-g	3.27c-g	1.40fgh	1.48de	1.23g	.14g	.95bc	1.26e-h
Past bloom	High	High	5.06b	3.89b	4.05a	1.70ab	3.59a	3.80bc	2.12cde	2.08c	1.22gh	.50ab	.86bcd	.98hi
	High	Low	5.51a	4.00ab	3.70ab	1.80a	3.61a	4.12ab	2.30bcd	1.97c	1.15gh	.39bcd	.98abc	1.25fgh
	Low	High	3.39efg	1.98cd	3.38bc	1.42bcd	2.19d-g	3.52cde	.78h	1.28ef	.98h	.20fg	.65d	.82i
	Low	Low	3.24fg	1.82cd	3.16cde	1.42bcd	2.54c-g	3.60bcd	.81h	.99f	.64i	.20fg	.76cd	.89i
Averages:														
PJ			3.14t	2.78s	2.69t	1.20u	2.39s	2.87s	2.28r	2.13r	1.61r	.40r	.93s	1.74s
EH			3.68s	2.74s	2.92s	1.40t	2.33s	2.98s	2.26r	2.05r	1.61r	.43r	1.08r	2.07r
EB			3.70s	3.21r	3.48r	1.46s	2.63rs	3.62r	1.70s	1.92s	1.45s	.33s	.88st	1.24t
PB			4.30r	2.92s	3.57r	1.58r	2.98r	3.76r	1.50s	1.58t	1.00t	.33s	.81t	.98u
	High		4.42w	3.93w	3.45w	1.57w	3.08w	3.54w	2.46w	2.51w	1.66w	.49w	.95w	1.60w
	Low		2.98x	1.89x	2.88x	1.26x	2.08x	3.07x	1.42x	1.33x	1.17x	.26x	.90w	1.42x
		High	3.66y	2.82z	3.22y	1.48y	2.49y	3.35y	1.89y	1.84z	1.42y	.39y	.90y	1.53y
		Low	3.75y	3.01y	3.11y	1.34z	2.67y	3.27y	1.98y	2.00y	1.41y	.35y	.95y	1.49y
C. V. %				7.7	8.6	11.9	15.7	8.5		6.8	9.6	22.0	12.7	12.4

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.
[2](b-e) indicates the inclusion of b, c, d, e

math stubble to a height of 3½ inches resulted in greater production than cutting the stubble to a height of 1½ inches.

At Connecticut, approximately the same number of harvests was taken for "S 37" as was taken for Potomac. Time of harvest of the first crop at all growth stages was approximately a week later than Potomac. The variety, "S 37," was less productive (18 per cent) than Potomac under Connecticut conditions. Stage of growth at first harvest had less influence on total forage produced by "S 37" than on forage produced by Potomac. Nevertheless, delaying time of first harvest resulted in increasing total yields. Over the three-year period, the "S 37" stands fertilized at the high rate of nitrogen out-yielded those fertilized at the low rate of nitrogen by 1.36 tons of dry matter per acre. Yield increases attributed to cutting height of aftermath were of more importance at the high rate of fertilization. When these differences were apparent, the 3½-inch cutting height was better.

Aftermath Production

The reader should bear in mind that aftermath yields reported for the pre-joint treatment are totals for the third and any subsequent harvests, whereas yields listed under the other stages are totals for the second and subsequent harvests. This distinction was adopted for the pre-joint treatment because the differential height of cut, which was the principal method in attempted redistribution, was necessarily delayed until the third cutting. For the pre-joint treatment, the first cut was made at a pre-joint stage and the second when the same crop of stems was heading. In the other plots, cuts above or below the apex level in the regrowth could be made at the second harvest since the first crop of stems was removed in the first cut. In terms of dates, then, the "aftermath" reported here for grass cut at the pre-joint stage began to grow later in the season than did the aftermath for grass cut at early head. Because of the adverse effects of summer heat and drought, this difference may be important.

Potomac. Yields of aftermath forage produced by Potomac orchardgrass during the three-year harvest period differed by more than 4 tons of dry matter per acre. The most beneficial time of first harvest for the production of large aftermath yields was at the early head growth stage. Delaying time of first harvest until past bloom reduced aftermath yields an average of 25 per cent for the region for the three harvest years.

The higher rate of nitrogen increased aftermath yields for the region 50 per cent for the three-year period. Only at Maryland under dry conditions were yields comparable for the two rates of nitrogen.

The overall effect of the difference in stubble height was usually negligible. Even when some effect was noted, the results were not consistent at all locations. Cutting the aftermath to a stubble height of either 1½ inches (Rhode Island, Pennsylvania, Maryland), or 3½ inches (New York and West Virginia), sometimes resulted in highest yields.

The imposed treatments interacted more frequently at Rhode Island and Maryland than elsewhere and influenced aftermath production more than total yields. Larger increases in yield due to the extra nitrogen were often found when the first harvest was taken early, and least advantage of the extra nitrogen was obtained when the first harvest was taken at past bloom. Higher aftermath yields were obtained at Rhode Island and Maryland at the low rate of nitrogen with the 1½-inch stubble height management, whereas at the higher rate of nitrogen larger yields were sometimes obtained when the stubble was cut to 3½ inches.

Late Maturing Varieties. Aftermath production of Pennlate was generally greatest when the first growth was cut at the early head growth stage at all locations. Aftermath production was increased with additional nitrogen except during a dry year at Maryland. On the other hand, height of cutting had, in general, little influence on aftermath yields.

Several instances of interaction between time of first harvest and rate of nitrogen were noted for Pennlate. Delaying time of first harvest until past bloom lessened the advantage from the additional nitrogen. However, none of the earlier harvest stages was consistently best in this respect.

TABLE 5

Dry Matter Produced by Late Maturing Orchardgrass Varieties in the First Harvest Year (1960)

Treatment			Total Yield T/A				Aftermath Yield T/A			
			S 37	Pennlate			S 37	Pennlate		
Stage at First Harvest	N	Aftermath Cut	Conn.	N. Y.	Pa.	Md.	Conn.	N. Y.	Pa.	Md.
Pre-joint	High	High	3.92d[1]	5.65b	3.59b	3.40c	2.09bc	2.54bcd	1.26de	2.17bc
	High	Low	3.55de	5.52b	3.68ab	3.38c	1.94cd	2.43cde	1.26de	2.35a
	Low	High	2.23h	4.08e	2.31cd	1.82g	.88h	1.56gh	.69g	1.36fg
	Low	Low	2.66gh	4.51de	2.60c	2.16fg	1.05gh	1.84efg	.59g	1.55e
Early head	High	High	3.86d	5.65b	3.63ab	3.37c	2.51a	3.28a	2.27a	2.18b
	High	Low	4.04cd	5.53b	4.27a	3.62bc	2.53a	3.11a	2.57a	2.46a
	Low	High	2.86fg	4.20e	1.92d	2.64de	1.52ef	2.19efg	1.33d	1.84d
	Low	Low	2.72g	4.15e	2.16cd	2.37ef	1.71de	2.23def	1.44cd	1.77d
Early bloom	High	High	4.79ab	6.25a	4.02ab	4.09ab	2.43a	2.77b	2.19ab	1.86d
	High	Low	4.42bc	6.35a	4.03ab	4.27a	2.27ab	2.76b	1.97b	2.07c
	Low	High	3.62de	4.71cd	2.37cd	2.66de	1.67de	1.60fgh	1.03ef	1.30gh
	Low	Low	3.03f	5.02c	2.45cd	2.61de	1.34efg	1.89efg	1.22de	1.42efg
Past bloom	High	High	4.93a	5.93ab	4.22ab	4.06ab	2.05c	2.09efg	1.62c	1.48ef
	High	Low	4.74ab	6.21a	4.04ab	4.05ab	1.96cd	2.26def	1.47cd	1.73d
	Low	High	3.65de	5.02c	2.61c	2.86d	1.39efg	1.34h	.79fg	1.22hi
	Low	Low	3.30ef	4.90cd	2.22cd	2.74de	1.28fg	1.49h	.75g	1.11i
Averages:										
PJ			3.09t	4.94s	3.04r	2.69t	1.49s	2.09t	.95u	1.86s
EH			3.37s	4.88s	3.00r	3.00s	2.07r	2.70r	1.90r	2.06r
EB			3.96r	5.58r	3.22r	3.41r	1.93r	2.26s	1.60s	1.66t
PB			4.16r	5.52r	3.27r	3.43r	1.67s	1.80u	1.16t	1.38u
	High		4.28w	5.89w	3.94w	3.78w	2.22w	2.66w	1.83w	2.04w
	Low		3.01x	4.57x	2.33x	2.48x	1.36x	1.77x	.98x	1.45x
		High	3.73y	5.19y	3.08y	3.11y	1.82y	2.17y	1.40y	1.68z
		Low	3.56y	5.28y	3.18y	3.15y	1.76y	2.25y	1.41y	1.81y
C. V.%				4.7	11.4	7.9		7.9	9.8	4.0

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.

TABLE 6

Dry Matter Produced by Late Maturing Orchardgrass Varieties in the Second Harvest Year (1961)

Treatment			Total Yield T/A				Aftermath Yield T/A			
			S 37	Pennlate			S 37	Pennlate		
Stage at First Harvest	N	Aftermath Cut	Conn.	N. Y.	Pa.	Md.	Conn.	N. Y.	Pa.	Md.
Pre-joint	High	High	4.42bc[1]	5.02bc	4.49a	4.28a	3.01a	2.87a	2.05bc	2.17a-f[2]
	High	Low	3.51d	4.34bcd	4.71a	4.09a	1.25g	2.77ab	2.22b	1.60b-f
	Low	High	2.44e	3.79ef	3.01bcd	2.53c	1.68ef	2.18def	1.09efg	1.26d-g
	Low	Low	2.50e	3.57f	3.42bc	2.94bc	1.57efg	1.91fg	1.23ef	1.33c-g
Early head	High	High	4.66ab	5.04bc	5.13a	4.20a	3.16a	2.63abc	3.42a	1.99ab
	High	Low	3.91cd	4.82bcd	4.97a	4.16a	2.51b	2.48bcd	3.27a	2.00ab
	Low	High	2.78e	4.17ef	2.70d	2.81bc	2.15cd	2.18def	1.64d	1.78abc
	Low	Low	2.53e	4.28de	2.80d	2.59bc	1.81de	2.29cde	1.90d	1.77a-d
Early bloom	High	High	4.88ab	6.02a	4.90a	4.24a	2.55b	2.67ab	2.06bc	1.71a-e
	High	Low	4.03cd	6.24a	5.00a	4.07a	1.85de	2.81ab	2.23b	1.74a-d
	Low	High	2.60e	5.01bc	3.45bc	2.46c	1.53efg	2.03efg	1.08efg	1.13fg
	Low	Low	2.52e	4.73cd	3.41bc	2.76bc	1.48efg	1.81g	1.33e	1.34c-g
Past bloom	High	High	5.18a	5.99a	4.79a	4.58a	2.41bc	2.19def	1.86cd	1.23efg
	High	Low	4.85ab	6.32a	4.66a	4.67a	2.03de	2.19def	1.77cd	1.37c-g
	Low	High	2.90e	4.87bc	3.51bc	3.18b	1.43fg	1.67g	.98fg	1.07g
	Low	Low	2.74e	5.31b	3.61b	3.21b	1.29g	1.75g	.88g	1.02g
Averages:										
PJ			3.22t	4.30t	3.91r	3.46s	1.88s	2.43r	1.65s	1.59s
EH			3.47s	4.58st	3.90r	3.44s	2.41r	2.40r	2.64r	1.89r
EB			3.50s	5.50r	4.19r	3.38s	1.85s	2.35r	1.68s	1.48s
PB			3.92r	5.62r	4.14r	3.91r	1.79s	1.95s	1.37t	1.17t
	High		4.43w	5.54w	4.83w	4.29w	2.35w	2.58w	2.36w	1.73w
	Low		2.63x	4.47x	3.24x	2.81x	1.62x	1.98x	1.30x	1.34x
		High	3.73y	4.99y	4.00y	3.53y	2.24y	2.30y	1.81y	1.54y
		Low	3.56y	5.01y	4.07y	3.56y	1.72z	2.25y	1.85y	1.52y
C. V.%				6.1	9.5	9.7		8.6	9.8	16.9

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.
[2](a-f) indicates the inclusion of a, b, c, d, e, f

TABLE 7

Dry Matter Produced by Late Maturing Orchardgrass Varieties in the Third Harvest Year (1962)

Treatment			Total Yield T/A				Aftermath Yield T/A			
			S 37	Pennlate			S 37	Pennlate		
Stage at First Harvest	N	Aftermath Cut	Conn.	N.Y.	Pa.	Md.	Conn.	N. Y.	Pa.	Md.
Pre-joint	High	High	3.49bc[1]	2.14b-e[2]	1.38de	2.64a-d	2.46a	.91a	.49a	.94abc
	High	Low	3.21cd	1.77de	1.35def	2.35a-e	1.94bc	.77a	.39ab	.46efg
	Low	High	1.74f	1.91cde	1.16efg	1.87de	1.02fg	.73a	.31bc	.79bcd
	Low	Low	2.18efg	1.68e	.90g	1.79e	1.33e	.57a	.24cde	.72cde
Early head	High	High	2.65de	2.88ab	1.58a-d	2.53a-e	2.32a	1.45a	.45a	.82bcd
	High	Low	2.00efg	2.65abc	1.55a-d	2.70abc	1.66cd	1.18a	.40a	1.00ab
	Low	High	1.93fg	2.28a-e	1.27def	1.75e	1.31e	1.09a	.19def	.94abc
	Low	Low	1.84fg	2.25a-e	1.01fg	1.99cde	1.28ef	1.07a	.10f	1.16a
Early bloom	High	High	4.29a	3.01a	1.85ab	2.74abc	1.97b	.91a	.43a	.59def
	High	Low	3.88ab	2.98a	1.74abc	2.92a	1.37de	1.32a	.38ab	.67cde
	Low	High	2.14efg	2.48a-d	1.53bcd	1.74e	.68h	.77a	.30bcd	.60def
	Low	Low	2.32efg	2.62abc	3.41cde	1.92cde	.81h	.90a	.23cde	.74bcd
Past bloom	High	High	2.43ef	2.93a	1.89a	2.84ab	1.57de	.85a	.21c-f	.25g
	High	Low	2.66de	2.36a-e	1.87ab	2.93a	1.67cd	.50a	.20c-f	.34fg
	Low	High	2.25efg	2.67abc	1.46cde	2.34a-e	.85gh	.55a	.15ef	.31g
	Low	Low	2.21efg	2.82ab	1.29def	2.01b-e	.79gh	.50a	.13ef	.32g
Averages:										
PJ			2.66r	1.88s	1.20t	2.16r	1.69r	.75t	.36r	.73s
EH			2.10s	2.52r	1.35s	2.24r	1.64r	1.16r	.28s	.98r
EB			3.16r	2.77r	1.64r	2.33r	1.21s	.98s	.34r	.65s
PB			2.38r	2.70r	1.61r	2.53r	1.22s	.60t	.17t	.30t
	High		3.07w	2.59w	1.64w	2.71w	1.87w	.99w	.37w	.63w
	Low		2.08x	2.34x	1.26x	1.92x	1.01x	.77x	.21x	.70w
		High	2.62y	2.54y	1.52y	2.31y	1.52y	.91y	.32y	.66y
		Low	2.54y	2.39z	1.38z	2.32y	1.36z	.85y	.26z	.68y
C. V.%				16.5	12.7	18.4		20.6	21.2	20.2

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.
[2](b-e) indicates the inclusion of b, c, d, e

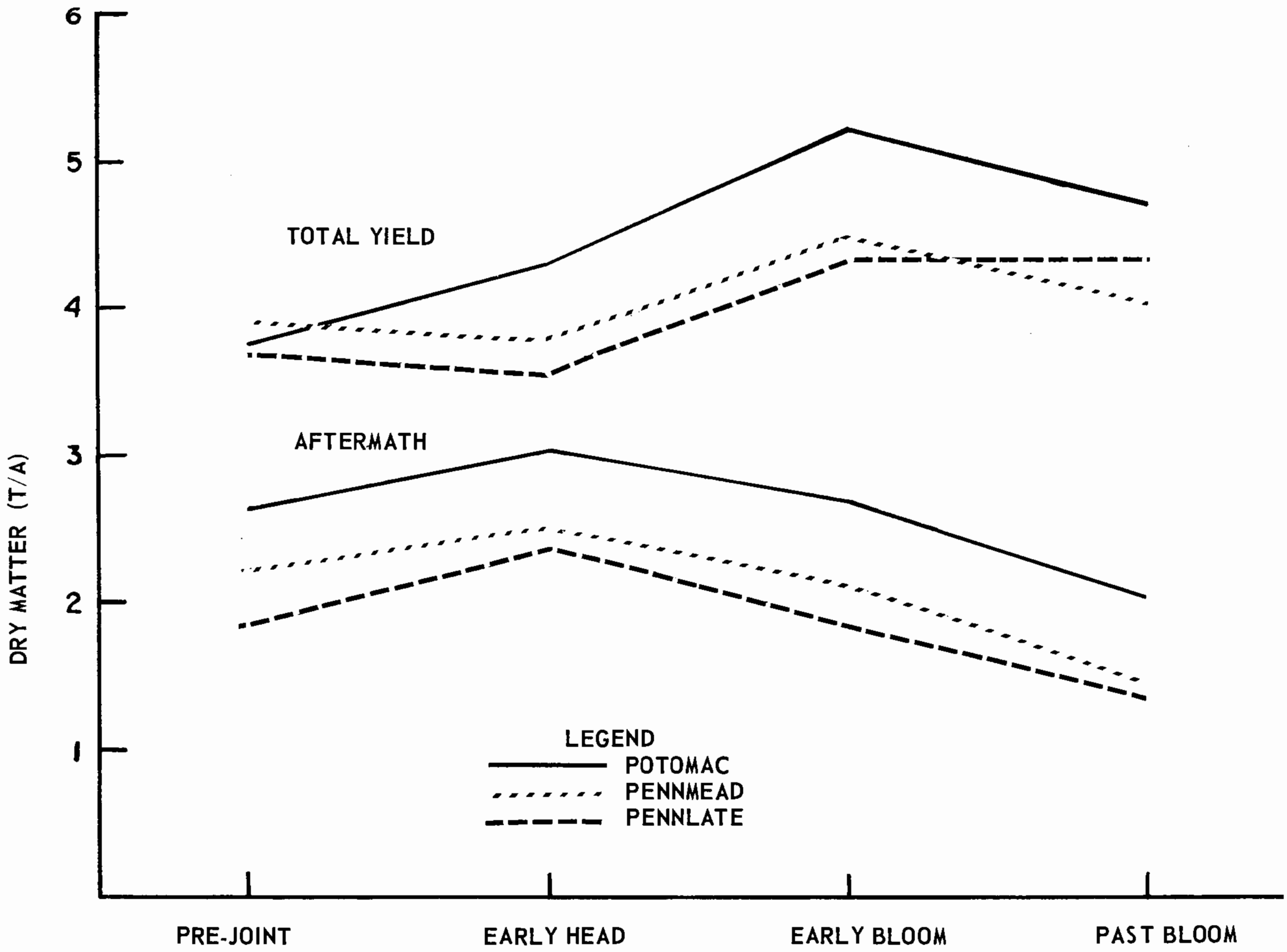

Figure 1. Dry matter yields of three orchardgrass varieties harvested each spring at different stages of growth over a 3-year (1960-62) *period at West Virginia.*

Two late maturing orchardgrass varieties were compared with Potomac at West Virginia. Under these conditions, time of heading of Pennmead was intermediate between that of Potomac and Pennlate. Varietal differences in yield when the three varieties were grown for three years at one rate of nitrogen (high) and aftermath cut at one height (3½ inches) are graphically portrayed in Figure 1. Aftermath yields of Pennmead were approximately 20 per cent less and those of Pennlate 28 per cent less than aftermath yields of Potomac. These yield differences were twice those observed for total yields. It should be noted that when the first cutting each season was taken at the pre-joint growth stage, seasonal total yields of the varieties were equal.

Aftermath production of S 37 was maximized by taking the first harvest at early head, by using the higher rate of nitrogen and cutting the aftermath stubble to a height of 3½ inches.

Regrowth Potential

The recovery potential of Potomac orchardgrass in the dark as determined by the weight of etiolated regrowth produced following the first harvest for each of four growth stages at West Virginia is presented in Table 8. In general, the trends indicated that food reserves were highest

TABLE 8

Potomac Orchardgrass Recovery Potential

Stage at First Harvest	Level of N	Cutting Height	Etiolated Regrowth (mg./tiller) Harvest Year: First, Spring* (W. Va.)	Second, Spring (W. Va.)	Second, Fall (Pa.)	Third, Spring (W. Va.)	Third, Fall (Pa.)
Pre-joint	High	High	34.77abc[1]	14.67bcd	3.62b	12.33c	10.95b
	High	Low	28.03c	16.00a-d[2]	3.62b	12.67c	13.18b
	Low	High	37.06abc	22.33a	7.83a	20.67a	8.54b
	Low	Low	28.37c	19.00ab	6.36ab	13.67bc	9.62b
Early head	High	High	29.87bc	11.00cde	5.22ab	16.33abc	11.92b
	High	Low	38.93ab	7.33e	3.33b	12.67c	19.72a
	Low	High	39.90a	11.33cde	6.57ab	19.67ab	8.30b
	Low	Low	38.30abc	10.33cde	3.85b	20.00ab	9.90b
Early bloom	High	High	9.27d	18.67ab	7.64a	18.33abc	11.92b
	High	Low	10.10d	16.00a-d	3.85b	16.33abc	11.40b
	Low	High	15.87d	17.33abc	5.48ab	14.66abc	8.79b
	Low	Low	11.73d	16.67a-d	3.93b	16.67abc	12.10b
Past bloom	High	High	10.10d	9.66de	6.58a	14.33abc	11.98b
	High	Low	8.43d	10.33cde	3.81b	13.67bc	8.64b
	Low	High	14.23d	12.33b-e	4.04b	15.67abc	9.31b
	Low	Low	10.67d	12.00b-e	4.52ab	18.00abc	8.34b
Averages:							
PJ			32.06r	18.00r	5.27r	14.83r	10.57rs
EH			36.75r	10.00s	4.74r	17.17r	12.46r
EB			11.74s	17.17r	5.22r	16.50r	11.05rs
PB			10.86s	10.08s	4.74r	15.42r	9.57s
	High		21.19x	12.96x	4.66w	14.58x	12.46w
	Low		24.52w	15.17w	5.32w	17.38w	9.36x
		High	23.88y	14.66y	5.87y	16.50y	10.21y
		Low	21.82y	13.46y	4.11z	15.46y	11.61y

*On this sampling date, the plants had not been subjected to the differential height of cut.
[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.
[2](a-d) indicates the inclusion of a, b, c, d

in the stubble following cutting at the early vegetative stage or early heading in combination with the low rate of nitrogen, whereas food reserve levels were lowest following cutting at the past bloom stage in combination with the high rate of nitrogen. These differences were much more pronounced during the first harvest season than they were in later years. It is not known, however, whether this effect was dimished as a result of the accumulative effects of the cutting treatments or as a result of drought. Etiolated growth was generally less with the highest rate of nitrogen fertilization. On the other hand, height of cutting aftermath had little effect on reserves in the stubble of spring growth.

Recovery potential of Potomac orchardgrass was also determined in the fall of the second and third harvest years at Pennsylvania. Differences in etiolated growth associated with treatment effects were larger at the end of the third harvest year than at the end of the second harvest year. In fact, the only treatment which affected etiolated growth in the fall of the second harvest season was that of aftermath height of cut; reserves were higher in plants cut to a 3½-inch stubble as compared to a 1½-inch stubble. Following a droughty third harvest season, several management treatments affected the recovery potential of Potomac orchardgrass. Reserves were highest when the first harvest was taken at early head and the high rate of nitrogen was used in conjunction with clipping the aftermath at a height of 1½ inches. Low recovery potential values were obtained when the first harvest was delayed until the past bloom stage. In general, greater recovery was obtained with the high rate of nitrogen.

Persistence

Potomac. Stands of Potomac, as indicated by per cent ground cover, were not adversely affected by cutting at different stages of maturity at any location within the region (Tables 9-11). High rates of nitrogen fertilization, however, reduced ground cover at all locations when compared with lower rates of nitrogen fertilization. Cutting height at which the first aftermath was removed did influence stand survival but not in the same manner at the various locations. At Connecticut and West Virginia, stands were denser under the high stubble cut, whereas at Maryland and Pennsylvania the reverse was true. At New York, stand survival was essentially unaffected by height of stubble. The entire stand was lost at Rhode Island during the winter of 1962-63, irrespective of management treatments.

Late Maturing Varieties. Stands of Pennlate orchardgrass were affected differentially within

TABLE 9

Stand Ratings of Potomac Orchardgrass in the Spring of the Second Harvest Year (1961)

Treatment			Stand Rating 1=10% 10=100% ground cover					
Stage at First Harvest	N	Aftermath Cut	Conn.	R. I.	N. Y.	Pa.	Md.	W. Va.
Pre-joint	High	High	9.8	Excellent	7.3a[1]	5.3b	9.7a	9.0abc
	High	Low	9.6	stands and	7.0ab	8.0ab	10.0a	9.0abc
	Low	High	9.8	treatment	6.3ab	6.3ab	9.7a	8.8abc
	Low	Low	9.8	differences not	7.0ab	7.7ab	10.0a	8.6abc
Early head	High	High	9.9	apparent	7.3a	6.7ab	8.3b	8.9abc
	High	Low	9.9		6.7ab	8.7a	9.0ab	8.6abc
	Low	High	9.7		7.0ab	8.0ab	9.7a	8.9abc
	Low	Low	9.3		6.7ab	8.0ab	9.7a	9.3a
Early bloom	High	High	9.5		6.3ab	7.0ab	9.3ab	8.8abc
	High	Low	9.7		6.0b	7.0ab	9.3ab	8.3c
	Low	High	9.5		7.0ab	5.3ab	10.0a	8.8abc
	Low	Low	9.8		6.7ab	7.7ab	9.7a	9.1ab
Past bloom	High	High	9.0		6.7ab	7.3ab	9.0ab	8.7abc
	High	Low	9.5		7.0ab	7.3ab	9.7a	8.4bc
	Low	High	9.7		7.0ab	6.3ab	9.7a	8.8abc
	Low	Low	9.6		7.0ab	7.3ab	9.7a	8.6abc
Averages:								
PJ			9.8		6.9r	6.8rs	9.8r	8.9r
EH			9.7		6.9r	7.8r	9.2s	8.9r
EB			9.6		6.5r	6.7s	9.6rs	8.8r
PB			9.4		6.9r	7.1rs	9.3rs	8.6r
	High		9.6		6.9w	6.5x	9.2x	8.7w
	Low		9.6		6.8w	7.7w	9.8w	8.9w
		High	9.6		6.9y	7.2y	9.4z	8.8y
		Low	9.6		6.8y	7.1y	9.5y	8.7y
C. V. %					3.9	13.5	5.9	3.9

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.

the region by stage of growth at first harvest (Tables 12-14). At Maryland stands at the end of three years were thinner when harvests were made for the first time each year at the pre-joint stage of maturity in conjunction with high rates of nitrogen, whereas at New York and Pennsylvania stands were thinned with the high rate of nitrogen regardless of time of first harvest. At West Virginia (data not presented), stands persisted well, irrespective of time of first harvest. Stands of Pennlate thinned under high nitrogen fertilization, and cutting height had little influence on stand density (Tables 12-14).

The effect of imposing cutting and fertilization treatments on S 37 orchardgrass stands at Connecticut for one year was negligible. Stands previously cut at early head or past bloom and fertilized at the high rate of nitrogen deteriorated appreciably, however, following another harvest season. Winter-killing during the winter of 1962-63 was so severe that stand estimates were deemed meaningless in the spring of 1963.

Nutritive Evaluation

In vivo evaluations of Potomac orchardgrass forage were undertaken in cooperation with NE-24 representatives at Maryland and West Virginia. Figure 2 illustrates the drastic altera-

TABLE 10

Stand Ratings of Potomac Orchardgrass in the Spring of the Third Harvest Year (1962)

Treatment			Stand Rating 1=10% 10=100% ground cover					
Stage at First Harvest	**N**	**Aftermath Cut**	**Conn.**	**R. I.**	**N. Y.**	**Pa.**	**Md.**	**W. Va.**
Pre-joint	High	High	8.2	7.7cd[1]	3.3c	7.3b	8.8de	7.6ab
	High	Low	8.5	7.0de	3.0c	6.3c	9.2bcd	6.3c
	Low	High	9.8	9.7a	4.3abc	8.3a	10.0a	8.6a
	Low	Low	9.6	9.7a	5.0ab	9.0a	10.0a	7.9a
Early head	High	High	10.0	5.0bcd	3.3c	7.3b	7.8g	7.8a
	High	Low	9.3	7.0de	3.0c	7.0bc	8.5ef	5.6c
	Low	High	10.0	9.3ab	5.0ab	8.7a	9.7ab	8.2a
	Low	Low	10.0	9.3ab	5.0ab	9.0a	9.5abc	7.6ab
Early bloom	High	High	8.0	7.7cd	4.3abc	7.3b	9.0cde	7.6ab
	High	Low	9.1	7.7cd	3.3c	7.0bc	9.2bcd	6.6bc
	Low	High	10.0	9.7a	5.0ab	9.0a	10.0a	8.4a
	Low	Low	10.0	9.0abc	5.0ab	8.7a	10.0a	8.3a
Past bloom	High	High	9.8	5.0f	3.7bc	8.7bc	8.2f	7.7ab
	High	Low	9.8	6.0ef	3.7bc	7.0bc	8.5ef	7.6ab
	Low	High	9.7	8.3a-d[2]	5.3a	9.0a	9.5abc	8.1a
	Low	Low	10.0	8.3a-d	5.3a	9.0a	9.7ab	8.2a
Averages:								
PJ			9.0	8.5r	3.9r	7.8r	9.5r	7.6rs
EH			9.8	8.4r	4.1r	8.0r	8.9s	7.3s
EB			9.3	8.5r	4.4r	8.0r	9.5r	7.7rs
PB			9.8	6.9s	4.5r	7.9r	9.0s	7.9r
	High		9.1	7.0x	3.3x	7.0x	8.6x	7.1x
	Low		9.9	9.2w	4.8w	8.8w	9.8w	8.2w
		High	9.4	8.2y	4.1y	8.0y	9.1y	8.0y
		Low	9.5	8.0y	4.1y	7.9y	9.3y	7.3z
C. V. %					8.3	5.2	3.5	7.8

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.

[2](a-d) indicates the inclusion of a, b, c, d

TABLE 11

Stand Ratings of Potomac Orchardgrass in the Spring of the Residual Harvest Year (1963)

Treatment			Stand Rating 1=10% 10=100% ground cover					
Stage at First Harvest	**N**	**Aftermath Cut**	**Conn.**	**R. I.**	**N. Y.**	**Pa.**	**Md.**	**W. Va.**
Pre-joint	High	High	3.5	Stand	1.3f[1]	4.7c	8.8def	8.3abc
	High	Low	1.0	winter-	1.3f	5.3bc	9.0cde	8.0bc
	Low	High	6.0	killed	3.0b-e[2]	5.0bcd	9.8ab	8.9ab
	Low	Low	.5		2.7c-f	6.7a	9.8ab	8.5ab
Early head	High	High	4.0		1.3f	4.3d	8.3f	8.6ab
	High	Low	1.0		1.3f	4.7cd	8.7ef	7.3cd
	Low	High	8.0		4.7a	6.0ab	9.8ab	9.2a
	Low	Low	.5		4.3ab	6.0ab	10.0a	8.6ab
Early bloom	High	High	6.0		2.3def	4.7cd	8.7ef	7.8bcd
	High	Low	3.0		1.3f	5.0cd	9.0cde	6.7d
	Low	High	2.5		3.3a-d	5.0cd	9.5abc	8.6ab
	Low	Low	3.5		3.3a-d	6.0ab	10.0a	8.9ab
Past bloom	High	High	4.5		1.3f	5.0cd	8.8def	6.7d
	High	Low	3.5		1.7ef	4.7cd	9.3bcd	7.3cd
	Low	High	7.5		3.7a-d	6.0ab	9.5abc	8.9ab
	Low	Low	4.0		4.0abc	6.7a	9.8ab	8.8ab
Averages:								
PJ			2.8		2.1s	5.4r	9.4r	8.5r
EH			3.4		2.9r	5.2r	9.2r	8.4rs
EB			3.8		2.6rs	5.2r	9.3r	8.0rs
PB			4.9		2.7rs	5.6r	9.4r	7.9s
	High		3.3		1.5x	4.8x	8.8x	7.6x
	Low		4.1		3.6w	5.9w	9.8w	8.8w
		High	5.2		2.6y	4.9z	9.2z	8.4y
		Low	2.1		2.5y	6.0y	9.4y	8.0z
C. V. %					14.0	9.5	3.2	7.0

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.

[2](b-e) indicates the inclusion of b, c, d, e

tions that occur in the nutritive value of the spring growth of Potomac orchardgrass during maturation. Differences between locations may be related to physical and chemical characteristics of the grass (hay, Md.; green forage, W. Va.) and environmental conditions during the growth of the grass. Even with some apparent differences due to method of evaluation, the inescapable conclusion is that the nutritive value of orchardgrass decreases rapidly after heading.

An **in vitro** nutritive evaluation of certain Potomac and Pennlate orchardgrass samples collected at Pennsylvania and West Virginia in the third harvest year is presented in Table 15. These data show that the nutritive value of orchardgrass decreased rapidly following heading. On the other hand, the apparent quality of the aftermath forage was similar regardless of when the first harvest was taken. Differences due to locations were surprisingly small for either variety, but one notable difference was that the digestibility of the dry matter for the early growth stages of Potomac was considerably higher at West Virginia than it was at Pennsylvania, whereas the reverse was true at the past bloom growth stage. Another difference was that the digestibility of both dry matter and protein for the second cutting of the pre-joint treatment of Potomac was considerably higher at West Vir-

TABLE 12

Stand Ratings of Late Maturing Orchardgrass Varieties in the Spring of the Second Harvest Year (1961)

Treatment			Stand Rating 1 = 10 % 10 = 100 % ground cover			
			S 37	Pennlate		
Stage at First Harvest	N	Aftermath Cut	Conn.	N. Y.	Pa.	Md.
Pre-joint	High	High	9.3	7.0a[1]	6.7a	7.3bcd
	High	Low	9.2	6.7a	7.3a	7.7abc
	Low	High	8.5	6.0b	6.3a	8.7ab
	Low	Low	8.5	5.7bc	7.7a	9.0a
Early head	High	High	9.6	5.7bc	5.7a	8.7ab
	High	Low	9.5	6.0b	8.0a	8.3ab
	Low	High	8.0	5.7bc	6.0a	8.7ab
	Low	Low	9.5	5.3c	5.3a	8.3ab
Early bloom	High	High	9.8	5.7bc	5.7a	6.3d
	High	Low	9.0	6.0b	7.0a	7.3bcd
	Low	High	9.0	5.3c	5.3a	8.3ab
	Low	Low	9.0	5.7bc	6.0a	8.7ab
Past Bloom	High	High	9.8	6.0b	5.0a	6.3d
	High	Low	9.8	6.0b	6.7a	6.7cd
	Low	High	9.3	5.7bc	6.3a	8.7ab
	Low	Low	9.5	5.3c	6.7a	9.0a
Averages:						
PJ			8.9	6.3r	7.0r	8.2rs
EH			9.2	5.7s	6.2r	8.5r
EB			9.2	5.7s	6.0r	7.7s
PB			9.6	5.8s	5.9r	7.7s
	High		9.5	6.2w	5.8x	7.3x
	Low		8.9	5.6x	6.8w	8.7w
		High	9.2	5.9y	6.5y	7.9z
		Low	9.2	5.8y	6.8y	8.1y
C. V. %				3.1	16.8	10.2

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.

ginia than at Pennsylvania. With Pennlate at the early head stage, digestible dry matter and digestible protein percentages were higher at West Virginia than at Pennsylvania.

The digestible dry matter and digestible protein contents of the first crop for the two varieties were more closely associated with stage of growth than date of harvest.

DISCUSSION

It was expected from the beginning of these studies that orchardgrass would perform well. Orchardgrass is so well adapted to the conditions of the Northeast, particularly the southern part of the region, that it invades alfalfa stands.

These investigations clearly show that orchardgrass has characteristics which make it an excellent perennial forage grass. Yields

Table 13

Stand Ratings of Late Maturing Orchardgrass Varieties in the Spring of the Third Harvest Year (1962)

Treatment			Stand Rating 1 = 10 % 10 = 100 % ground cover			
			S 37	Pennlate		
Stage at First Harvest	N	Aftermath Cut	Conn.	N. Y.	Pa.	Md.
Pre-joint	High	High	7.1	2.3de[1]	6.0b	7.7cd
	High	Low	9.2	1.3a	6.0b	8.3bc
	Low	High	9.5	3.3a-d[2]	9.0a	8.8ab
	Low	Low	9.5	3.3a-d	8.3a	9.3a
Early head	High	High	0.6	3.3a-d	6.7b	8.8ab
	High	Low	0.5	3.0bcd	6.0b	8.8ab
	Low	High	8.0	4.0ab	9.0a	9.3a
	Low	Low	7.4	4.0ab	8.3a	9.3a
Early bloom	High	High	6.8	2.7cd	6.3b	7.5d
	High	Low	8.8	2.7cd	7.0b	8.5ab
	Low	High	9.2	3.7abc	8.7a	9.3a
	Low	Low	9.6	4.0ab	9.0a	9.3a
Past bloom	High	High	0.3	3.0bcd	6.3b	7.2d
	High	Low	0.3	3.3a-d	6.7b	7.7cd
	Low	High	7.1	4.3a	9.0a	9.0ab
	Low	Low	8.7	4.0ab	8.7a	9.3a
Averages:						
PJ			8.8	2.6s	7.3r	8.5st
EH			4.1	3.6r	7.5r	9.1r
EB			8.6	3.3r	7.8r	8.7s
PB			4.1	3.7r	7.7r	8.3t
	High		4.2	2.6x	6.4x	8.1x
	Low		8.6	3.7w	8.8w	9.2w
		High	6.1	3.2y	7.6y	8.4z
		Low	6.8	3.1y	7.5y	8.8y
C. V. %				9.1	8.1	4.5

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.

[2](a-d) indicates the inclusion of a, b, c, d

exceeded 5 tons of dry matter per acre at six locations when moisture was ample and cool temperatures prevailed. In several instances yields equivalent to 7 tons of hay were obtained. In addition, aftermath production in excess of 3 tons of dry matter per acre were produced at all locations. This is important because aftermath crops are usually produced during good hay-making weather and when permanent pastures in the Northeast are least productive. High rates of nitrogen fertilizer were essential for the high level of aftermath production. Except under extreme drought, orchardgrass aftermath production was well distributed throughout the summer. Dry matter production decreased approximately 35 per cent the third harvest season compared with the previous season. In view of the severity of the drought which occurred, this is not a large yield reduction. Soil moisture content at a 4-inch depth was monitored during the entire growing season with gypsum blocks at New York and West Virginia. From June to September available soil moisture never exceeded 30 per cent at either location.

The stands of orchardgrass were usually affected less by the cutting treatments imposed than were stands of reed canarygrass, smooth bromegrass, or timothy treated in a similar manner. In certain instances the interaction of treatment effects appeared to be of considerable importance. For example, in the third harvest season at West Virginia the overall average ef-

TABLE 14

Stand Ratings of Pennlate Orchardgrass in the Spring of the Residual Harvest Year (1963)

Treatment			Stand Rating 1 = 10 % 10 = 100 % ground cover		
Stage at First Harvest	**N**	**Aftermath Cut**	**N. Y.**	**Pa.**	**Md.**
Pre-joint	High	High	1.7cd[1]	5.7ab	8.0de
	High	Low	1.7cd	5.0abc	7.8e
	Low	High	2.3abc	5.3abc	9.3ab
	Low	Low	2.0bcd	6.3a	9.5a
Early head	High	High	1.3d	5.0abc	8.7c
	High	Low	1.3d	4.7bc	8.8bc
	Low	High	2.3abc	5.7ab	9.3ab
	Low	Low	2.7ab	5.7ab	9.5a
Early bloom	High	High	1.7cd	5.2abc	8.8bc
	High	Low	1.3d	5.0abc	8.8bc
	Low	High	2.7ab	5.7ab	9.5a
	Low	Low	3.0a	5.3abc	9.7a
Past bloom	High	High	1.3d	4.3bc	8.5cd
	High	Low	1.3d	4.0c	8.5cd
	Low	High	2.0bcd	5.3abc	9.7a
	Low	Low	2.0bcd	5.3abc	9.5a
Averages:					
PJ			1.9rs	5.6r	8.7s
EH			1.9rs	5.7r	9.1r
EB			2.2r	5.2rs	9.2r
PB			1.7s	4.8s	9.0r
	High		1.5x	4.8x	8.5x
	Low		2.4w	5.6w	9.5w
		High	1.9y	5.2y	9.0y
		Low	1.9y	5.2y	9.0y
C. V. %			10.1	13.6	3.3

[1]Values having the same letter are from the same statistical population at the 5 per cent level of significance. Comparisons may be made within each column.

fect of the cutting height treatment was only one-third of that observed for this particular treatment in combination with harvesting at early head and using the high rate of nitrogen fertilizer.

Severity of the aftermath cutting management of orchardgrass was increased the second and third harvest years to increase stress in order that persistence might adequately be assessed. Since orchardgrass stores reserves at the base of each tiller (65, 78, 79), cutting close to the soil surface removes a portion of these reserves. Nevertheless, even this intensified management was not extremely harmful to orchardgrass stands. This may be related to frequency of harvest, in this case only once per month.

Extra plots at New York and Rhode Island were cut first each spring after jointing was initiated. It was theorized that cutting at the early jointing stage would necessitate regeneration of both stem and leaf tissues after a brief period of photosynthesis and would deplete food reserves more than cutting at either the prejoint or early head stage of growth. Little evidence of injury, however, could be traced to this treatment. Tolerance to treatments such as these permits much flexibility in utilization of orchardgrass forage.

It is clear that in order to obtain the advantage of a later harvest date for the spring crop by utilizing late-maturing varieties, some yield reduction can be expected. More importantly in these studies, the yield reduction of aftermath was particularly large. It would be most advantageous, perhaps, for farmers to grow more than one variety to distribute harvest dates.

TABLE 15

Digestibility of Potomac and Pennlate Forage*

Stage at First Harvest	Harvest Schedule†	Digestible (In Vitro) Constituents							
		Pennsylvania (1962)				West Virginia (1962)			
		Per Cent Protein		Per Cent Dry Matter		Per Cent Protein		Per Cent Dry Matter	
		Potomac	Pennlate	Potomac	Pennlate	Potomac	Pennlate	Potomac	Pennlate
Pre-joint	1st Harvest	24.7	22.8	77.2	82.1	23.7	27.7	85.0	83.9
	2nd Harvest	18.7	15.9	65.7	72.0	24.3	19.2	75.9	70.1
Early head	1st Harvest	18.3	12.1	63.9	66.0	19.4	19.0	79.4	75.9
	2nd Harvest	18.4	17.3	71.5	72.1	16.5	16.6	68.1	72.8
Early bloom	1st Harvest	12.3	10.2	60.5	63.0	9.1	10.8	62.9	62.9
	2nd Harvest	18.2	18.6	70.5	70.9	19.3	17.1	75.8	69.5
Past bloom	1st Harvest	11.0	8.1	55.5	57.4	6.7	7.4	47.6	58.9
	2nd Harvest	18.6	19.6	72.6	76.1	18.1	16.1	65.6	64.1

*Nitrogen was applied at 75 pounds N per acre after each harvest.

†Specific dates are in Appendix Table 1.

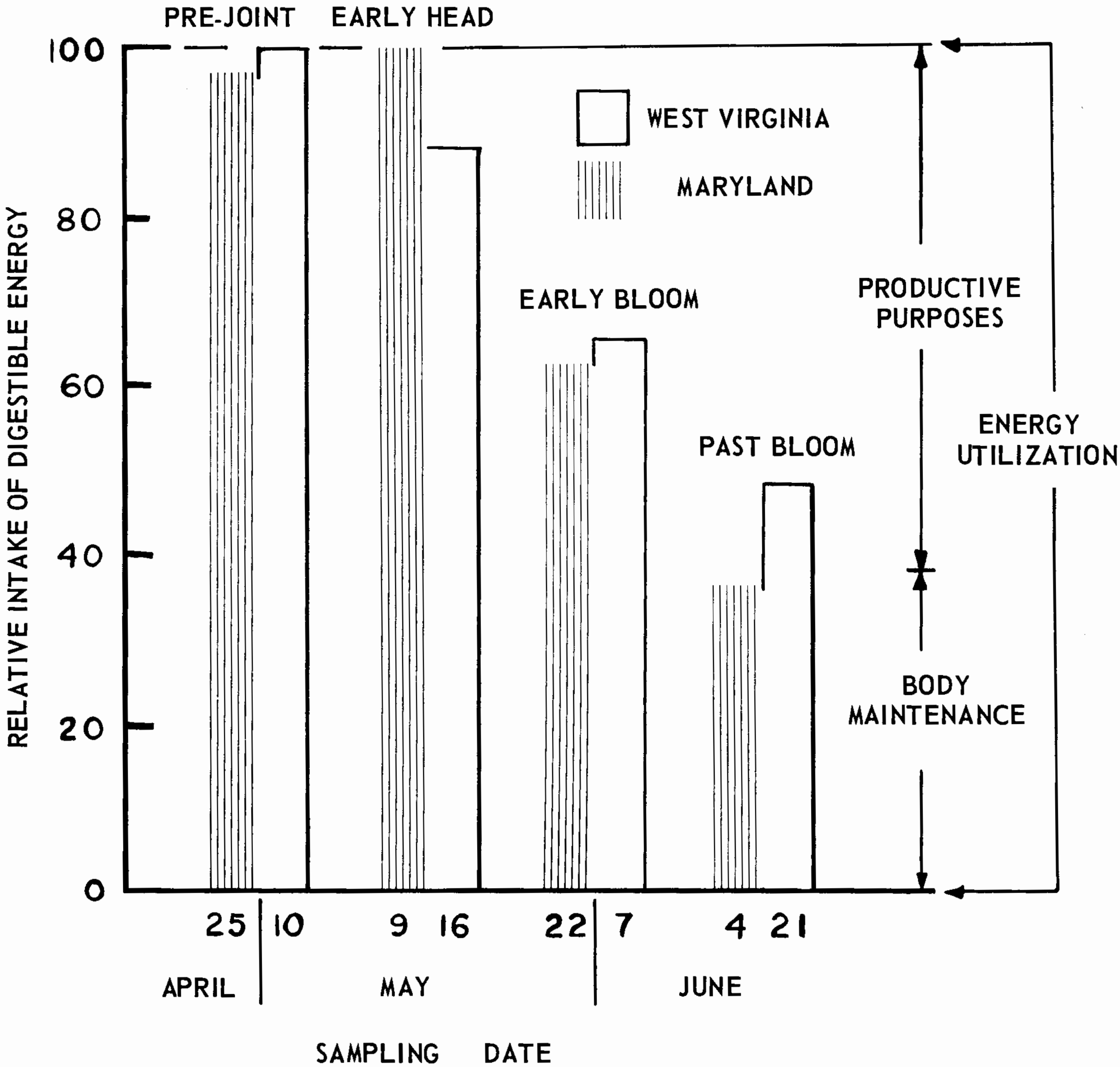

Figure 2. Nutritive value of Potomac orchardgrass cut at four growth stages and fed to sheep at Maryland and West Virginia in 1961. *Data obtained from cooperative efforts with Regional Technical Committee NE-24 (The Nutritive Evaluation of Forages) conducted by R. W. Hemken, Maryland Agricultural Experiment Station, and R. L. Reid, West Virginia Agricultural Experiment Station.*

Agronomists have recognized for some time that orchardgrass is not as winter hardy as grasses such as bromegrass or timothy. Results at Connecticut, Rhode Island, and New York bear out this belief and show further that the variety S 37 is not as winter hardy as Potomac or Pennlate. It was not clear why stands of Potomac died at Rhode Island. Stands were severely injured at New York by ice sheets and by heaving. Plants heaved upward 1 to 2½ inches with reference to a benchmark anchored below the frost line, and then subsided to within a half-inch of the original position. Studies by Howell and Jung (32) showed that Potomac orchardgrass cut each spring at early bloom was generally more cold resistant than grass cut regularly at earlier growth stages. No such trend in stand persistence, however, occurred at any location.

The characteristic bunch-type growth usually associated with older orchardgrass stands was prevalent on plots fertilized at the high rate of nitrogen in conjunction with the low cutting height of aftermath. Only moderate clumping was noted on plots fertilized at the high rate of

Figure 3. Variation in clumpiness of Potomac orchardgrass at West Virginia in the spring of 1962. The stand at left was fertilized at the high rate of nitrogen, and aftermath was cut to a 1½-inch stubble. The stand at right was fertilized at the low rate of nitrogen, and aftermath was cut to a 3½-inch stubble. Both stands were cut each spring at the early heading stage of growth.

nitrogen in conjunction with the high cutting height and still less clumping on plots fertilized at the low rate on nitrogen with either cutting height. It appears plausible to explain variation in clumpiness (Figure 3) on the relative amounts of competition among tillers and among plants. Nitrogen increases the vigor of orchardgrass tillers and thereby increases competition among tillers. Cutting close to the soil surface places stress on the tillers because no photosynthetic surface remains after cutting and a portion of the food reserves are removed. Therefore, tillers or plants which are least vigorous are further weakened or killed by the competition and crowded out by the more vigorous units. Clumpiness associated with high rates of nitrogen is not, however, limited to orchardgrass. Most perennial grasses grow in this manner at high rates of nitrogen.

The vigor of orchardgrass tillers grown at relatively high rates of fertility is best illustrated by the small amount of weed encroachment observed over the four-year period. Competition apparently was so severe that weeds were seldom a problem. According to Henderlong **et al.** (28) this competitive characteristic of orchardgrass is greatest when both nitrogen and potassium are present in large quantities.

Basal bud development did not seem to be suppressed by the presence and growth of the main tiller. Thus, tillers at widely different stages of development were present at any one time.

Because the aftermath of orchardgrass does not joint, lodging was a problem, particularly on the high nitrogen plots when they were allowed to grow for more than four weeks. Lodging of the spring growth did not occur as early or as extensively as on bromegrass.

It has been generally recognized that nitrogen fertilization reduces carbohydrate reserves in orchardgrass. This has led to the general belief that the capacity of orchardgrass to recover following a harvest is greatly reduced at high rates of nitrogen. Davidson and Milthorpe (13) pointed out, however, that carbohydrate reserves make up only a portion of the reserves utilized for regrowth. They concluded, further, that other reserves must be regarded as being quantitatively of equal significance in regrowth. Moreover, nitrogen fertilization did not greatly reduce reserves (9 per cent) as measured by etiolated regrowth in these studies. Therefore, the importance of carbohydrate reserve reduction at high rates of nitrogen should not be overemphasized.

The practice of expressing etiolated growth per tiller as a measure of reserves is not unequivocal. This method of expressing the reserve status does not account for variation in tiller number or development at the time the method is employed. The significance of this can be illustrated with the West Virginia data. Differences among treatments were usually larger when the etiolated growth was expressed on a unit area basis rather than on a tiller basis, although trends of the reserves of orchardgrass plants were similar with regard to treatment effects. For example, reserves were decreased 36 per cent on a tiller basis and 54 per cent on a unit area basis by delaying first harvest from pre-joint to past bloom.

Average trends indicated that high levels of food reserves remained in the stubble following cutting when orchardgrass was in the early vegetative stage, whereas in the past-bloom stage of growth food reserve levels were low. Food reserve levels remaining after a harvest at the early head stage of growth were variable (high in 1960 and 1962, low in 1961). The difference in response for stage of growth treatments or the early heading treatment among years might be explained on an energy basis. Considering both first harvest yields and recovery growth in the dark as units of energy expended by plants, one might expect that first harvest yields and recovery potential values would be negatively correlated. This hypothesis was substantiated by a highly significant negative correlation (—.70) between first harvest yields and recovery potential for the three-year period at West Virginia.

The nutritive value of orchardgrass forage is considered by many farmers to be poor. This belief is undoubtedly related to two facts. Orchardgrass, like most other perennial forage grasses, declines in nutritive value as the first crop each spring passes from a vegetative growth stage to the seed stage of growth. Orchardgrass cut after early bloom provides little more than maintenance energy to livestock. In addition, orchardgrass is an early maturing species (new varieties are exceptions) which is difficult to harvest at an early growth stage because of inclement weather. By comparison, therefore, farmers would be cutting orchardgrass at a later growth stage than those of smooth bromegrass or timothy on a particular date.

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Appendix

TABLE 1A
Harvest Schedule of Potomac Orchardgrass

State	Stage at First Harvest	Harvest Number 1st	2nd	3rd	4th	5th	6th	7th	Total Harvests
				1960					
Connecticut	Pre-joint	5-11	6- 9	7- 6	7-27	8-31	10-10		6
	Early head	5-20	6-14	7- 6	8- 2	9-15	10-10		6
	Early bloom	6- 6	7- 1	7-27	8-31	10-10			5
	Past bloom	6-20	7-18	8-10	9-15	10-10			5
Rhode Island	Pre-joint	5- 9	5-26	6-16	7-11	9- 8			5
	Early joint	5-16	6- 6	7- 6	8-17				4
	Early head	5-19	6- 6	7- 6	8-17				4
	Early bloom	6- 2	6-27	7-29	9- 9				4
	Past bloom	6-16	7-19	8-30	9-23				4
New York	Pre-joint	4-25	5-26	7- 5	8-29	10-11			5
	Early joint	5- 5	6-21	7-22	9- 2	10-11			5
	Early head	5-12	6-21	7-25	9- 6	10-11			5
	Early bloom	6- 6	7-11	8-16	10-11				4
	Past bloom	6-16	7-21	8-31	10-11				4
Pennsylvania	Pre-joint	5-11	6-17	7-21	10-13				4
	Early head	5-18	6-28	7-21	10-13				4
	Early bloom	6- 4	7-10	8-18	10-13				4
	Past bloom	6-17	7-21	8-26	10-13				4
Maryland	Pre-joint	4-22	5-18	6-24	8- 2	9- 7	10-14		6
	Early head	4-29	6-17	8- 1	9- 7	10-14			5
	Early bloom	5-18	6-24	8- 2	9- 7	10-14			5
	Past bloom	6- 2	7-13	8-23	10-14				4
West Virginia	Pre-joint	4-23	5- 6	6- 1	6-27	7-28	8-19	9-14	7
	Early head	4-29	5-24	6-20	7-28	8-17	9-14		6
	Early bloom	5-13	6-13	7-18	8-17	9-14			5
	Past bloom	5-27	6-28	7-28	8-19	9-14			5
				1961					
Connecticut	Pre-joint	5-18	6-12	7- 5	7-28	8-28	10-17		6
	Early head	6- 1	6-28	7-24	8-16	9-14	10-17		6
	Early bloom	6-12	7- 5	7-28	8-28	10-17			5
	Past bloom	6-29	7-24	8-16	9-14	10-17			5
Rhode Island	Pre-joint	5-11	5-29	6-29	7-28	9-5			5
	Early head	5-24	6-26	7-28	9- 5				4
	Early bloom	6- 6	7- 5	8- 7	9- 8				4
	Past bloom	6-20	7-24	8-28	10- 6				4
New York	Pre-joint	5-12	6- 7	7- 6	8- 6	9- 7	10-10		6
	Early joint	5-17	6-16	7-18	8-23	10-10			5
	Early head	5-24	6-26	7-25	9- 6	10-10			5
	Early bloom	6-12	7-12	8- 9	9- 7	10-10			5
	Past bloom	6-26	7-25	8-29	10-10				4
Pennsylvania	Pre-joint	5-10	5-25	6-29	7-26	8-17	9-27		6
	Early head	5-19	6-29	7-26	8-17	9-26			5
	Early bloom	6-23	7-26	8-17	9-26				4
	Past bloom	6-12	7-26	8-17	9-26				4
Maryland	Pre-joint	4-26	5-22	6-29	7-28	8-30	10- 6		6
	Early head	5- 9	6-12	7-17	8-28	10- 6			5
	Early bloom	5-26	6-29	7-28	8-30	10 -6			5
	Past bloom	6-12	7-17	8-28	10- 6				4
West Virginia	Pre-joint	4-15	5-21	6-28	7-25	8-28	9-12		6
	Early head	5-11	6-15	7-17	8-14	9-12			5
	Early bloom	5-31	7- 7	8- 1	9-12				4
	Past bloom	6-13	7-13	8-17	9-12				4

TABLE 1A (Continued)

State	Stage at First Harvest	1st	2nd	3rd	4th	5th	6th	Total Harvests
		Harvest Number						
				1962				
Connecticut	Pre-joint	5-12	5-29	6-24	7-15	8-16	10- 9	6
	Early head	5-21	6-17	7- 5	7-30	8-27	10- 9	6
	Early bloom	6- 1	7- 2	7-30	8-27	10- 9		5
	Past bloom	6-15	7-11	8- 8	10- 9			4
Rhode Island	Pre-joint	5-18	6- 7	7- 9	8- 8	9-13		5
	Early head	5-25	6-27	7-27	9- 4			4
	Early bloom	6- 7	7-11	8-13	9-13			4
	Past bloom	6-26	7-25	8-27	10- 2			4
New York	Pre-joint	5- 4	5-29	7- 9	8-27	10-11		5
	Early joint	5-10	6-15	8- 8	9- 7	10-11		5
	Early head	5-17	6-25	8-17	10-11			4
	Early bloom	5-29	7- 9	8-27	10-11			4
	Past bloom	6-15	8-15	10-11				3
Pennsylvania	Pre-joint	5- 9	6- 7	10-10				3
	Early head	5-22	10-10					2
	Early bloom	6- 6	10-10					2
	Past bloom	6-14	10-10					2
Maryland	Pre-joint	4-25	5-16	6-15	7-18	10-19		5
	Early head	5- 7	6-15	7-18	10-19			4
	Early bloom	5-18	6-27	8- 7	10-19			4
	Past bloom	6- 1	7-10	8- 7	10-19			4
West Virginia	Pre-joint	4-30	5-17	6-19	8- 2	9-30		5
	Early head	5- 5	6- 6	7-13	8-17	9-30		5
	Early bloom	5-22	6-28	8- 7	9-30			4
	Past bloom	6- 6	7-13	8-17	9-30			4

TABLE 1B
Harvest Schedule of Late Maturing Orchardgrass Varieties

State	Stage at First Harvest	1st	2nd	3rd	4th	5th	6th	Total Harvests
		Harvest Number						
				1960				
Connecticut (S 37)	Pre-joint	5-11	6- 9	7- 6	7-27	8-31	10-10	6
	Early head	5-26	6-14	7- 6	8- 2	9-15	10-10	6
	Early bloom	6- 9	7- 1	7-27	8-31	10-10		5
	Past bloom	6-26	7-18	8-10	9-15	10-10		5
New York (Pennlate)	Pre-joint	4-25	6- 8	7-20	8-31	10-11		5
	Early head	5-26	7- 5	8-17	10-11			4
	Early bloom	6-10	7-15	8-17	10-11			4
	Past bloom	6-24	8- 1	9- 8	10-11			4
Pennsylvania (Pennlate)	Pre-joint	5-11	6-17	7-21	10-13			4
	Early head	5-25	6-28	7-21	10-13			4
	Early bloom	6- 9	7-10	8-15	10-13			4
	Past bloom	6-27	7-21	8-26	10-13			4
Maryland (Pennlate)	Pre-joint	4-29	5-27	7- 8	8-18	10-14		5
	Early head	5-13	6-17	8- 1	9- 7	10-14		5
	Early bloom	5-27	7- 1	8-18	10-14			4
	Past bloom	6-10	7-13	8-23	10-14			4
West Virginia (Pennlate)	Pre-joint	4-23	5-24	6-20	7-18	8-17	9-14	6
	Early head	4-29[1]	5-27	6-23	7-28	8-19	9-14	6
	Early bloom	5-24	6-19	7-18	8-17	9-14		5
	Past bloom	5- 6	6-28	7-28	8-19	9-14		5

(Continued on Page 40)

TABLE 1B (Continued)

State	Stage at First Harvest	1st	2nd	3rd	4th	5th	6th	Total Harvests
		Harvest Number						
				1961				
Connecticut (S 37)	Pre-joint	5-26	6-16	7-12	8- 8	9- 7	10-7	6
	Early head	6- 1	6-28	7-24	8-25	10-17		5
	Early bloom	6-16	7-12	8- 8	9- 7	10-17		5
	Past bloom	7- 5	7-28	8-25	10-17			4
New York (Pennlate)	Pre-joint	5-17	6-16	7-18	8-15	10-10		5
	Early head	6- 5	7- 6	8- 4	9- 7	10-10		5
	Early bloom	6-15	7-20	8-15	10-10			4
	Past bloom	6-24	8- 1	9- 8	10-11			4
Pennsylvania (Pennlate)	Pre-joint	5-11	6-16	8- 4	9-26			4
	Early head	6-12	8- 4	9-26				3
	Early bloom	6-13	8-13	9-26				3
	Past bloom	6-29	8-19	9-26				3
Maryland (Pennlate)	Pre-joint	5- 9	6- 8	7-17	8-28	10- 6		5
	Early head	5-22	6-29	7-28	8-30	10- 6		5
	Early bloom	6- 8	7-17	8-28	10- 6			4
	Past bloom	6-22	7-28	8-30	10- 6			4
West Virginia (Pennlate)	Pre-joint	4-17	5-12	6-13	7-17	8- 9	9-12	6
	Early head	5-25	6-28	7-27	9-12			4
	Early bloom	6-12	7-17	8- 9	9-12			4
	Past bloom	6-27	7-27	8-23	9-12			4
				1962				
Connecticut (S 37)	Pre-joint	5-23	6- 7	7- 2	7-27	8-26	10-9	6
	Early head	5-28	6-17	7- 5	7-27	8-26	10-9	6
	Early bloom	6- 9	7- 5	7-27	8-26	10- 9		5
	Past bloom	6-24	7-20	8-16	10- 9			4
New York (Pennlate)	Pre-joint	5-10	6- 7	7-26	9- 7	10-11		5
	Early head	5-22	7- 2	8- 7	10-11			4
	Early bloom	6- 7	7-26	8-17	10-11			4
	Past bloom	6-25	8-17	10-11				3
Pennsylvania (Pennlate)	Pre-joint	5- 9	6- 7	10-10				3
	Early head	6- 6	10-10					2
	Early bloom	6-14	10-10					2
	Past bloom	6-25	10-10					2
Maryland (Pennlate)	Pre-joint	5- 7	6- 1	7-10	10-19			4
	Early head	5-16	6-27	8- 7	10-19			4
	Early bloom	6- 1	7-10	8- 7	10-19			4
	Past bloom	6-15	7-18	8- 7	10-19			4
West Virginia (Pennlate)	Pre-joint	4-30	5-24	6-28	8- 7	9-30		5
	Early head	5-10	6- 7	7- 6	8-20	9-20		5
	Early bloom	5-31	7- 6	8-20	9-30			4
	Past bloom	6-13	7-23	8-24	9-30			4

[1]Cut too early

TABLE 2A

Bi-weekly Precipitation

State	April 1-15	April 16-30	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	August 1-15	August 16-31	September 1-15	September 16-30	Total Inches	Deviation + above N* — below N
							1959							
Connecticut	3.2	1.4	1.0	0.2	3.2	1.7	4.3	1.6	0.9	5.2	0.8	0.3	23.7	—0.4
Rhode Island	1.7	1.3	0.9	2.0	3.7	3.2	4.1	0.1	1.5	2.4	0.8	0.1	21.8	+0.3
New York	1.0	1.3	0.6	0.9	0.6	1.9	4.2	0.5	1.6	2.9	0.2	0.9	16.7	—4.2
Pennsylvania	2.0	2.2	1.4	1.6	1.9	0.5	3.0	2.7	1.0	4.9	0.6	0.2	22.0	+0.6
Maryland	3.3	0.1	1.4	0.6	2.8	0.4	3.4	2.1	2.3	1.2	0.9	0.2	18.3	—6.2
West Virginia	2.7	1.6	1.7	0.9	0.5	0.7	1.4	2.1	1.1	2.1	0.1	1.0	15.8	—7.3
							1960							
Connecticut	2.8	0.8	3.8	1.5	1.7	0.8	4.6	4.3	1.9	1.4	4.5	2.6	30.8	+6.6
Rhode Island	2.7	0.5	2.4	1.6	1.3	0.5	3.5	0.8	1.3	0.5	1.8	5.5	22.2	+0.7
New York	1.4	0.9	2.7	2.4	2.4	1.2	0.7	0.8	1.2	1.3	3.7	0.3	18.9	—2.0
Pennsylvania	1.4	0.6	3.4	3.9	1.3[1]	1.1[1]	3.0	0.6	0.7	0.2	3.8	1.2	21.2	—0.2
Maryland	2.5	0.5	3.0	1.5	1.1	0.4	2.9	3.0	3.9	0.9	5.2	0.7	25.6	+1.1
West Virginia	1.2	0.6	2.8	2.1	1.4	0.6	2.6	2.7	2.9	0.6	2.1	0.9	20.5	—2.6
							1961							
Connecticut	1.9	2.8	1.9	4.4	1.2	1.4	1.4	2.6	0.2	2.6	1.0	2.1	23.5	—0.7
Rhode Island	3.8	4.2	1.7	4.3	1.1	1.6	0.2	0.9	1.6	4.8	2.0	8.6	34.8	+3.3
New York	3.0	3.0	2.5	1.7	3.6	2.1	1.6	2.7	1.9	2.4	2.8	0.0	27.3	+6.4
Pennsylvania	2.4	1.8	1.2	1.1	2.5	0.6	2.4	2.7	3.4	1.5	1.9	0.0	21.5	+0.1
Maryland	3.1	0.7	2.3	0.2	2.9	1.7	1.6	0.7	0.6	5.7	0.6	0.2	20.3	—4.2
West Virginia	2.1	2.0	1.4	1.4	3.8	3.0	3.3	2.3	3.1	0.8	1.2	3.2	27.6	+4.5
							1962							
Connecticut	3.5	0.1	1.2	1.2	2.5	1.9	0.9	1.0	1.5	2.2	0.2	2.8	19.1	—5.1
Rhode Island	3.0	0.1	1.1	0.8	3.4	2.1	1.4	0.4	1.8	2.3	0.2	3.6	20.2	—1.3
New York	1.9	0.8	0.6	0.4	2.1	0.1	0.2	1.1	2.0	1.7	1.3	3.2	15.3	—5.6
Pennsylvania	4.3[1]	0.2[1]	0.9[1]	0.3[1]	1.7	1.0	0.4	0.3	0.4	1.2	1.6	2.3	14.7	—6.7
Maryland	3.0	0.2	0.6	2.5	1.1	2.2	0.7	0.8	0.1	0.1	0.5	2.4	14.2	—10.4
West Virginia	3.4	1.4	0.5	1.4	2.1	0.1	2.0	0.7	3.3	0.1	1.8[2]	2.3[2]	19.1	—4.0

*Normal (1931-1960)
[1]Data for Centre Hall were not available, therefore data taken at State College were used.
[2]U.S.W.B. Airport Station

TABLE 2B

Bi-weekly Air Temperature

State	April 1-15	April 16-30	May 1-15	May 16-31	June 1-15	June 16-30	July 1-15	July 16-31	August 1-15	August 16-31	September 1-15	September 16-30	Daily Means	Deviation + above N* — below N
	MEAN DAILY AIR TEMPERATURE													
							1959							
Connecticut	46	50	57	63	64	64	68	73	69	73	68	62	61.5	+0.5
Rhode Island	47	50	55	62	64	64	69	73	70	74	70	61	63.3	+2.2
New York	42	49	55	61	66	66	68	73	68	74	68	61	62.7	+2.2
Pennsylvania	47	53	60	66	68	71	70	75	72	75	68	65	65.9	+2.2
Maryland	54	62	66	71	75	79	76	83	79	85	79	78	73.8	+5.1
West Virginia	50[1]	58[2]	63	64[4]	69	69[4]	73	76	74	78	71	67	67.9	+0.9
							1960							
Connecticut	45	53	56	60	63	68	67	68	67	68	63	57	61.3	+0.3
Rhode Island	44	52	53	59	63	67	67	68	68	70	65	58	61.2	+0.1
New York	42	58	53	60	61	66	65	68	67	67	63	62	60.9	+0.4
Pennsylvania	44	60	51	61	65[3]	68[3]	65	69	71[3]	70	65	61	62.6	—1.1
Maryland	56	66	57	69	73	74	75	77	78	82	80	76[2]	71.9	+3.2
West Virginia	51	64	54	66	69	70	70	74	75	74	70	66	66.9	N
							1961							
Connecticut	39	47	54	54	66	65	66	73	67	69	73	61	61.2	+0.2
Rhode Island	42	48	53	56	65	64	68	73	68	71	74	63	62.1	+1.0
New York	36	46	54	53	64	63	65	72	67	68	72	61	60.1	—0.4
Pennsylvania	37	48	56	55	68	65	71	76	73	73	75	63	63.3	—0.4
Maryland	46	57	64	58	77	72	76	83	78	78	87	74	70.6	+1.9
West Virginia	41	51	60	54	68	65	69	75	71	73	76	63	63.8	—3.1
							1962							
Connecticut	43	51	50	64	64	69	67	67	67	68	64	55	61.0	N
Rhode Island	44	50	49	60	62	67	66	66	68	66	63	56	59.8	—1.3
New York	39	52	52	64	62	68	66	66	66	68	62	52	59.7	—0.8
Pennsylvania	42[1]	58[1]	59[1]	70[1]	68	71	70	71	70	71	64	53	64.2	+0.5
Maryland	53	61	65	77	78	82	80	78	77	80	74	64	72.4	+3.7
West Virginia	44	56	63	72	70	72	73	69	72	73	68[2]	57[2]	65.8	—1.1

*Normal (1931-1960)

[1]Estimated value, 1 day missing

[2]U.S.W.B. Airport Station

[3]Data for Centre Hall were not available, therefore data taken at State College were used.

[4]Estimated value, 2-6 days missing

TABLE 3A

Analysis of Variance of Potomac Orchardgrass Yields Produced in the First Harvest Year (1960)

State	Stage	Nitrogen	Cutting Height	SxN	SxCH	NxCH	SxNxCH
			Total Yield				
Connecticut	73.5**	537.3**	3.1	1.5	< 1	< 1	1.9
Rhode Island	92.6**	1888.0**	< 1	3.5*	< 1	11.2**	< 1
New York	55.2**	398.8**	1.9	4.2*	< 1	< 1	< 1
Pennsylvania	14.3**	300.0**	< 1	4.0*	1.3	< 1	< 1
Maryland	29.1**	190.4**	18.2**	3.9*	< 1	1.6	< 1
West Virginia	41.5**	253.5**	< 1	4.5*	< 1	4.6*	3.0*
			Aftermath				
Connecticut[1]							
Rhode Island	3.4*	2335.0**	< 1	3.7*	1.1	9.5**	1.7
New York	89.7**	791.3**	1.9	7.9**	1.1	< 1	1.4
Pennsylvania	75.6**	194.5**	< 1	2.5	< 1	< 1	< 1
Maryland	20.8**	170.6**	14.4**	3.4*	< 1	< 1	1.7
West Virginia	26.2**	319.8**	< 1	7.2**	< 1	3.9	2.2

*.05 level of probability

**.01 level of probability

[1]Data not available

TABLE 3B

Analysis of Variance of Potomac Orchardgrass Yields Produced in the Second Harvest Year (1961)

State	Stage	Nitrogen	Cutting Height	SxN	SxCH	NxCH	SxNxCH
			Total Yield				
Connecticut	28.0**	227.1**	12.8**	11.9**	2.6	13.6**	< 1
Rhode Island	85.5**	1519.9**	15.7**	12.0*	2.7	1.7	1.0
New York	59.4**	221.3**	1.4	1.9	2.8	< 1	< 1
Pennsylvania	4.0*	96.3**	10.9**	< 1	1.5	< 1	< 1
Maryland	21.7**	416.8**	2.8	1.3	< 1	6.1*	1.1
West Virginia	43.7**	58.5**	3.5	1.8	1.6	< 1	< 1
			Aftermath				
Connecticut[1]							
Rhode Island	35.0**	1036.2**	25.1**	4.3*	6.1**	4.3*	1.6
New York	34.8**	353.9**	2.3	1.9	2.4	< 1	< 1
Pennsylvania	22.4**	119.2**	9.9**	1.7	3.7*	< 1	< 1
Maryland	76.1**	29.5**	< 1	4.2*	< 1	7.4*	1.5
West Virginia	20.8**	45.3**	9.6**	2.3	< 1	< 1	< 1

*.05 level of probability

**.01 level of probability

[1]Data not available

TABLE 3C

Analysis of Variance of Potomac Orchardgrass Yields Produced in the Third Harvest Year (1962)

State	Stage	Nitrogen	Cutting Height	SxN	SxCH	NxCH	SxNxCH
			Total Yield				
Connecticut	42.2**	387.2**	1.5	6.9**	< 1	10.6**	12.0**
Rhode Island	11.0**	990.3**	8.0**	1.4	< 1	< 1	1.2
New York	30.0**	52.1**	2.0	1.6	< 1	1.5	< 1
Pennsylvania	11.0**	44.7**	7.6**	1.2	1.9	< 1	< 1
Maryland	6.1**	68.5**	2.2	1.3	< 1	1.7	< 1
West Virginia	29.8**	32.8**	< 1	< 1	3.5*	4.1	2.1
			Aftermath				
Connecticut[1]							
Rhode Island	41.2**	971.7**	18.8**	8.2**	13.5**	6.5*	3.5*
New York	54.6**	154.5**	< 1	3.4*	2.8	< 1	1.4
Pennsylvania	5.2**	100.3**	2.3	1.2	< 1	< 1	< 1
Maryland	11.2**	3.1	1.8	4.8**	4.0*	6.3*	1.2
West Virginia	81.7**	10.9**	< 1	< 1	2.0	3.3	2.1

*.05 level of probability
**.01 level of probability
[1]Data not available

TABLE 3D

Analysis of Variance of Late Maturing Orchardgrass Variety Yields Produced in the First Harvest Year (1960)

State	Stage	Nitrogen	Cutting Height	SxN	SxCH	NxCH	SxNxCH
			Total Yield				
S 37							
Connecticut	41.8**	271.5**	4.8*	< 1	2.3	0.0	2.9
Pennlate							
New York	27.0**	343.0**	1.5	1.1	< 1	< 1	1.9
Pennsylvania	1.7	243.9**	< 1	< 1	2.2	< 1	2.2
Maryland	24.5**	331.5**	< 1	2.7	< 1	< 1	1.6
			Aftermath				
S 37							
Connecticut[1]							
Pennlate							
New York	57.1**	39.9**	2.4	1.7	1.0	4.9*	< 1
Pennsylvania	11.7**	458.7**	< 1	5.6**	2.8	< 1	2.8
Maryland	204.6**	853.7**	41.7**	15.4**	1.7	23.1**	5.2

*.05 level of probability
**.01 level of probability
[1]Data not available

TABLE 3E

Analysis of Variance of Late Maturing Orchardgrass Variety Yields Produced in the Second Harvest Year (1961)

State	Stage	Nitrogen	Cutting Height	SxN	SxCH	NxCH	SxNxCH
			Total Yield				
S 37							
Connecticut	8.1**	316.1**	16.3**	2.3	< 1	8.8**	< 1
Pennlate							
New York	56.3**	149.2**	< 1	2.1	2.1	< 1	< 1
Pennsylvania	2.6	218.3**	1.1	6.7**	< 1	1.0	< 1
Maryland	6.1**	223.0**	< 1	< 1	< 1	1.1	< 1
			Aftermath				
S 37							
Connecticut[1]							
Pennlate							
New York	15.4**	114.3**	1.1	4.9**	< 1	< 1	1.1
Pennsylvania	101.7**	458.2**	2.5	10.0**	1.8	1.3	1.0
Maryland	15.6**	27.1**	< 1	1.5	1.1	1.1	1.5

*.05 level of probability
**.01 level of probability
[1]Data not available

TABLE 3F

Analysis of Variance of Late Maturing Orchardgrass Variety Yields Produced in the Third Harvest Year (1962)

State	Stage	Nitrogen	Cutting Height	SxN	SxCH	NxCH	SxNxCH
			Total Yield				
S 37					1.2	4.0	1.2
Connecticut	19.6**	97.9**	< 1	13.7**	< 1	1.7	< 1
Pennlate							
New York	12.1**	4.5*	1.5	1.4	< 1	1.5	< 1
Pennsylvania	15.8**	51.7**	6.0*	< 1	< 1	< 1	
Maryland	1.7	40.9**	< 1	< 1			< 1
			Aftermath				
S 37							
Connecticut[1]							
Pennlate							
New York	25.6**	16.1**	1.4	< 1	4.5**	< 1	1.6
Pennsylvania	21.3**	80.6**	10.7**	6.5**	< 1	< 1	< 1
Maryland	50.7**	2.6	< 1	< 1	7.0**	1.9	1.8

*.05 level of probability
**.01 level of probability
[1]Data not available

TABLE 4A
Analysis of Variance of Potomac Orchardgrass for Spring Stand Ratings

State	Stage	Nitrogen	Cutting Height	SxN	SxCH	NxCH	SxNxCH
			1961				
Connecticut[1]							
Rhode Island	< 1	< 1	< 1	< 1	< 1	< 1	< 1
New York	1.6	< 1	< 1	2.3	1.1	< 1	< 1
Pennsylvania	2.9*	16.3**	< 1	3.5*	< 1	< 1	2.7
Maryland	3.4*	11.6**	< 1	1.7	< 1	< 1	< 1
West Virginia	1.8	1.6	< 1	2.7	< 1	2.5	1.3
			1962				
Connecticut[1]							
Rhode Island	11.1**	120.8**	< 1	1.3	< 1	< 1	1.0
New York	1.5	47.6**	< 1	< 1	< 1	1.7	< 1
Pennsylvania	< 1	234.2**	< 1	< 1	< 1	4.4	3.4*
Maryland	14.0**	148.6**	4.0	1.5	< 1	4.1	< 1
West Virginia	2.0	40.8**	18.3**	1.1	3.2*	6.1*	< 1
			1963				
Connecticut[1]							
Rhode Island	Killed						
New York	2.4	90.0**	< 1	2.4	1.1	< 1	< 1
Pennsylvania	1.6	58.4**	13.5**	2.2	2.6	4.0	1.1
Maryland	< 1	122.6**	11.4**	3.9*	< 1	< 1	< 1
West Virginia	3.1*	55.2**	4.6*	3.2*	2.3	1.1	1.8

*.05 level of probability
**.01 level of probability
[1]Data not available

TABLE 4B
Analysis of Variance of Late Maturing Orchardgrass Varieties for Spring Stand Ratings

State	Stage	Nitrogen	Cutting Height	SxN	SxCH	NxCH	SxNxCH
			1961				
S 37							
Connecticut[1]							
Pennlate							
New York	8.1**	22.8**	< 1	1.9	1.6	1.2	< 1
Pennsylvania	2.3	11.0**	1.0	5.7**	< 1	3.5	2.2
Maryland	4.0*	43.1**	1.5	5.8**	1.1	< 1	< 1
			1962				
S 37							
Connecticut[1]							
Pennlate							
New York	6.3**	32.8**	< 1	< 1	< 1	< 1	< 1
Pennsylvania	1.1	180.5**	< 1	< 1	2.0	1.4	< 1
Maryland	8.7**	108.9**	11.3**	5.5**	1.3	2.2	1.0
			1963				
S 37							
Connecticut[1]							
Pennlate							
New York	2.1	44.1**	< 1	2.3	< 1	< 1	< 1
Pennsylvania	2.8	15.0**	< 1	< 1	< 1	1.0	1.4
Maryland	7.5**	137.1**	< 1	4.9**	< 1	< 1	< 1

*.05 level of probability
**.01 level of probability
[1]Data not available

TABLE 5A

Dry Matter Produced by Potomac Orchardgrass (Average for 1960-1962)

Treatment			Total Yield T/A						Aftermath Yield T/A					
Stage at First Harvest	**N**	**Aftermath Cut**	**Conn.**	**R. I.**	**N. Y.**	**Pa.**	**Md.**	**W. Va.**	**Conn.**	**R. I.**	**N. Y.**	**Pa.**	**Md.**	**W. Va.**
Pre-joint	High	High	4.18	3.53	4.42	3.09	3.96	3.76	2.78	2.73	2.73	1.62	2.06	2.62
	High	Low	3.88	3.66	4.45	3.17	4.05	3.70	2.34	2.84	2.64	1.64	2.06	2.43
	Low	High	2.66	1.50	3.38	2.28	2.71	2.83	1.49	1.17	1.90	1.17	1.52	1.75
	Low	Low	2.62	1.80	3.32	2.30	2.85	2.89	1.73	1.52	1.91	1.07	1.56	1.68
Early head	High	High	4.50	3.68	4.80	3.30	3.71	4.32	3.03	2.30	3.13	1.94	2.27	3.04
	High	Low	3.98	3.73	4.66	3.38	3.87	3.88	2.39	2.67	3.07	2.07	2.28	2.74
	Low	High	2.96	1.59	3.42	2.34	2.67	3.28	1.74	1.11	2.08	1.30	1.86	2.31
	Low	Low	3.25	2.04	3.45	2.51	3.02	3.22	1.98	1.52	2.09	1.52	2.05	2.29
Early bloom	High	High	5.05	4.55	5.50	3.63	4.53	5.23	2.67	2.41	2.64	1.71	1.89	2.71
	High	Low	4.84	4.57	5.46	3.81	4.69	4.71	2.30	2.48	2.66	2.05	1.86	2.42
	Low	High	3.22	2.10	4.33	2.60	3.01	3.68	1.52	1.10	1.70	.85	1.37	1.78
	Low	Low	3.48	2.17	4.53	2.74	3.37	3.72	1.56	1.34	1.81	1.13	1.61	1.74
Past bloom	High	High	5.35	4.44	5.42	3.68	4.52	4.72	2.31	2.30	2.19	1.65	1.51	2.03
	High	Low	5.39	4.44	5.22	3.84	4.72	4.88	2.27	2.20	2.18	1.69	1.72	2.13
	Low	High	3.51	2.23	4.35	2.61	3.32	4.19	1.26	1.19	1.49	.91	1.21	1.61
	Low	Low	3.59	2.24	4.26	2.61	3.53	4.12	1.23	1.15	1.40	.81	1.36	1.50
Averages:														
PJ			3.34	2.62	3.90	2.69	3.42	3.29	2.09	2.06	2.30	1.38	1.80	2.12
EH			3.67	2.76	4.08	2.90	3.32	3.67	2.28	1.98	2.59	1.71	2.14	2.60
EB			4.15	3.36	4.95	3.22	3.90	4.33	2.01	1.83	2.20	1.43	1.68	2.16
PB			4.46	3.34	4.81	3.18	4.02	4.48	1.77	1.71	1.82	1.26	1.45	1.82
	High		4.65	4.08	4.99	3.50	4.26	4.40	2.51	2.53	2.65	1.80	1.96	2.52
	Low		3.16	1.97	3.88	2.49	3.07	3.49	1.56	1.26	1.80	1.10	1.57	1.83
		High	3.93	2.95	4.45	2.94	3.56	4.00	2.10	1.85	2.23	1.39	1.71	2.23
		Low	3.88	3.09	4.42	3.06	3.78	3.89	1.98	1.96	2.22	1.50	1.81	2.12

TABLE 5B

Dry Matter Produced by Late Maturing Orchardgrass Varieties (Average for 1960-1962)

			Total Yield T/A				Aftermath Yield T/A			
Treatment			S 37	Pennlate			S 37	Pennlate		
Stage at First Harvest	**N**	**Aftermath Cut**	**Conn.**	**N. Y.**	**Pa.**	**Md.**	**Conn.**	**N. Y.**	**Pa.**	**Md.**
Pre-joint	High	High	3.94	4.27	3.15	3.44	2.52	2.11	1.27	1.76
	High	Low	3.42	4.05	3.25	3.29	1.71	1.99	1.29	1.47
	Low	High	2.14	3.26	2.16	2.07	1.19	1.49	.70	1.13
	Low	Low	2.44	3.25	2.31	2.30	1.32	1.44	.69	1.20
Early head	High	High	3.72	4.52	3.45	3.36	2.66	2.45	2.05	1.66
	High	Low	3.32	4.33	3.60	3.49	2.23	2.26	2.08	1.82
	Low	High	2.52	3.55	1.96	2.40	1.66	1.82	1.16	1.52
	Low	Low	2.36	3.56	1.99	2.31	1.60	1.86	1.15	1.56
Early bloom	High	High	4.65	5.09	3.59	3.69	2.32	2.12	1.56	1.39
	High	Low	4.11	5.19	3.59	3.64	1.83	2.30	1.53	1.49
	Low	High	2.78	4.07	2.45	2.29	1.29	1.47	.80	1.01
	Low	Low	2.62	4.12	2.43	2.43	1.21	1.53	.93	1.16
Past bloom	High	High	4.18	4.95	3.63	3.83	2.01	1.71	1.23	.99
	High	Low	4.08	4.96	3.50	3.88	1.89	1.65	1.15	1.14
	Low	High	2.93	4.19	2.53	2.79	1.22	1.19	.64	.87
	Low	Low	2.75	4.34	2.37	2.65	1.12	1.25	.58	.81
Averages:										
PJ			2.99	3.71	2.72	2.77	1.69	1.76	.99	1.39
EH			2.98	3.99	2.75	2.89	2.04	2.09	1.61	1.64
EB			3.54	4.62	3.02	3.04	1.66	1.86	1.20	1.27
PB			3.48	4.61	3.01	3.29	1.56	1.45	.90	.95
	High		3.93	4.67	3.47	3.59	2.15	2.08	1.52	1.46
	Low		2.57	3.79	2.28	2.40	1.33	1.51	.83	1.16
		High	3.36	4.24	2.86	2.98	1.86	1.79	1.18	1.29
		Low	3.14	4.23	2.88	3.01	1.61	1.78	1.18	1.33