

GRASS GARDENS OF THE GREAT PLAINS REGION.—THEIR CARE, AND SOME IMPORTANT
CONSTITUENTS.

RUSSEL A. OAKLEY.

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For years botanists have been trying to determine the cause of prairies or grasslands, and as a result many theories have been advanced which, taken collectively, explain the existence of such areas in a large number of cases. As yet, however, no adequate theory or set of theories has been given that solves the problem for a portion of the Great Plains region. Perhaps the so called "wind" theory comes nearer filling the conditions than any other one alone.

The greatest grassland in the world is in North America and includes the Great Plains. This area may be said to be a typical grassland area since it occupies the interior of the continent, and also because it is free from forests except in edaphic situations. The whole region seems to be, to a greater or less extent, an expression of the climate.

Since the region mentioned is a grassland region, it seems natural that attention should be turned, in a more or less experimental way, to the culture and breeding of grasses. Recognizing the importance of this, the Experiment Stations of the Great Plains have established gardens or experimental fields for the purpose of testing the economic value of grasses; and also for the purpose of breeding up grasses that will become adapted to our climatic conditions. It is the purpose of this paper to discuss such gardens and some important constituents in as much detail as space will permit.

The Experiment Stations of this region are yet in their youth and as a consequence not every line or branch of experimentation is conducted in the very best manner possible. The grass garden is a very noticeable example of this. There are other reasons too why grass gardens of this region are not as they should be; one is that heretofore they have not been considered of prime importance, the breeding of wheat and other cereals having received the greater attention. Another is that only recently has the region had to deal, to any great extent with worn out pastures. When the price of pasture land suddenly leaped to four dollars per head per season, stockmen and farmers were confronted with the fact that they must either renovate

their old pastures, seed new ones, or cut down the number of stock per acre. The reasons given help to explain the conditions of the grass gardens in the Experiment Stations today.

The grass garden affords a place for the testing at a minimum expense, of grasses that appear to be more or less promising. It is true that some Experiment Stations of this region have been unable to make the results of the plat tests check with those of the field, still in a majority of cases they are not, and should not be at variance. The cost of maintaining a garden is considerable but on the other hand it will prove itself to be worth many times its running expense to those who wish to seed down a part of their land for pasture or meadow.

The possibilities of the garden along the line of selection and breeding are almost unlimited. As yet, little has been accomplished in this respect; however there is no reason, if the proper attention is given, why as striking results might not be obtained as those of Illinois and Minnesota in the breeding and selection of corn and wheat. The time may not be far distant when the so-called "grass" question, in its many phases, will be as important as that of cereal breeding.

The botanical significance of the grass garden need not be overlooked although it holds a minor place from the Experiment Station point of view. For the identification of doubtful specimens, received from various sources, no better means could be secured. On the whole the grass garden deserves as important a place in the botanical or agricultural departments, as does the orchard or vineyard in the horticultural department of the Experiment Station.

The grass garden of the Kansas Experiment Station will be described in as much detail as possible and those of some of the other important Stations of the region touched on as extensively as space will permit.

As has before been intimated the grass garden is a comparatively new feature in the Experiment Station work in Kansas, and as a consequence its dimensions are by no means extensive; although abundant space has been allowed for its growth. In all it comprises an area of about an acre. The garden is beated on a gentle south-

east slope the soil of which is slightly below the average Kansas high prairie soil in quality, but perhaps is nearly equal to that of most pastures, and is moreover free from stones. While the garden comprises only about an acre, it contains in all three hundred sixty plats of varying sizes. One hundred fifty six of these are six feet square; twenty six are eight feet wide and run the full length of the garden, about two hundred feet; these however, in some cases are divided into two or more plats; the remaining plats are of various sizes.

Since its beginning the grass garden has always been under the direct care and supervision of the Botanical department, and both the botanical and the experimental phases of the garden have to a certain extent, been held in view. At first the garden contained only the native grasses of Kansas. These were arranged more or less in their natural order and to a certain extent served both purposes mentioned above. It was intended that at least this portion of the garden should be devoted solely to the native grasses and as others were introduced they should find location elsewhere. This plan was carried out for a few years, but during the course of time, as will always be the case, species died out leaving the plats vacant. These vacancies were filled without regard, in all cases, to the natural order or the nativity of the species. It was also found that the expence of maintaining such a garden would greatly exceed its utility. Hence the idea was abandoned and the garden grew in the order in which the grasses were received. When possible, species of the same genus were planted in order.

It may be stated here that the Kansas Experimental garden is not composed of grasses alone but of forage plants *in general* such as legumes, salt-bushes, etc. The annual forage crops are planted in the beds left vacant by the grasses and consequently no order is preserved. In the case of the clovers, and a few other perennial forage plants, order is preserved to the same extent as in the case of the grasses.

The south half of the garden is devoted to the growing of grasses obtained from the United States Department of Agriculture. These grasses occupy plats much larger in area than the others as will be seen by the plot. No order whatever is attempted

here. At the extreme south plats of the same size are set aside for the purpose of growing various annual forage crops.

All the plats in the garden are staked in the southwest corner with heavy wooden stakes, painted white. The top of the stake bears a label one and one half by two and one half inches square; printed on this with horticulturist's ink is the number of the plat, the botanical and the common name of the plant.

It is the intention of the Station to give the grasses that are tested in the garden as nearly as possible ordinary field conditions. At times during periods of extreme drouth it has been found necessary to irrigate the whole garden. The botanical portion, or the plats containing grasses that no longer need testing, are watered quite freely. Water for irrigation is supplied by the city water works system. Since the garden is laid with surface pipes very little hose is necessary. Other care that is given the garden consists in hoeing the weeds, together with the the surface cultivation that accompanies this operation. No distinction is made between the botanical and the tests plats in this respect. Seed in all cases is planted in drills; thus facilitating the weeding process and insuring a better stand. In cases where it is desired to obtain seed, care is taken to prevent the grasses from forming a mat or becoming sod-bound; since this condition is detrimental to seed production.

A thorough system of records is kept for every plat. The system includes a well organized card index consisting of cards bearing the plat number, name of grass, source, and various data of importance. At least three times during the year field notes are taken regarding the condition of maturity, apparent value, at this time, for pasture or forage, drouth resistance, etc. Points of much importance are recorded on the cards of the index. By the discrete use of these notes the comparative value of the several grasses is approximately determined.

The grass garden of the Kansas Experiment Station serves a triple purpose; that of a botanical garden; as a field to test the value of the different grasses; and for the purpose of grass breeding.

In its first capacity the garden is not, as yet, well developed, and owing to conditions previously mentioned, is not systematically arranged and only at a very great expense will it ever become so. It is hoped that the important types will soon be represented, not only for the benefit of the Experiment Station, but also for an object lesson for the students of the Kansas Agricultural College, with which the station is connected.

In its second capacity it may be said to be a success. This has been more or less in a general way, but nevertheless of great importance. One point has been reached to a considerable degree, on which it seems some other Stations have fallen short. That is the making of plat results approximate those of the field. The more nearly this is accomplished the greater will be the success of the experiment. The success of the Kansas garden in this respect is due to one thing chiefly; throughout the whole experiment everything is done with the view of making the plat conditions approximate those of the field. The experimental phase of the garden is open to growth, and as time goes on even better results are expected.

In its third capacity the garden is in its embryonal stage, since the breeding and selection of grasses has but recently begun. Nothing definite has yet been accomplished, but everything points favorably toward success in this phase. More room is needed so that tests of yield may be made when necessary. The possibilities in this line are unlimited and cannot be touched upon here. On the whole the "grass garden" phase of the Experiment Station work in Kansas has been as great a success as any that has been dealt with; and in the course of time when it is possible to give the garden the attention that is due it, vastly greater success will result.

The Experiment Station of Nebraska has felt the need of a field wherein to test grasses and as a consequence has appropriated an area of ten acres for this purpose. This field includes all the land used in forage plant experiments, since the garden comprises forage plants in general. This experimental garden is under the supervision of the Agricultural department of the Experiment Station and is maintained solely for the purpose of testing the economic value of grasses and other

field notes, such as :Minnesota number, size of plat, date of ripening, days maturing, strength, disease, etc. From all reports these experiments of the Minnesota Station are quite successful.

The garden of the Iowa Experiment Station comprises forage plants in general, and is controlled by the department of Agronomy. The plats of this garden are quite extensive, but not arranged according to any system; although they are intended for both tests and botanical purposes. Irrigation is never used and at all times field conditions are given as nearly as possible. Quantitative estimates of yield are obtained from platx of an area of one fortieth of an acre. In these plats and also in most of the others the seed is sown broadcast. All records of the plants are kept in notebooks.

A grass garden for botanical purposes was at one time maintained by the Experiment Station of Wisconsin, but for some time has been abandoned. Attempts were made to test in the field some of the grasses that were particularly ^{promising in the small plots. The experiment} proved a failure and for this reason as well as on account of the great expense the garden was discontinued. The Wisconsin Station believed^s that the grass garden is ~~x~~ desirable from a botanical standpoint; but since there was such a disparity between results from the small plats and actual field tests, they think it of little importance experimentally. As a substitute they test the grasses directly in the field and consider the results as final.

These points concerning the grass gardens of Nebraska, Minnesota and Iowa are very brief and also general; nevertheless they serve to give an idea of how such gardens are conducted. Many other stations of the region maintain such gardens, and some, important ones; but space will not permit discussion of them. The grass garden question is a real live issue with the Experiment Stations, and it is only a question of time before it is generally so regarded by the stations.

Suggestions for the betterment of our gardens are always in order; and if the gardens are not satisfactory in every respect let us at least have ideas on the sub-

forage plants. The grasses are not arranged according to any system. The plan of testing the grasses first in plats three by three feet is followed. If after from one to three years, they give promise of being of value they are transferred to larger ones. One-fifth to one-tenth acre plats are used where quantitative tests of yield are desired. In all plats whether large or small ordinary field conditions are approached as nearly as possible. Irrigation is never used. In the small plats the seed is planted in rows; but in the larger ones it is sometimes sown broadcast. A wooden stake with the number is placed in the southeast corner of the plat. Records of the grasses consist of filed notes taken at frequent intervals throughout the growing season.

The Minnesota Experiment Station does not possess a regular systematic grass garden; but has large sized plats for the purpose of testing some of the promising grasses as they are introduced; and also for the purpose of breeding up some of the more common ones. All of this work is under the direct supervision of the Agricultural department of the Station. At one time the Botanical department maintained a rather expensive systematic garden but ^{hence} this was thought to be too expensive and [^] was discontinued.

The field in question is devoted to the testing of forage plants in general. This field is subdivided into a series of from one to a few acres which in turn are further subdivided to meet the demands of planting. In some cases the so-called "Centgener" system is used, the centgener comprising one hundred plants. Quantitative estimates of yield are sometimes made on the larger plats. The seed is sometimes drilled and sometimes sown broadcast. Field conditions are approached as nearly as possible; irrigation never being used except in some cases to germinate the seed. The plats are staked with a portion of a lath. A guide of tin is nailed to the top of the stake and into this is slipped a card bearing the letter of the field, the Roman number of the series, and the Arabic number of the plat. These are recorded at the top of the label; below are the Minnesota number and the origin of the seed. Records are kept in the yearly field book in which are recorded the ordinary

ject that will bring about changes in the right direction. Perhaps there is no other experimental field that requires any more, or even quite so much planning as does the grass garden. The discussion immediately following involves the writer's ideas of a garden as it should be.

In planning a garden attention must be given to the fact that as the experiments with grasses continue the garden will be forced to increase considerably in size. The inception of the experiment is the time to consider this feature and due allowance must be made for expansion. A rectangular piece of ground as it is a very convenient shape for the garden as it is easily divided into plats and easy to plot when necessary, which will be found to be the case quite frequently. A base line should be run and all plats laid off from it. In this way they may be made uniform. The field should now be divided into two parts, one to comprise the botanical or permanent garden, and the other the test plats. This idea seems to be more or less a new feature, but nevertheless it will prove to be an advantageous arrangement. Beginning along the base line, plots six feet square should be laid off. This will be found a very convenient size for the permanent garden, which as has before been stated, are for botanical purposes. When a sufficient number of these for the permanent garden have been laid off, the remainder of the field will be divided into the test plats. These plats should be at least twelve feet square, and as the permanent garden enlarges they will be sacrificed to its demands.

In locating a garden it should always be borne in mind that, for at least a large portion of the plat, ordinary field conditions are necessary. Still the garden should not be so placed that it will be subject to extreme exposure. The soil should be of good average quality and in good tillable condition. Another point to be considered in the selection of the location, is that of drainage. For this feature a gentle slope will give the best results. If the ground be too flat the results are evident, and if it be too uneven heavy rains will cut the field up badly. Since the garden is to comprise only a comparatively small area, the subject of drainage may seem of minor importance in its location; however it may not always remain

small, and the proper conditions should be considered for its expansion. The experimental field should be so located that irrigation by some means may be employed when necessary. This point, however, will be touched upon later on in the discussion.

After the garden has been divided, in the manner suggested, into botanical and experimental plats, the arrangement of the grasses is next to be considered. There are several systems that might be employed and to good advantage, as for example, they might be arranged alphabetically with reference to genera, or they might be arranged in the order of their economic importance. Both of these systems are imperfect since genera are being continually revised with the employment of new nomenclature; and the importance of the grasses economically is a difficult thing to establish definitely. The botanical portion of the garden is the only portion that needs be involved, to any great extent, in the systematic arrangement. At present the best method seems to be the arranging of the grasses in the natural order of the genera, following some standard classification. If it were possible for us to know the exact number of species with which we would have to deal we might anticipate the same and leave the plats accordingly. In this way the natural order of the species would be preserved, which, of course, would be an ideal arrangement; as it would show the relation of genera and species most strikingly. This, however, is impossible and also impractical; for to do this it would necessitate a large number of vacant plats in the permanent garden, to be filled from year to year with various kinds of annual forage crops. In a number of cases it would be found impractical to keep the genera in sequence; in this event the natural order will have to be according to the tribes. With this idea in view the addition of new species to the permanent garden may be made on the end adjoining the experimental plats.

According to Britton and Brown's classification the family Gramineae is divided into twelve tribes, of which for our purpose only eleven need be considered. The tribes with the number of included genera are as follows:

I. Maydeae - - -1	VII. Agrostideae - - - - -20
II. Andropogoneae-6	VIII. Aveneae - - - - - 7
III. Zoysieae - - -1	IX. Chlorideae - - - - -13
IV. Paniceae - - 11	X. Festuceae - - - - - 29
V. Oryzeae - - - 3	XI. Hordeae - - - - - 8
VI. Phlarideae - 3	XII. Bambuseae - - - - - 1 (omit).

Space in the botanical garden may be allotted each tribe according to the number of genera it contains; or according to the number of species with which the Station is apt to deal. This means of course that a large number of exotic and even some native species will be left entirely out of consideration. The botanist or agriculturist of a practical turn of mind can make a fairly close estimate as to the number of species that will ultimately receive a place in this permanent garden; and lay his plans accordingly. Paths will not be found necessary between the plats, since the little tramping that will be done will not effect them in the least.

There is no portion of this region perhaps where drouths do not occur occasionally. However slight the drouth may be, it seems very important that some means of irrigation be provided, so that the least drouth-resisting species may be carried over to a more favorable season. This applies only to the botanical garden. Nearly every Station in this region is so situated as to have the advantage of a water works system of some kind. Where this is the case, irrigation is quite easily accomplished, although there are a number of points to be considered in such an event. For all purposes it is best to have the hydrant located at one corner of the garden. At a very low cost surface pipes may be run in, and by means of stop cocks and fifty feet of one and one half inch hose, the whole field may easily be watered. Since the water is necessary only in summer, the pipes that lead in from the hydrant may be laid above ground. They will not be found to interfere in the least with operations in the garden. A water pressure of not less than fifty pounds per square inch should be maintained if possible, as high pressure calls for less pipe and hose. (See plan of garden on plate II.) Irrigation by means of ditches could not be used

to any advantage in the garden since the flooding would cut the plats up badly; and again the Experiment Station can afford a more convenient system.

In order to prevent a confusion of species each plat should be carefully staked, and labelled in a uniform manner. Not only is this of great convenience to those directly concerned, but it adds to the appearance of the field and is of much satisfaction to visitors as it gives them much ready information. Heavy wooden stakes 2 X 4 X 16 inches are found to be very satisfactory. The part of the stake that remains above ground should be given at least two good coats of white paint, and the part in the ground should be dipped once or twice in hot coal tar. When treated in this manner it has been found that the stakes will last a number of years. The southeast corner of the plat is the proper place for the stake. At the top or at the side of the stake, a guide made of sheet zinc should be firmly tacked or screwed. This guide should be so constructed as to admit of a zinc label 1 1/2 x 2 1/2 inches. The label should bear the numbers of the plats, the Station number, and the botanical and common names of the grass. These should be written with Horticulturist's ink. If desired the number of the plat may be stamped on the stake with black paint. Care should be taken to revise the labels every time a change is made. Since the permanent garden grows at the expense of the experimental garden, the consecutive numbering of the plats is rendered difficult. Probably the only way in which this could be accomplished would be to number them across the tribes, and as plats were added to the end they could be given consecutive numbers. For convenience in plotting, the test plats could be numbered from the opposite end of the field, as the plats adjoining the permanent garden were used up, the numbers could be discarded. Thus the two series would not interfere. (See plate II).

A grass garden of any kind is not complete without a thorough system of records. Not only are they necessary in order that results of the experiment may be published; but also are they necessary to prevent the repeating of tests, which means much unnecessary work and expense. And again they are necessary in order that the experiment may be conducted in a scientific manner. Notes should be taken at least

four times a year, and oftener if the conditions demand it. Notebooks with specially prepared forms will be found very convenient. No better form could probably be suggested than that used by the Division of Agrostology, United States Department of Agriculture. These forms may be filed away to be kept for reference, or the principal points may be transferred to cards and an index kept as that described under the Kansas grass garden. The card index system seems to be the most satisfactory although perhaps more expensive. Time and money are well spent in keeping records and notes in good logical order since it will save much guessing and approximating.

Although we think of a grass garden as an experimental field where grasses are given a trial and as a place where unfavorable conditions should be possible, so that each species may have an opportunity to show its ability to withstand adverse conditions, still we must not look upon it as an experiment to be started out and then allowed to take care of itself. A certain amount of care is necessary for this as for any other planted field. The different parts of the garden, the botanical and the experimental, require quite different methods of treatment. This difference in treatment might almost begin with the preparation of the plat. The soil of the botanical garden should be given a thorough stirring. This might be accomplished by means of deep ploughing at the beginning or by spading after the field has been laid off into plats and the stakes set. After the stirring a treatment should be given that will pack the sub-surface leaving the soil loose on top. In this way an excellent seed bed will be obtained.

Although the other portion of the field is to be devoted to experimental purposes it must not be implied that a poor preparation may be given. It should be put in good condition, as good as that of a large field in which grass is to be sown for pasture or meadow. This will necessitate a stirring equal to that of average ploughing, and the smoothing of the surface to make a soil bed.

After the plats have been put in the condition described, the planting will be the next thing to consider. As for the botanical plats, transplanting from the test plats or from fields may be employed. When seed is to be sown planting in drills is

by far the best method for all plats. Not only are the plats more easily cultivated when the grass is planted in drills, but also a better stand is obtained in this way. Farmers have for many years used the press drill for planting wheat, and of late years it is becoming a favorite method of planting alfalfa, sorghum, kafir corn, oats and grass seed in general. Aside from the facility of culture, the advantages of the drill methods are too obvious to need discussion. While we can conceive of places where the drill could not be used to advantage in planting grass seed, as for instance the seeding of patches in stony pastures; still with the improved machinery of today little difficulty in this respect is experienced. Since the drill may be used to advantage in seeding fields, nothing is gained in using other methods in the grass gardens.

As has previously been stated, there is no portion of the Great Plain region where irrigation may not be used at times to advantage, and in fact may be resorted to as a necessity. Again we must draw the line in the treatment of the different portions of the garden. In the botanical garden favorable conditions are desired. This means that water must be used freely when needed. Everything is to be kept in perfect condition. These plats have nothing whatever to do with the test or experiments, hence field conditions are unnecessary. On the other hand the experimental plats contain grasses that are grown for trial; it is not known whether they are fitted to withstand their environment, hence any attempt at nursing them must be discarded. It is only when unfavorable conditions come that we are able to judge of their relative merits. When the drouth exists, let these grasses take their chances as nearly as possible with those of the field. With this idea in mind, there are very few times when irrigation need be used in the test garden. Such times might be when the plats are unduly exposed, or when an account of a smaller size, they are subjected to conditions that do not exist in the field. Perhaps if the Experiment Stations that find such a wide divergence between the behavior of grasses in plats and those in the field would leave out irrigation in the care of their experimental gardens, they might more nearly bring about consistent results. We would not recommend that

that the test plat be not irrigated, but that those in charge use their very best judgement in the matter, keeping in mind all the time, the purpose of the experiment.

In broken or tilled soil, weeds are perhaps the worst enemy of grass. It is often stated that certain grasses would do well for meadow, pasture or other purposes, if they could only once get ahead of the weeds. Many grasses after getting well started form bunches, others form turf or mats, that render them capable of crowding out the weeds. Farmers often plant cleaning crops before sowing grasses or clovers. In this way the grass has time to develop a good root system before the weeds begin. It is necessary to the welfare and also to the appearance of the botanical garden that the weeds be kept out. The most practical way that suggests itself at present is by the judicious use of the hoe. A little less care perhaps may be given the experimental garden, although it must be remembered that a garden as a rule is more foul than a large field, hence allowance must be made for this. It will not interfere with the experiment, nor do away with field conditions to keep the weeds in the experiment plats well under control, if not entirely removed. An objection might be raised to keeping the weeds removed since it would be impractical to carry the method into the field; still as has before been stated, in the field cleaning crops may be planted, and also various methods of culture may be employed in preparing the field that will remove, or at least put a check to the weeds. This sort of treatment could not be used in the garden as the plats are used from season to season for various tests. Aside from this, such methods are unnecessary and undesirable.

After the grasses in the permanent grass garden have become well established, very little cultivating is necessary. However, there is little doubt that an occasional breaking up of the sod or mat would be in many cases beneficial. The reason for this is evident since upon long standing the plats tend to become sod-bound. Such grasses as the blue stem and others of importance, fail to produce seed when they reach this condition. Upon the breaking up of their sod the plants again form seed and are in general rejuvenated. In the experimental plats a sod^{bound} condition is hardly apt to exist, as the grasses remain there for a few seasons only; but should it ever

occur the breaking up of the sod by some method would be directly in keeping with the experiment, since this method may be extended into the field by the use of the disc harrow or some other practical implement. It seems best to give these plats no further culture than that which they receive from the hoeing of the weeds. The hoeing means only surface cultivation, but in times of drouth this is very effective.

To a large degree the success of the grass garden as an experiment depends upon its care. Care means much to any growing crops of any kind, grasses included. It cannot be doubted that the grasses that do well in the plats will do equally well in the field, the conditions in both cases being the same. While there are certain conditions that exist in the field, such as grazing and tramping of stock, still for dry forage purposes these may be overlooked. It should be the aim of those in charge to make the tests mean as much as possible. Personal views must be left entirely out, for if one starts to prove a point, one is sure to do it.

In a paper of this kind, it is impossible to enter into a discussion of all the grasses of the garden, ^{and} as a consequence only a very few will be touched upon. Without exception, those discussed are native of Kansas, and will be written up with regard to their relation to that state. The following is a list of the grasses in question:-

Andropogon provincialis (Lam.).

Andropogon scoparius (Michx.).

Bouteloua curtipendula (Michx.).

Bulbilis dactyloides (Nutt.)

Elymus canadensis (Linn.).

Chloris verticellata (Nutt.).

Agropyron repens (Linn.).

Sorghum halapense (Linn.).

Dactylis glomerata (Linn.).

Festuca elatior (Linn.).

The grasses of the above list are ones with which we are quite familiar, although there are a few perhaps that have not attracted general attention as being of special importance for economic purposes. Some, in fact, are so common as to be considered as weeds in many localities. Tests, botanical and otherwise, however, have shown them to be promising forage crops. Other grasses of greater importance might supplant a few that are enumerated here, yet for special reasons these particular ones have been chosen.

In this discussion it is intended that each grass shall be taken up in turn, beginning with the botanical description according to the Bulletin of American Grasses by the United States Department of Agriculture, with an occasional reference to Britton's "Manual of Flora of the United States and Canada"; also touching on their distribution, comparative tests (botanical and chemical), and points of importance that may be brought up. No attention will be paid to the order in which the grasses are taken up; since the only order that counts for much is that of their economic importance, and as that has not yet been established in all cases, no order whatever will be followed.

ANDROPOGON PROVINCIALIS (Lam.)

Big Blue-stem.

A stout perennial, 6 - 16 dm. high, with long leaves, and rather thick spikes 3 - 10 cm. long. Sessile spikelet 8-10 mm. long. Awn of the fourth or flowering glume 10-15 mm. long, loosely spiral; first and second glumes nearly equal but slightly exceeding the third. - From the Rocky Mountains eastward to the Atlantic and southward to the Gulf of Mexico. August to October.

The Big Blue-stem is perhaps the most widely known of any of our native grasses. It occurs in every county of Kansas and in many localities it comprises the important constituents of the pastures and grass land. The Experiment Station of Kansas is putting forth efforts toward the culture and breeding of this grass. It has been found that a good stand in cultivated fields is comparatively easy to secure from the seed. The great difficulty, however, is due to the fact that as soon as the ^{lies in the procuring of the seed. This difficulty} is due to the fact that as soon as the

grass becomes sod bound, little seed is matured. When the conditions are such that the seed of the "Big Blue-stem" can be placed on the market at reasonable rates, the people of this region will be one step further in the solving of the grass question.

ANDROPOGON SCOPARIUS (Michx.).

Little Blue-stem.

A rather slender perennial 4- 21 dm. high, the solitary racemes, 2 1/2-5 cm. long, terminating the culms and branches. Sessile spikelet about 6 mm. long, the pedicellate spikelet 2-3 mm. long; awns 10 - 15 mm. long.-Dry fields and borders of woods, New Brunswick westward to the Saskatchewan, southward to Florida, Texas and southern California, (Mexico). July to October.

It is estimated that where both of these grasses grow in Kansas, the Little Blue-stem makes up as large a percentage of the ordinary pasture constituents as does the Big Blue-stem. Like the Big Blue-stem, it is found in nearly every county in the state, and ranks nearly as high in its utility. It has been proven that this grass will do well in cultivated fields, but like the other it is handicapped by slight seed production. It is the opinion of the author of that this grass will stand the effects of tramping and grazing better than the Big Blue-stem.

BOUTELOUA CURTIPENDULA (Michx.).

Tall Grass or Side Oats.

A densely tufted perennial 3-9 dm. high, with numerous (20-60), usually spreading or reflexed spikes scattered along the common axis, forming a long, somewhat one-sided raceme 20 -40 cm. long. Sheaths loose, sparsely pubescent; leaf blades 10-30 cm. long, 4 mm. wide, scabrous. Spikes 6-16 mm. long, reflexed. Spikelets 7-10, mm. long; empty glumes unequal, the first awn pointed, the second acute; flowering glumes about 4mm. long with three short awns.-Dry fields, hillsides and prairies. Ontario and Manitoba south to New Jersey, Mississippi, Texas, and California, (Mexico), Central and South America). May to October.

The Tall Grama Grass is not as important a constituent of our pastures or grass lands as is either of the Blue-stems; nevertheless it is a very valuable grass in many respects. On the hillsides and in stony soil, this grass may be found to thrive when the others mentioned could not exist. It is also particularly adapted to withstand the drouth as its anatomy from an ecological standpoint will show. The Tall Grama Grass has another advantage over the Blue-stems, that of abundant seed-production. The seed that is produced is easily harvested and a very large percentage of it is fertile. This grass does remarkably well in cultivated fields as has been shown by grass garden tests. On the whole it is exceedingly valuable for hay or pasture.

BULBILIS DACTYLOIDES (Nutt.).

Buffalo Grass.

A low, fine leaved, and extensively creeping perennial, rarely more than 1-1.5 dm. high; staminate spikes, 2 or 3, approximate; spikelets 4-5 mm. long, 2-3 flowered, the empty glumes 1-nerved, the flowering glumes 3-nerved; pistillate spikelets ovoid, the outer glume indurated. Similar to Bermuda Grass in habit of growth. - Dry prairies and river bottoms. Minnesota and South Dakota (ascends to 1,650 m. in Black Hills), to Arkansas, southern Texas, and Colorado, (Mexico), March to August.

With respect to dominance of pasture grasses, Kansas might be divided roughly as follows; one hundred fifty miles west of east line, Blue-stem dominant; remaining portion, Buffalo Grass dominant. While there is no sharp line of demarcation this between the two areas, still upon investigation this division will prove to be approximately correct. The Blue-stem overlaps the borders to the west by means of the valleys, and on the hilltops to the east the Buffalo grass is found. Either may be found in the area of the other in edaphic situations; but in few, if any, cases are they dominant outside the areas mentioned. The value of Buffalo Grass depends largely upon its drouth resisting qualities and upon its utility during the winter months. The Grass cures without cutting and is relished by stock, being very nutritious.

On account of its procumbent habit, it is without value as hay. The question of propagating this grass is a very important one, since it is with difficulty that the seed is procured. Attempts have been made to propagate it vegetatively, but without success. This grass is deserving of much attention from the grass breeder of the Experiment Station.

ELIUMUS CANADENSIS (L).

Nodding Wild Rye.

(Britton). Culms 6-15 dm. tall; leaves 1-3 dm. long or more, 4-20 mm. wide, rough, sometimes glaucous, nodding, its peduncle much exerted; spikelets divergent from the rachis, 3-5 flowers; empty scales awl-shaped, rigid 3-5 nerved, 1.6-3.2 cm. long, including the long slender, rough awns; flowering scales 8-14 mm. long, nearly smooth to hirsute, bearing a slender scabrous, straight or divergent awn 2-5 cm. in length. -- On river banks of Nova Scotia and New Brunswick to Alberta, south to Georgia, Texas and New Mexico. July - August. In most localities this grass has been considered a weed as it grows along the road sides and in waste places. Of late years it has been subjected to experimental tests, and has proven itself worthy of farther consideration as a forage grass. It is not probable that the "Wild Rye" would be of value as a pasture grass, although it stands the drouth very well. Seed is produced quite abundantly and a large percentage of it is fertile; also a minimum amount of effort is required in harvesting. The grass grows well under cultivation and is relished as hay by stock. There is one thing, however, that interferes greatly with the use of this grass, and that is the presence in the head of a disease known as ergot. This disease is characterized by an elongated black growth proceeding from the base of the pistil. It is when the grass is cut and fed as hay that the disease appears to be most effective. The grass is not attacked by the disease every season, but only when the weather conditions are favorable. In Kansas, during the year of 1902, a large number of cattle died from the effects of eating ergotized Wild Rye. If this grass could be freed from this disease it would without doubt be of considerable importance as hay in some sections of the country.

CHLORIS VERTICELLATA (Nutt.).

Wind-Mill Grass.

A low, spreading perennial, with rather stout upright flowering branches 1.5-5 dm high and numerous widely spreading, slender spikes 8-13 cm. long. Sheaths exceeding the internodes, with few long hairs at throat and margins; leaf blades obtuse or often acuminate, scabrous above, smooth beneath. Spikelet about 3 mm. long; first and second glumes scabrous on the keel, lanceolate, aristate-acute; flowering glume 3-nerved, bearing a slender scabrous awn 8-10 mm. long, the fourth sterile glume broadly ovate, bearing an awn 6-8 mm. long. -Prairies, Kansas to Texas. May to Sept.

Very little attention has been attracted by this grass, probably on account of its not being very abundant, however where it occurs in quantity it has proven itself to be quite valuable for pasture purposes. It is a low growing grass and has a tendency toward forming a turf or mat. It withstands drouth and close grazing to a considerable extent. It is well liked by stock, but on account of its low habit it cannot be used as hay. The seed though quite abundant is procured with difficulty. The grass grows well in cultivated fields, and bids fair to come into use in the future.

AGROPYRON REPENS (L.)

Couch Grass.

An erect, stoloniferous perennial, 3-12 dm. high, with flat leaves, which are pilose along the nerves above, and terminal, densely flowered spikes. Sheaths striate usually smooth; leaf-blades 10-30 cm. long, smooth or scabrous. Spikelets green, 3-6 flowered; empty glumes 5-7 nerved, obtuse or notched, acute or short awned; flowering glumes acute or short awned. Naturalized from Europe. In fields and waste places almost throughout North America, except in extreme north.

This species of *Agropyron* is very variable and it is probably the variety *glaucum* that is most commonly found in Kansas. Like the "Nodding Wild Rye", it has been considered in many localities as a weed. For the reason that it is able to propagate itself by rootstocks, it is enabled to establish itself in places when

many other grasses could not exist. This habit also makes the grass exceedingly hard to eradicate, which might be an objection to its being grown in cultivated fields. The grass stands the dry weather extremely well and for this reason it is of importance. As a pasture grass it is not eaten readily by stock when the Blue-stem or Buffalo Grass can be obtained; but if cut in the proper stage it makes very good hay. Seed of this grass may be procured at an average cost, and a good stand is easily obtained. In dry regions the grass is without doubt of value as a hay crop or for pasture.

SORGHUM HALEPENSE (L.) Pers.

Johnson Grass.

(Britton).— Culms 9-20 dm. tall, sheaths smooth; leaves 3 dm. or more long, 6-25 mm. wide; panicle from 1.5- 4.5 dm. long; outer scales of sessile spikelet 4-6 mm. long, usually purplish, pubescent with long appressed hairs; awn when present 8-16 mm. long. In fields and waste places, southern Pennsylvania to Missouri and Kansas, south to Florida and Texas. Native of southern Europe and Asia. July -Sept.

Johnson Grass is probably better known in southern portion of the Great Plains region where it is so widely distributed that it is recognized as a weed. In Kansas in 1898 it was reported from only nine counties, at the present time it has a much wider distribution, although not yet attracting much attention. Seed from this grass is easily secured and it is with little difficulty that a good stand is obtained. For pasture or hay this grass is certainly very valuable; but on account of the difficulty with which it is eradicated it must be watched closely and sown with discretion. Perhaps as far north as northern Nebraska the cold winters would be an effective check upon its spreading. It stands drouth and tramping by stock remarkably well, and is relished by stock either when green or when cured as hay. If effective methods for controlling this grass could be installed, it could be highly recommended in many localities.

DACTYLIS GLOMERATA (L).

Orchard Grass.

A coarse, erect grass 9-12 dm. high, forming dense tufts, with long, flat or slightly keeled, leaf-blades and 3-5 flowering spikelets, crowded into dense, one-sided clusters at the ends of the panicle branches. Ligule thin, membranaceous, elongated; flowering glume 4-6 mm. long, short awn-pointed. -Extensively naturalized in fields and waste ground; New Brunswick to South Carolina, west to Manitoba, Idaho, and Colorado (Europe). May to August.

Orchard-grass, as it is commonly known, has not a very wide native distribution in Kansas; but has been cultivated quite extensively and with good success in the eastern part of the state. The merits of the grass both for pasture and hay are generally known and need not be discussed here. This grass does well alone or when sown with other grasses or clovers; however it cannot be recommended for dry regions or for regions subject to periods of drouth. Orchard Grass will not stand tramping nor grazing to any great extent, but makes excellent hay.

FESTUCA ELATIOR (L.)

Fall or Meadow Fescue.

(Britton) - Culms 6-10 dm., tall, erect, simple; leaves 1-4 dm long, 4-8 mm. wide, flat, smooth beneath, more or less rough above; panicle 1 - 3.5 dm. in length often nodding at the top, simple to very compound, the branches ascending or erect, 5-20 c m. long; spikelets 5-9 flowered, 9-12 mm. long, empty scales acute, the first 1-3 nerved, the second 3-5 nerved; flowering scales acute or short pointed, smooth and glabrous, 5-6 mm. long, indistinctly 5-nerved. In fields and waste places, United Nova Scotia to Ontario, south to North Carolina, Tennessee and Kansas. July to August.

This grass is not well known to the people of Kansas since its native distribution is restricted to about ten counties, and little having been done regarding its cultivation. Tests in the grass garden of the Experiment Station have shown this grass to possess many valuable qualities, principally however, for use as hay.

It stands dry weather quite well and is available for pasture for a considerable period. The seed may be obtained at about the same cost as that of English Blue-grass; although perhaps, not quite so plentiful. No doubt in the future if properly tested this grass will show up with much promise.

The following is a table of chemical analyses of the grasses previously described. Unless otherwise stated, the analyses are those of the Iowa Experiment Station. The figures given in most cases are the averages of five samples taken at various stages of maturity, as, for example, from April to September. This in a way represents the composition of the grasses throughout the ^{growing} season. The Government analyses represent but one sample and hence can hardly be compared with the others. The table gives only a very general idea of the feeding value of the grasses, since many other points not herein noted must be taken into account.

Table of Chemical Analyses.

Natural Condition.

Iowa Experiment Station Analyses.	H OH	Fat	Pro- tein	Al- bumen	Crude fibre	Ash	N.free extract
<i>Andropogon provinciales</i>	69.69	1.59	2.88	(2.37)	10.87	2.49	15.88
<i>Andropogon scoparius</i>	66.59	1.27	2.88	(2.37)	10.75	2.49	15.88
<i>Bouteloua curtipendula</i>	77.88	.55	2.24	(1.79)	2.13	7.26	9.94
<i>Bulbilis dactyloides.</i>	42.06	.95	3.06	(2.46)	21.75	4.46	27.72
<i>Elymus canadensis</i>	61.35	1.52	4.16	(3.16)	12.71	3.08	17.60
<i>Chloris verticellata</i> (Govt.)	No analyses						
<i>Agropyron repens</i>	77.99	1.24	3.95	(2.50)	5.69	2.60	8.65
<i>Sorghum halapense</i> (Govt.)	21.47	2.43		(6.92)	11.11	14.30	44.77
<i>Dactylis glomerata</i> (Govt.)	80.	1.04	(3.18)	(2.52)	6.79	2.26	6.72
<i>Festuca elatior</i>	78.97	1.30	4.99	(3.77)	5.98	2.82	(7.94)
Water Free Substance							
<i>Andropogon provincialis</i>		5.63	10.54	(7.25)	32.63	7.09	44.13
<i>Andropogon scoparius</i>		3.78	8.76	(7.21)	32.40	7.52	47.53
<i>Bouteloua curtipendula</i>		2.48	10.12	(8.11)	32.84	9.60	44.96
<i>Bulbilis dactyloides</i>		1.65	6.13	(4.93)	35.11	4.82	44.87
<i>Elymus canadensis</i>		3.97	10.78	(8.27)	32.98	8.05	44.21
<i>Chloris verticellata</i>	No analyses						
<i>Agropyron repens</i>		5.65	17.59	(10.99)	25.69	11.81	39.13
<i>Sorghum halapense</i> (Govt.)		2.84		(11.80)	25.05	8.07	52.24
<i>Dactylis glomerata</i> (Govt.)		5.34	17.36	(13.59)	32.78	11.74	32.88
<i>Festuca elatior</i>		5.54	21.95	(16.18)	25.51	12.40	34.53

Explanation of Plates.

Plate I. Experimental Garden, Kansas Experiment Station.

Plate II. Plan of Model Grass Garden. Plots to left to be used for the botanical garden.

Dotted lines represent pipes, x stop cocks, numerals indicating the arrangement of the tribes.

Plate III. *Andropogon provincialis* - 1, Flowering culm; 2, Glume enlarged.

Plate IV. *Boutelous curtispindula*, culm with flowering axis.

Plate V. *Agropyron rigidum*, - Flowering spike enlarged.

Plate VI. *Festuca elatior*. - Panicle showing manner of emerging from sheath.

EXPERIMENTAL GARDEN, KAN. EXP. STAT.

24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1
25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
49	50	51	52	53	54	55	56	57	58	59	60	61	62	63	64	65	66	67	68	69	70	71	72
73	74	75	76	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91	92	93	94	95	96
97	98	99	100	101	102	103	104	105	106	107	108	109	110	111	112	113	114	115	116	117	118	119	120
121	122	123	124	125	126	127	128	129	130	131	132	133	134	135	136	137	138	139	140	141	142	143	144
145	146	147	148	149	150	151	152	153	154	155	156	157	158	159	160	161	162	163	164	165	166	167	168
169	170	171	172	173	174	175	176	177	178	179	180	181	182	183	184	185	186	187	188	189	190	191	192
193	194	195	196	197	198	199	200	201	202	203	204	205	206	207	208	209	210	211	212	213	214	215	216
217	218	219	220	221	222	223	224	225	226	227	228	229	230	231	232	233	234	235	236	237	238	239	240
241	242	243	244	245	246	247	248	249	250	251	252	253	254	255	256	257	258	259	260	261	262	263	264
265	266	267	268	269	270	271	272	273	274	275	276	277	278	279	280	281	282	283	284	285	286	287	288
289	290	291	292	293	294	295	296	297	298	299	300	301	302	303	304	305	306	307	308	309	310	311	312
313	314	315	316	317	318	319	320	321	322	323	324	325	326	327	328	329	330	331	332	333	334	335	336
337	338	339	340	341	342	343	344	345	346	347	348	349	350	351	352	353	354	355	356	357	358	359	360

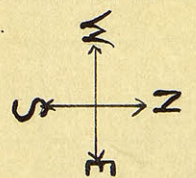
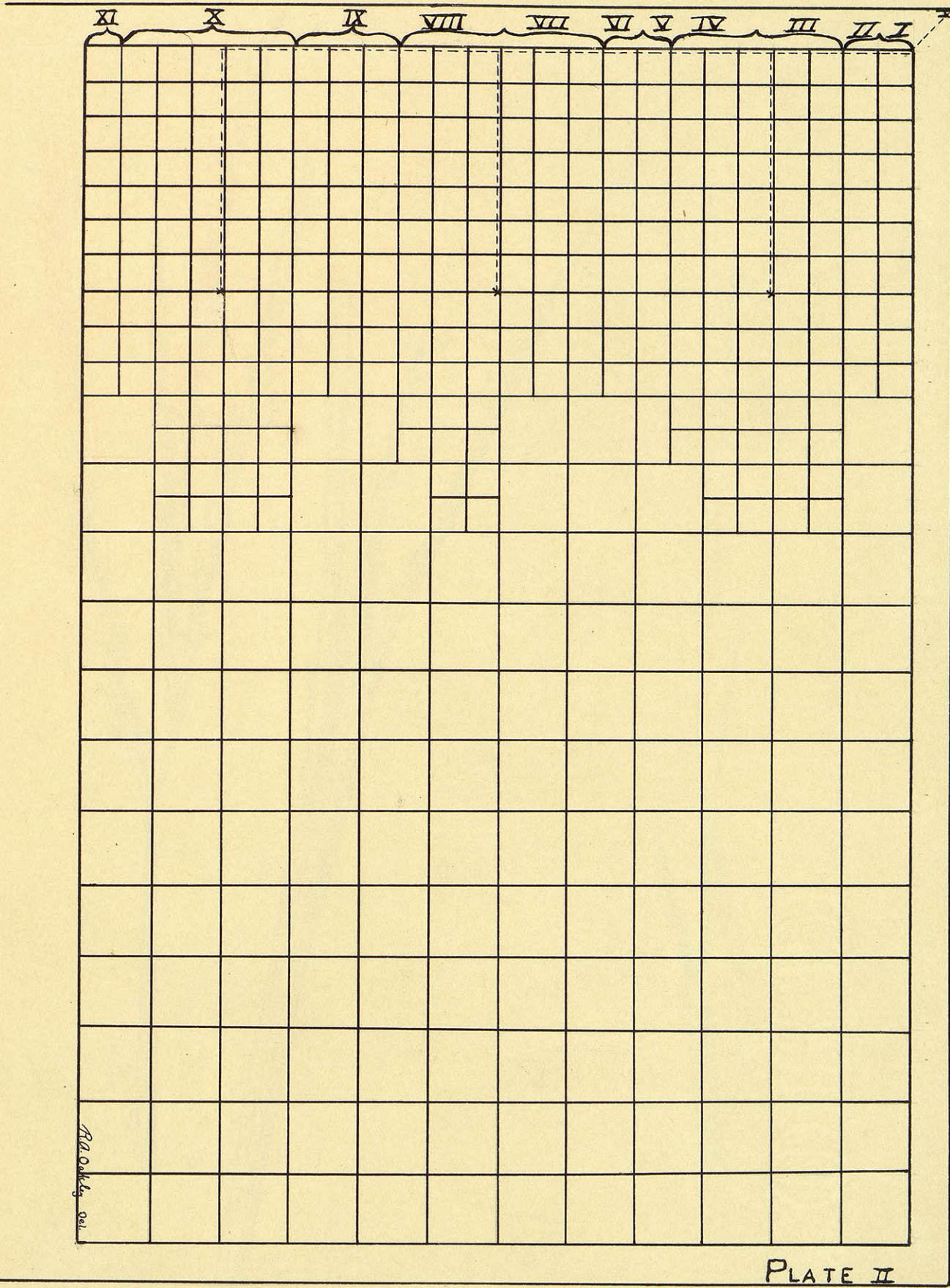


PLATE I

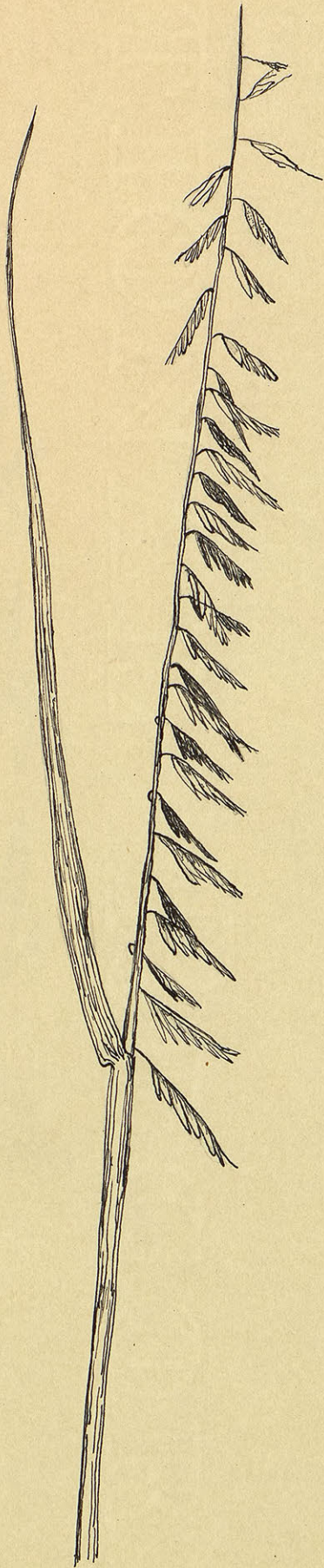
R.A. Dudley det.

PLAN OF GRASS GARDEN.



RAOKL 001





After Wechs
R.A.O.

