BICOLOR LESPEDEZA IN SOUTHERN ILLINOIS

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Since the turn of the century, modern farming equipment and intensive land use have been responsible for a loss of wildlife habitat and a decline in game populations. Establishment of annual food patches for upland game species was one of the initial efforts to improve upland game populations. Because of cost and maintenance requirements, interest in this program did not become great except on intensively managed areas (Scott and Klimstra, 1954). Wildlife biologists recognized the need for a program which would be more permanent and which could be integrated with good land usage. As a result, attention was directed to perennials which might be of benefit to both agriculture and wildlife. One of several plants employed was bicolor lespedeza, *Lespedeza bicolor*. The value of this plant was believed twofold in that it would provide both food and cover for game animals, especially the bobwhite quail, *Colinus virginianus*.

Bicolor lespedeza is a leguminous shrub native to China, Japan, Korea, and Manchuria (Crider, 1952). Introductions of this plant into the United States have been made by the U. S. Department of Agriculture at different times since 1897. It was first used as an ornamental shrub; not until the middle 1930's was consideration given to its use in soil and wildlife conservation. The initial distribution of common bicolor lespedeza in the United States was limited largely to areas where long growing seasons insured maturity and ripening of seed before frost.

Within a few years, this plant became one of the most popular woody plants to be utilized in wildlife management throughout much of southeastern United States. Both game managers and soil conservationists made extensive use of this shrub in farm-game programs. According to Davison (1948), the use of bicolor greatly advanced the conservation of game and the management of farm lands suitable for wildlife; farms of even moderate size were able to produce food and shelter for quail.

The first plantings of common bicolor lespedeza in Illinois were made in the late 1930's by the Civilian Conservation Corps in erosion control projects. In Madison County, where extensive work was conducted, small plantings of bicolor were made in combination with trees and shrubs in ten plots; these contained from 25 to 300 seedlings. The Soil Conservation Service established a few trial plantings in extreme southern Illinois in the late 1930's and early 1940's.

Following World War II, the Illinois Department of Conservation, the Soil Conservation Districts, and the United States Soil Conservation Service cooperated in promoting an extensive wildlife habitat restoration program. This resulted in the establishment of several bicolor lespedeza plantings (Davidson, 1952) in southern Illinois beginning in the spring of 1948. Plots of this shrub were

established by using seed and seedlings of strains 100, 101, and 1B; most were planted with conifers, hardwoods, multiflora rose, *Rosa multiflora,* and sericea lespedeza, *Lespedeza capitata* var. *sericea.* Some of the smaller plantings were trial plots, while others were established from the Soil Conservation Service "wildlife packets" for use as food and cover in conjunction with farm ponds and in idle areas. The majority of the plantings were made at the rate of 1,000 seedlings or as one-eighth acre plots. Anderson (1950) recommended that no plantings be made north of U. S. Route 40; therefore, few areas of bicolor were established north of the Southern Zone.

The evaluation of the response of bicolor to the environment of southern Illinois was begun in 1950, and continued through 1953. The following phases were included in the investigation: (1) the adaption of bicolor lespedeza to southern Illinois climate and soils; (2) seed production and retention; (3) effects of planting and cultural methods on establishment and survival; and, (4) utilization by wildlife. Two types of study areas, set up to accomplish these objectives, included an area for detailed study in Washington County and secondary areas for general observations in nine additional counties.

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Techniques of Study

General Description of Southern Illinois. Southern Illinois has diversified physiographic, climatic, and agricultural conditions. The continental location of this region combined with the latitude causes hot summers and cool or cold winters, with January normally the coldest and July the hottest months (Page, 1949). The average length of the growing season from the north to the south of the Southern Zone varies from 185 to 213 days, a difference of approximately 28 days. In general, the average annual precipitation for the southern 34 counties is between 38 and 46 inches. Approximately one-half of the precipitation falls during the growing season, but it is erratic, fluctuating from year to year and from month to month. The average amount of snow for southern Illinois is 14.7 inches.

Physiographic contrast between glaciated and non-glaciated areas is most pronounced in this section of Illinois (Leighton, Ekblaw, and Horberg, 1948). The glaciated area of southern Illinois covers part or all of the counties except the southern seven. Thus, in this area, glacial debris of all descriptions may be found; 70 per cent of the upland soil in Illinois has been formed primarily from loess (Smith, 1942).

Major prairie areas are in the north central section with extensive

deciduous forest areas to the south and along major streams and rivers. The prairie soils are gray, with the upper layers deficient in organic matter. In general, this group of soils has poor surface drainage resulting in crop damage during seasons of heavy rainfall. The tight clay pan also reduces the water holding capacity of the soil causing serious crop loss during periods of drought.

The timber soils are mainly from loess, and are leached, acidic, and low in organic matter. Much of this group is characterized by a silty texture of both surface and subsoils. The alluvial soils of this section are developed under deciduous forest conditions and extend mostly along the Mississippi, Ohio, Kaskaskia, and Wabash rivers, varying in drainage from fair to poor.

Forty-one per cent of all cropland is used for inter-tilled crops, 29 per cent for hay and rotation pasture, 17 per cent for small grain, and 13 per cent remains idle (Committee on Productive Capacity of Illinois Agriculture, 1951). In the northern 18 counties of the Southern Zone, 15 per cent of the area is classed as forest land, and in the southern 16 counties, 26 per cent falls in this class. The proportion of land in forest is changing as the result of land-use practices; overgrazing and cutting are constantly causing clearing of forest (King and Winters, 1952). However, this tends to be offset by the return of open fields to forest either by planting or natural plant succession on abandoned submarginal agricultural land. As a result, forest lands show an increase of 3 per cent from 1940 to 1948. About 22 per cent of the land in southern Illinois is potential forest area; this is classed as the poorest land in the section for production of agricultural crops. It includes areas which are badly eroded, gullied, and swampy; additional acres are falling into this category due to poor land use.

In recent years, federal, state, and local agencies have studied the farm program in southern Illinois and have initiated changes commensurate with better land usage. As a result, the trend in agriculture has been directed toward grassland farming and timber production. The projection of such a program has raised the problem of insuring staple food and cover for wildlife, especially quail.

Intensive Study Areas. Two sites, the J. W. Huegely and the Gene Poirot farms near Nashville in Washington County, were included in the intensive study area. These were selected because (1) they were centrally located in the Southern Zone; (2) their soil, climatic and agricultural conditions were fairly representative of those in southern Illinois; and (3) the land owners and tenants showed an interest (and cooperated) in conservation farming. Both farms had a history of intensive agriculture, and were among the first in Washington County to convert to a soil conservation farm plan. According to the Soil Conservation Service classification, six soil groups, Classes I, II, III, IV, V, and VI (Klingebiel, 1951) are represented on the area; most of the soils fall into Classes III and IV.

The plantings on the J. W. Heugely farm, hereinafter referred

to as Plots H-A, H-B, and H-C, were established in the spring of 1949 under the supervision of the U. S. Soil Conservationist in Washington County. These plantings were part of a series of bobwhite food and cover trials scattered throughout Region III of the United States Soil Conservation Service (Anderson: private communication); they were established according to the Regional Biologist's specifications. The planting on the Gene Poirot farm, established in the spring of 1950, referred to hereinafter as Plot P-D (Table 1), was not part of the above trials.

Secondary Study Areas. In addition to the two intensive study areas, limited observations were made of 28 plantings variously located in the western one-half of the Southern Zone. General data with respect to each of the plantings are presented in Tables 2 and 3.

Method of Analysis. The quadrat method was used to obtain samples for determining seed production, seed retention, growth, and reproduction for plantings which were studied intensively. Four-foot quadrats were employed because they were adaptable to both seed and seedling plantings and were easily handled. Mortality in plantings established from seedlings was calculated by counting the total number of plants remaining in each plot; the quadrat method was not an adequate means for determining seedling loss because, in many instances, mortality was too small to be evident in a sample. However, quadrats were used for this purpose in plantings established from seed. Following the growing season, annual and total growth was determined by measuring the height of plants in a minimum of four quadrats in each planting.

Samples for determination of seed production and retention were gathered from the intensive study area after the first heavy frost. These were collected during the latter part of November, December, and January, 1951-52 and 1952-53; plantings on secondary study areas were sampled only during the fall of 1952. Seeds were hand stripped from two four-foot quadrats in each plot, placed in cloth sacks, and stored.

Laboratory analysis of seed samples was begun after the seeds had been dried and twigs, leaves, and other parts removed. After cleaning the unhulled seed, samples were weighed; results were expressed in pounds of seed per acre for each planting. The sample taken following the first heavy frost was used to determine total annual yield.

A six dram sample was taken from each monthly collection to calculate per cent of mature seed and number of seeds per pound. Hulls were removed by rubbing seeds between the forefinger and thumb. After counting, mature seeds were segregated and the per cent of these per sample was determined. Maturity was established on the basis of coloration, size, and condition of seed coat.

Animal utilization was determined from field observations and collections from the plots throughout southern Illinois. Quail crops were obtained from the intensive study area during the 1951 hunting season.

Mortality

Mortality of bicolor plants appeared to result mainly from weather, site location, cultural practices, and animal activities. By September, 1952, on the intensive study area, Plot H-A showed a 32 per cent loss; Plot H-B a 6 per cent loss; Plot H-C a 20 per cent loss; and Plot P-D a 6 per cent loss.

Site Location. The loss of plants due to site location was due largely to inadequate soil drainage. Plot H-A, situated on "C" slope, showed no loss due to drainage. Plot H-B contained a small area in the planting where ten plants died. Plot H-C, bisected by a wide shallow waterway, showed a loss of 20 plants in this moist area. Plot P-D, with a poorly-drained segment at the north end, showed a complete loss in this site. On the secondary plots, Planting 1 displayed a complete loss of plants in the region of two waterways; a loss of 40 per cent in the total planting was attributed to this factor. Planting 11, purposely established in a poorly drained area, showed a 68 per cent mortality after two growing seasons; Plantings 10, 12, 13, 14, located in better drained sites on the same farm, revealed little mortality (Table 4). Planting 23, established from seed in 1950 (Table 2), also showed adverse effects of poor drainage; six consecutive quadrat samples taken in March, 1953, from the lowest to the highest point up the slope of a waterway revealed 0, 14, 16, 30, 32, and 46 plants, respectively.

Cultural Practices. Mortality due to cultural practices was variable. Partial exposure of roots of seedlings while handling and shipping and late spring planting had little effect on survival. Poor seedbed preparation and planting techniques, however, resulted in considerable mortality during the first growing season. Losses of 40 and 55 per cent in Plantings 1 and 8, respectively, were due to improper packing of soil around the roots.

On the intensive study area, competition with trees resulted in a loss of plants in those rows adjacent to timber. In Plot H-A, the row next to the timber and within the "drip line," showed a 37 per cent loss; Plot H-B, set even with the "drip line," had an 8 per cent loss. The remaining four rows in each plot suffered little or no loss.

Annual and perennial grasses and shrubs invaded the plots on the intensive study area. Most of the grasses were early season forms and matured before the bicolor became fully leaved. Plot H-A, which had a heavy litter of forest leaves, had only a few grasses; however, Plot H-B with little litter had more grasses and shrubs with sassafras, *Sassafras albidum,* predominating. Plot H-C contained an understory of cheat, *Bromus secalinus,* and scattered plants of dewberries, *Rubus flagellaris;* Plot P-D had a heavy understory of redtop, *Agrostis alba,* and bluegrass, *Poa pratensis.*

Seedbed preparation and the amount of cultivation regulated the rate of establishment of other plants (Table 4). Planting 9, planted in sod in 1948, had a heavy understory of perennial grasses and shrubs; important species were broom-sedge, *Andropogon virginicus,* and sericea lespedeza. Where sericea was seeded

TABLE 1.—Description of Bicolor Planting on Intensive Study Area, Washington County, Illinois.

Plot	Year Planted	Site Location	Plot Size and Planting Method	Soil Group Slope Erosion	Seedbed	Soil Treatment
H-A	April 1949	East edge of mature timber—under drip line	1,000 seedlings 350′ long, 5 rows spaced 2′ x 3′, hand planted	34 C-1	Plowed and disked	4 T lime/ac.-1946; 1,000 lbs. rock phosphate-1948; 300 lbs. 4-10-4/ac. at planting
H-B	April 1949	South edge of mature timber	1,000 seedlings 400′ long, 5 rows spaced 2′ x 3′, hand planted	34 B-1 35 A-0	Plowed and disked	4 T lime/ac.-1946; 300 lbs. 4-10-4/ac. at planting
H-C	April 1949	Field border 200′ east and 100′ south of timber	1,000 seedlings 667′ long, 3 rows wide; Multiflora rose border, hand planted	34 B-1	Plowed and disked	4 T lime/ac.-1946; 1,000 lbs. rock phosphate-1948; 300 lbs. 4-10-4/ac. at planting
P-D	April 1950	Open pasture	1,675 seedlings 480′ long, 7 rows spaced 2′ x 3′, plow planted	35 A-0	Plowed	4 T lime/ac.-1948

TABLE 2.—Secondary Study Area Plantings Established from Seedlings, Southern Zone, Illinois.

Planting Number	County	Year Planted	Soil Group	Percent Slope Erosion	Lime	Rock Phosphate	Plow and Disk	Planting Method	Commercial Fertilizer at Planting	Cultivated
1	Washington	1950	34	B-1C-2	x	.....	x	Plow	.....	2
2	Washington	1951	34	B-2	.....	.....	x	Plow	.....	1
3	Washington	1951	34	B-1	x	.....	x	Hand	.....	.....
4	Washington	1951	34	B-1	x	.....	x	Hand	.....	.....
5	Washington	1951	Glacial	Till	.....	.....	x	Machine	.....	.....
6	Washington	1952	34	D-2	x	.....	x	Machine	.....	2
7	Washington	1952	34	B-2	x	.....	x	Machine	14-16-16	2
8	Washington	1952	34	C-2	x	.....	.....	Plow	.....	.....
9	Marion	1948	34	B-2	.....	.....	.....	Machine	.....	.....
10	Marion	1951	34	B-1	x	.....	x	Machine	3-12-12	1
11	Marion	1951	35	A-0	.....	.....	x	Machine	3-12-12	2
12	Marion	1951	34	B-2	x	.....	x	Machine	3-12-12	2
13	Marion	1951	34	B-2	.....	.....	x	Machine	3-12-12	2
14	Marion	1951	34	B-1	x	x	x	Machine	3-12-12	2
15	Union	1948	56	A-0	x	.....	x	Machine	.....	2
16	Pope	1941	15b	D-3	.....	.....	.....	Hand	.....	.....
17	Fayette	1948	35-34	A-OB-1	x	x	x	Machine	.....	2
18	Madison	1939	119	D-3	.....	.....	.....	Hand	.....	2

All Plantings on Class III land except 5 (Class VII) and 6 (Class IV).

TABLE 3.—Secondary Study Area Plantings Established from Seed, Southern Zone, Illinois.

Planting Numbe	County	Year Seeded	Group	Percent Slope Erosion	Lime	Rock Phos-phate	Seedbed Preparation	Fertilizer at Planting	Rate of Seeding Pounds Per Acre
19	Washington	1950	34	C-3	.....	.....	Disk	.....	20
20	St. Clair	1948	15a	C-2	x	x	Disk	.....	20
21	St. Clair	1949	15a	C-2	x	x	Disk	.....	20
22	Jefferson	1948	34	B-2	x	.....	Disk	.....	20
23	Jefferson	1950	34	B-1	x	.....	Plowed and Disked	3-12-12	15
24	Fayette	1950	34	A-0	.....	.....	Disk	.....	15
25	Fayette	1950	34	B-1	.....	.....	Disk	.....	15
26	Pope	1952	15	C-3	.....	.....	Disk	8-8-8	15
27	Marion	1952	34	B-1	.....	.....	Plowed and Disked	3-12-12	15
28	Clinton	1952	34	B-1	.....	.....	Plowed and Disked	.....	15

All plantings on Class III land.

as a border, it eliminated much of the native vegetation and showed evidence of spreading into the bicolor. Much of the bicolor reproduction was killed due to competition of invading plants. No effect was noted, however, on the old plants. Planting 17, planted in an adjacent county the same year, with identical cultural practices except for a prepared seedbed and two cultivations, showed sericea lespedeza eliminating some of the bicolor reproduction along the border. A very limited amount of understory was noted, and most of the planting had a good litter of bicolor leaves and debris.

Planting 24, established from seed in fertile soil which had a heavy growth of bluegrass prior to disking, showed a density of only 12 plants per quadrat after three years (Table 5). Planting 25, located on poorer soil with a lesser stand of bluegrass and a few blackberries, *Rubus spp.*, had a density of 31 bicolor plants after three years. Bluegrass appeared to smother bicolor seedlings.

Weather. In all plantings observed, winter killing appeared to result from low temperatures. While in some cases canes were partially killed, total plant loss was quite evident. Winter kill was more noticeable in plantings located in the extreme northern part of the Southern Zone. Planting 17, established in 1948, in Fayette County, one of the extreme northern counties, showed almost complete winter kill. Reproduction, however, had taken place from seed to the extent that quadrat samples showed about seven plants per quadrat. Planting 16, located in Pope County, one of the southernmost counties, showed a 68 per cent loss by the fall of 1952.

Complete winter kill of all canes as reported in Maryland by Crider (1952) was not observed in this study. Planting 9, located in Marion County, after five years showed 30 per cent of the plants with original canes producing leaves. During 1949, through 1952, low temperatures of —2°, —1°, —14°, and 14° F. were recorded. Crider reported that all above-ground parts of common bicolor were killed at temperatures of —15°, —5°, —6°, and —12° F.; during the winter of 1944, however, a low of 5° did not affect the plants.

Plantings established from seedlings showed less effects of dry weather during the first growing season than those established from seed. This was evident in 1952 when a severe drouth occurred. Plantings 26, 27, and 28 made in Pope, Marion, and Clinton counties from seed, showed greater losses than Plantings 5, 7, and 8 which were established with seedlings (Tables 4 and 5). Seed plantings were dominated by weeds and annual grasses. The few successful plants observed were in areas where soil fertility and moisture were best.

Animal Activity. Activity of small rodents was believed responsible for the loss of 18 plants in Plot H-A, and 41 plants in Plot H-C during the winter of 1951-52. Prairie meadow mice, *Microtus ochrogaster,* and prairie deer mice, *Peromyscus maniculatus bairdii,* trapped in the area were believed to be largely responsible for this mortality. Kill was brought about by eating the roots just below the crown.

TABLE 4.—Response of Bicolor Lespedeza Plantings Established from Seedlings on Intensive and Secondary Study Areas.

Planting Number	Height in Feet	Per Cent Mortality	Understory			Plant Reproduction		
			None	Little	Heavy	None	Little	Heavy
H-A	6	32	x				x	
H-B	5	6		x			x	
H-C	7	20		x				x
P-D	6	6			x		x	
1	5	40			x		x	
2	3	1		x		x		
3	4	..			x	x		
4	5	2		x		x		
5	2	39			x	x		
6	3	24		x		x		
7	4	1	x			x		
8	2	55			x	x		
9	6	35			x			x
10	5	6			x	x		
11	2	68		x		x		
12	6	5		x		x		
13	6	4	x			x		
14	7	3	x			x		
15	10	..		x				x
16	9	68			x			x
17	7	..		x				x
18	Cattle damaged				x			x

ASPECTS OF GROWTH

Variations in growth of bicolor were attributed mainly to the effects of site location, cultural practices, and weather.

On the intensive study area, plots which received recommended cultural practices, reached an average height of four feet the first year, five feet the second year, and six feet the third year. The number of canes usually reached a maximum of six to eight per plant by the third year. Site location had pronounced effect on the growth of bicolor; especially important were soils and soil conditions. Plots H-A and H-B showed differences in growth within the plantings. Plants nearer the timber were not so vigorous or healthy as were the plants in the outer rows. Plot H-B, where soils were less fertile, had smaller plants.

Differences in soil types were characterized by two extremes, Planting 11, on 35 A-O, and Planting 15, on 56 A-O. The former, planted in 1951, reached a height of only two feet with one cane per plant after two growing seasons. Planting 15, planted in 1950 on a slight knoll, reached an average height of nine feet, and had an average of six canes per plant. Many of these canes were one and one-half inches in diameter. The difference in growth of these

TABLE 5.—Response of Bicolor Lespedeza Plantings Established from Seed, Secondary Study Areas.

Planting Number	Height	Understory			Plants Per Quadrat				
		None	Little	Heavy	1st Yr.	2nd Yr.	3rd Yr.	4th Yr.	5th Yr.
19.....	5		x		60	55	33		
20.....	9		x						11
21.....	9	x						18	
22.....	6			x					10
23.....	5		x				23		10
24.....	6			x			12		
25.....	7		x				31		
26.....	..			x	41				
27.....	..			x					
28.....	..			x					

TABLE 6.—Density and Understory of Eight Bicolor Plantings Established from Seed, Secondary Study Areas, Southern Illinois.

Planting Number	Date Planted	Date Sampled	Average Number Plants Per Quadrat	Rate of Seeding Per Acre	Understory
19.....	1950	10/51	60	15 lbs.	None
19.....	1950	9/52	55	15 lbs.	Little Cheat
20.....	1948	12/52	11	15 lbs.	Little Bluegrass
21.....	1949	12/52	18	15 lbs.	Little Bluegrass
22.....	1948	3/53	10	20 lbs.	Little
23.....	1950	3/53	23	15 lbs.	Little Bluegrass
24.....	1950	3/53	12	15 lbs.	Heavy Bluegrass
25.....	1950	3/53	31	15 lbs.	Light

two plantings was attributed to the greater fertility and better drainage of soil type 56 A-O. Planting 1, established on soil types 34 B-1 and C-2, had an average height of five feet at two years; that portion of this planting where erosion had been severe showed an average height of only two feet.

Plantings established from seed varied in height the first year from 8 to 15 inches. Planting 19, established in 1950 on soil type 34 C-3, reached a height of 18 inches the first year, with a density of 60 plants per quadrat. In 1952, the average height of the 35 remaining plants per quadrat was five feet. Planting 20, established in 1948 on 15a C-2, reached a height of nine feet after the 1952 growing season, with a density of 11 plants per quadrat. Planting 21, located on the same soil type, established in 1949, had a density of 18 plants with approximately the same height (Table 6). Adjacent plantings, 22 and 23, established in 1948 and 1950,

respectively, both revealed an approximate height of five to six feet and a density of 18 and 10 plants, respectively. These data indicate that as plantings established from seed increased in age, heavy losses occurred. This was probably due to competition between the bicolor plants.

On the intensive study area the only difference in fertility practices which possibly affected the plantings was the application of raw rock phosphate. Plots H-B and P-D did not receive the applications, and after the first year, revealed signs of phosphate deficiency. Noted effects of the use of commercial fertilizers were the production of healthier and more vigorous plants which showed earlier seasonal maturity.

Flowering. On the intensive study area, budding was first noted May 1, 1952, and April 15, 1953. The time when buds appeared varied throughout the Southern Zone due to the 31 to 43 days difference in the growing season that occurred between the northern and southern counties. All plants, including those unaffected by winter conditions, showed new growth originating near the crowns.

Flowers appeared to be restricted largely to the new canes; old canes rarely produced flowers. Dates of the first appearance of blooms varied greatly in all plantings; on the intensive study area these were July 20 in 1951, and June 15 in 1952. The peak of flowering occurred in late August, 1951, and early September, 1952. The more southern plantings in Union and Pope counties bloomed 10 to 15 days earlier than those in the northern counties. All plantings continued to produce blossoms until frost, which occurred in October of both years. Seed pods, blasted seed, and many flowers were still present on the plants when the first freeze occurred.

Seed Maturation and Production. In 1951, plantings on the intensive study area showed an average seed maturity of 64 per cent per plot, whereas the average mature seed produced in 1952 was 29 per cent (Table 7). Samples of seed from plantings 9, 15, 16, and 19 of the secondary areas were collected only in 1952; planting 16, approximately 30 miles northeast of Cairo, produced 33 per cent mature seed; planting 19, in Washington County, established from seed, had only 5 per cent mature seed; plantings 15, located in Union County, and 9, located in Marion County, did not produce seed.

The production of seed on the intensive study area in 1951 was much greater than in 1952 (Table 7). Average production of all plots in 1951 was approximately 578 pounds per acre, as compared to 81 pounds per acre in 1952, a year of drouth and shorter growing season.

Samples from plantings 9, 15, 16, and 19 of the secondary study areas during 1952 revealed that only plantings 16 and 19 produced seed (Table 7); the former yielded 154 pounds per acre and the latter 2 pounds. Planting 16, in Pope County on upland soil, and planting 15, in Union County on bottomland soil, had over 200 frost-free days. Annual precipitation for planting 15 was 42.5 inches, and for planting 16 it was 39.9 inches. The difference in production of these two plots

might be explained by the fact that heavier more fertile alluvial soils produced rank growth and slower maturity. Also, a slight difference in frost dates might have occurred between the upland and bottomland.

Seed Retention. Observations since the fall of 1949 indicate that bicolor varied considerably in seed retention throughout southern Illinois. Plantings having some wind protection seemed to retain seeds for a longer period. By January 29, 1951, Plots H-A, H-B, H-C, and P-D showed losses of 55 per cent, 84 per cent, 79 per cent, and 95 per cent, respectively (Table 7); Plot P-D was more exposed to winter winds than were the other plots. In the following winter (1952-53) all plots on the intensive study area had a 100 per cent loss by January 29, 1953 (Table 7). Secondary study areas showed only small amounts of seed on the plants after December 29; drouth and low seed production probably were responsible for the short period of retention.

Seed Size. A comparison of seeds produced on the intensive study areas, with those obtained from a commercial house in Georgia, and those produced at the National Observational Nursery, Soil Conservation Service, Maryland, revealed a great difference in size. Crider (1952) reported 85,000 seeds per pound for common bicolor grown in Maryland (Table 8). Seed received from Georgia, which was cleaned and screened before shipping, contained 79,103 seeds per pound. Samples from the intensive study for the years 1951 and 1952 had an average of 132,451 seeds per pound with 46 per cent mature. In 1951, the plantings produced 98,204 seeds per pound with 64 per cent mature, and in 1952, 166,698 seeds per pound with 29 per cent mature. Shorter growing seasons for this more northern region may be reflected in seeds of a smaller size.

Animal Utilization

Animal utilization was of secondary importance in this investigation, and therefore was not studied intensively. The data presented resulted from observations made during September, 1949, to May, 1953.

Bobwhite Quail. Only limited use of bicolor was made by quail on the intensive study area. Some plantings were utilized more than others, possibly relating to their location with respect to other cover. It was noted that periods of heaviest utilization occurred during inclement weather. This was most evident during a two-week period in December, 1951, when heavy snow and ice covered the ground and much of the standing vegetation. Bicolor plants stood about one-half their normal height due to the weight of the ice which bent or broke the canes. A good supply of seed was still intact on the plants although many were lying on the snow. A covey of 15 birds flushed from Plot H-C was observed to be eating seed directly from the top branches of the bent bicolor plants. Additional evidence of utilization of Plot H-C was noted during the winter of 1949-50 and 1952-53.

Other plantings on the intensive study area revealed little or no utilization by quail, although bobwhites were observed in the vicinity of these plantings on several oc-

TABLE 7.—Bicolor Seed Production, Maturation, and Retention, 1951 and 1952.

Plot	Size in Acres	Pounds of Seed Per Acre	Per Cent of Mature Seed	Per Cent Seed Fall by Month		
				Nov. 30	Dec. 29	Jan. 29
1951						
H-A	.14	553	77	24	34	55
H-B	.16	600	82	42	66	84
H-C	.16	650	47	10	42	79
P-D	.28	512	51	57	86	95
Average	.....	578	64	33	57	78
1952						
H-A	.14	182	70	80	91	100
H-B	.16	55	31	62	84	100
H-C	.16	71	13	77	81	100
P-D	.28	17	4	100	100	100
Average	.....	81	29	79	89	100
Secondary Areas 1952						
9	.14	0	..			
15	.50	0	..			
16	.045	154	33	.....	.....	.....
19	.066	2	5	.....	.....	.....

TABLE 8.—A Comparison of Sizes of Bicolor Seed.

Sample	Date	Per Cent Mature Seed	Total Number of Seeds per Pound
Composite samples from intensive study area	1951	64	98,204
	1952	29	166,698
		46.5 Average	132,451 Average
Georgia seed	.....	.....	79,103 Average
Maryland seed	.....	.....	85,000 Average

casions. Examination of 14 quail crops taken within a one-half mile radius of the plantings during November, 1951, revealed no bicolor seeds.

Cottontail Rabbit. Signs of cottontail rabbit, *Sylvilagus floridanus,* were observed in most plantings; the activity was usually associated with mature plantings. Intensive utilization was observed only during periods of inclement weather.

In December, 1950 and 1951, eight inches and three and one-half inches of snow, respectively, were recorded. On the intensive study area during these periods, Plots P-D and H-C were heavily utilized; all plants on Plot P-D revealed evidence of browsing. During this period, 95 per cent of the plants in Planting 19 of the secondary area were cut about two to three inches above the ground. Heavy concentrations of rabbit pellets and tracks were observed throughout the planting. Little evidence of browsing was noted during the winters of 1951-52 and 1952-53 when snowfall was light. During March, 1953, browsing was noted on other species of plants in the bicolor plots; little utilization of bicolor was evident.

White-tailed Deer. Deer, *Odocoileus virginianus,* were flushed from plantings in areas of deer concentrations, and trails were frequently through the plantings. Planting 26, in the Shawnee National Forest, Plantings 22 and 23 in the Mt. Vernon State Game Farm, and Planting 15, in the Union County State Game Refuge, showed evidence of deer browsing and bedding.

Small Rodents. Mice were noted eating the plants, utilizing stems and roots near the crown. Most intensive use occurred during the winter of 1951-52 when weather conditions were not so severe as in 1952-53 when little or no use was evident. Plots H-A and H-C, associated with agricultural crops which did not afford good winter cover, revealed the most damage from mice. Trapping in plantings produced prairie meadow mice and prairie deer mice.

Livestock. On the intensive study area in 1950 where cattle had access to Plot H-B, it was noted that they readily fed on bicolor plants; this was also observed in Planting 18. These animals fed largely on the new growth of both young and old plants. In Planting 18, which had been grazed for several years, the few remaining plants were restricted to new growth of the portion near the top of the old canes which the livestock could not reach.

Insects. Utilization by insects was most noticeable during periods of blossoming. No counts were made, but representatives of the following families were recorded: Locustidae, Chrysomelidae, Saturniidae, Bombidae, Apidae, Megachilidae, Pentatomidae, Vespidae, Sphecidae, Lampyridae, Cicadellidae, Lycaenidae, Curculionidae, and Miridae; extensive damage occurred in Plot P-D, in 1952, when red-legged grasshoppers, *Melanoplus femur-rubrum,* and differential grasshoppers, *Melanoplus differentialis,* fed heavily on the plants, stripping leaves, flowers, and bark. Poorly drained areas were most heavily damaged.

Discussion

The response of bicolor lespedeza (strains 100, 101, and 1B) to

weather conditions revealed a definite range of adaptability in southern Illinois; the strains studied are probably best suited to the southern one-half of the Southern Zone. The twenty-eight days difference in growing seasons, and twelve inches of additional rainfall from south to north resulted in variations in growth, mortality, and seed production. A greater turnover in plants occurring in the northern plantings was due to shorter growing seasons, lower winter temperatures, and less rainfall. Drought conditions of 1952 seemed to have greater effect on northern plantings where the intensive study area averaged 81 pounds per acre as compared to 154 pounds for a similar planting in the southern section.

Davison (Private Communication) reported bicolor established at Paducah, Kentucky, did not develop seed consistently during a 12-year period; early frosts decreased seed production by 90 per cent. Anderson (1950) stated that bicolor would perhaps make seed eight out of ten years in the region south of Effingham, Illinois, where the growing season averages 178 days or more.

The effects of soil drainage on plant mortality and growth was evident. Losses were great in plantings where sites included waterways or flat, poorly drained soils. As topography became more rugged, frequency of drainage mortality decreased noticeably. Where sizable plantings occurred within the prairie soils, the drainage factor was always present, and loss of plants occurred. Bicolor plants on light, poorly drained soils were smaller and less vigorous, and did not reach a desirable height or density. Suitable production was seldom, if ever, obtained under these conditions. Plants located in areas where topsoils were depleted showed similar results.

The effect of site location on bicolor was most noticeable on the intensive study area. During the 1952 drouth season, Plot H-A located on the east side of the timber had the best seed production; 70 per cent of the seeds were mature, and production reached 182 pounds per acre. Production and maturity was far less in plantings which were exposed to hot drying winds and midday sun.

Rodent and insect damage was most evident in plantings located adjacent to tillable fields and pastures. During the winter of 1951 and 1952, several plants were destroyed in Plot H-C and H-A of the intensive study area by prairie deer and meadow mice. An egress of rodents from bordering fields into the bicolor occurred following the harvest. Plot P-D, adjacent to permanent pasture, was virtually destroyed by grasshoppers during the drouth of 1952. In all cases the lespedeza provided the only available "edge." It was thus concluded that where this situation occurred, there was a potential threat by such pests.

Cultural practices had a definite effect upon the success of bicolor plantings. It should be noted that plantings on the intensive study area generally received recommended practices. However, wherever deviations occurred, plant growth, mortality, and seed production were adversely affected. These plants

made slow growth, were dominated by native vegetation, and seldom produced a desirable quantity of seed.

It is believed that if normal weather conditions prevail and standard cultural practices are applied, seed production in southern Illinois should exceed 300 pounds per acre. Davison (Private communication) is of the opinion successful plantings must produce 300 pounds per acre and preferably 500 pounds if bicolor is to be satisfactory as a food supply. Alabama studies (Pearson, 1943) revealed 463 pounds per acre after the first year of growth, and 579 pounds the second year. For Illinois, the intensive study area plantings equaled this production in 1951, the more normal year.

Plant competition was of importance in the establishment and maintenance of bicolor. Early maturing grasses were the most frequent and harmful to the plantings on the intensive study area. However, in the more southern part of southern Illinois, bicolor was dominated by vines, shrubs, and trees. In two of the older plantings in Illinois, sassafras and blackberry invaded those plantings in the southern county (Pope), while bluegrass had invaded those of the northern county (Madison). From the standpoint of food production, the Pope County planting was still productive as indicated by the 154 pounds of seed per acre during the drouth year. The Madison County area, dominated by bluegrass, was believed of little value as a food supply due to the heavy ground cover of grasses during winter which would make it difficult for game birds to find the seeds.

Without some cultural practices, such as cultivation and application of fertilizers, following the establishment of bicolor lespedeza, it will probably have little to offer as food for quail. Rosene (1952) was of the opinion that maintenance treatments every third year were necessary on average soils in the southeast. From observations made throughout the Southern Zone, it is believed that bicolor has more to offer as cover for upland game species than as a food plant. This is especially true of plantings established in the prairie section.

Summary

Despite certain limitations, bicolor lespedeza probably has a place in habitat management in the southern part of Illinois. With approximately 22 per cent of the land classed as potential forest, sites having a degree of permanency are available for wildlife plantings. Because trends in land use are shifting to grassland and forest, suitable food and cover plantings for game species must be found which can be integrated with such a program. Bicolor lespedeza appears to have certain characteristics adaptable to this trend, provided it is properly managed. With the development of new and improved strains of bush lespedezas, their use in Illinois should be greatly enhanced.

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