

TECHNICAL NOTES

EFFECTIVENESS OF ANNUAL AND PERENNIAL GRASSES AND LEGUME SPECIES FOR EARLY EMERGENCE AND EROSION CONTROL

Introduction

This study was conducted for the California Department of Transportation (Caltrans), Division of New Technology, Materials and Research. Caltrans is interested in using perennial grass species to control invasive weeds along California roads and highways as part of their effort to reduce the use of herbicides. Previous work has shown that although annual grass species provide early and effective erosion control, they did not prevent the invasion of undesirable weeds such as yellow star thistle and black mustard. This study compares the early growth characteristic of selected annual and perennial grasses and legumes and indicates which perennial grasses have early emergence and adequate growth to compete with annual species (November to February).

Methods

Seeding rates were based on Soil Conservation Service standards for critical area planting. Seed was planted in boxes measuring 2'x6'x8" deep (soil depth was 6"). The soil used was a fine sandy loam with a pH of 4.9 and an EC of 3.2. The nitrogen level was very high, phosphorous level was high and the potassium level was low. There was a total of 30 species involved in the study (refer to Table 1). Each species was sown individually and Idaho fescue was sown with six selected species (refer to Table 2). The seeding date was December 3, 1993 and the study was terminated May 9, 1994. Between these months, there was a total of five evaluations based on growth and plant population. The plots were not replicated nor was the study repeated a second year.

Results

Growth: All species had increased growth from mid-February to the first of May. Of the four species which had 3 cm or more growth during the first 33 days, two were annuals (refer to Table 3). The annuals were common barley and 'Cucamonga' brome and the perennials were California barley and California fescue. Of the five species which had growth of 6 cm or more at the end of 60 days, four were annuals. The annuals were 'Regreen', common barley, 'Wimmera 62' annual ryegrass, and 'Cucamonga' brome and the perennial was California brome. Common barley and 'Cucamonga' brome were the only species to have good growth at the end of 33 days and 60 days. During the first 60 days, 'Blando' brome and 'Zorro' annual fescue had growth of 3.5 cm or less. This was not expected as these two cultivars are prized for their early growth. The clover species, for the first 60 days, had significantly little growth (1.3 cm or less).

Prepared by Gene Bishop, Assistant Manager, Lockeford Plant Materials Center, Natural Resources Conservation Service, Lockeford, California.

Table 1

SPECIES USED IN STUDY	
<u>LEGUME SPECIES</u>	
'Hykon' rose clover***	<i>Trifolium hirtum</i>
Strawberry clover***	<i>Trifolium fragiferum</i>
Subclover***	<i>Trifolium subterraneum</i>
<u>ANNUAL GRASS SPECIES</u>	
'Blando' brome**	<i>Bromus hordeaceus hordeaceus</i>
'Cucamonga' brome*	<i>Bromus carinatus</i>
'Zorro' annual fescue**	<i>Vulpia myuros hirsuta</i>
'Regreen'***	<i>Elytrigia x Triticum</i>
Common barley***	<i>Hordeum vulgare</i>
'Wimmera 62' annual ryegrass**	<i>Lolium rigidum</i>
<u>PERENNIAL GRASS SPECIES</u>	
'Berber' orchardgrass***	<i>Dactylis glomerata</i>
Purple stipa*	<i>Stipa pulchra</i>
Blue wildrye*	<i>Elymus glaucus</i>
'Luna' pubescent wheatgrass***	<i>Elytrigia intermedia</i>
'Covar' sheep fescue***	<i>Festuca trachyphylla</i>
Pine bluegrass*	<i>Poa scabrella</i>
'Molate' red fescue*	<i>Festuca rubra</i>
California barley*	<i>Hordeum californica</i>
'Scaldis' hard fescue***	<i>Festuca trachyphylla</i>
California fescue*	<i>Festuca californica</i>
Squirreltail*	<i>Sitanion jubatum</i>
Idaho fescue*	<i>Festuca idahoensis</i>
California brome*	<i>Bromus carinatus</i>
* Native Species	
** Naturalized Species	
*** Introduced Species	

During December, rodent damage was found in the early germinating grass and legume species (most notable 'Hykon' rose clover, common barley, 'Regreen' 'Wimmera 62' annual ryegrass, and 'Cucamonga' brome) and how this may have affected early growth was not determined.

Population: The plant population per square foot was considered in relation to the number of seeds sown per square foot. For the first 33 days, there were three annual and five perennial species that had 50 percent plant population or more compared to planted seed per square foot (refer to Table 2 and 3). The annuals were 'Regreen', common barley, and 'Cucamonga' brome and the perennials were 'Berber' orchardgrass, blue wildrye, pine bluegrass, California barley, and California brome. By the end of 60 days the same species with the addition of 'Wimmera 62' annual ryegrass had a plant population of 50 percent or more compared to planted seeds per square foot.

SEEDING RATE AND COST			
SPECIES USED IN STUDY	COST OF SEED PER POUND	SEEDING RATE POUNDS/ACRE	SEED PER SQ FOOT
'Hykon' rose clover	\$1.65	18	68
Strawberry clover	\$2.42	18	119
Subclover	\$1.30	24	30
'Blando' brome	\$2.39	18	104
'Cucamonga' brome	\$5.70	20	47
'Zorro' annual fescue	\$6.80	12	238
'Regreen'	\$1.80	40	11
Common barley	\$0.16	125	39
'Wimmera 62' annual ryegrass	\$0.70	27	115
'Berber' orchardgrass	\$2.79	24	263
Purple stipa	\$49.00	20	54
Blue wildrye	\$11.00	15	47
'Luna' pubescent wheatgrass	\$3.10	36	72
'Covar' sheep fescue	\$5.49	15	183
Pine bluegrass	\$33.00	10	240
'Molate' red fescue	\$9.00	15	126
California barley	\$10.50	15	46
'Scaldis' hard fescue	\$1.50	15	204
California fescue	\$105.00	20	92
Squirreltail	\$105.00	20	29
Idaho fescue	\$14.00	15	155
California brome	\$6.30	15	47
Idaho fescue/Hykon rose clover		15/9	
Idaho fescue/'Zorro' annual fescue		15/4	
Idaho fescue/Barley		15/60	
Idaho fescue/Blue wildrye		15/10	
Idaho fescue/'Blando' brome		15/9	
Idaho fescue/'Luna' pubescent wheatgrass		15/18	

Review: Both 'Cucamonga' brome and common barley were found to have a good plant population and growth at the end of 33 days. California barley was the only perennial to have these attributes at 33 days. At the end of 60 days the annuals with a good plant population and growth were 'Regreen', common barley, 'Wimmera 62' annual ryegrass, and 'Cucamonga' Brome. While California brome was the only perennial to have these attributes at 60 days.

Competition

Competition was considered on three separate levels: competition within the same species, competition between two species, and competition between study species and weedy species. Competition was evaluated by its effect on plant growth and plant population.

Competition within the same species: As the weather warmed (mid February) and plant growth increased, in some species, both annual and perennial, there was a decrease in plant population. It is speculated Table 3

DATA ON PLANTS PER SQUARE FOOT AND GROWTH PATTERNS				
SPECIES EVALUATED IN THIS STUDY	PLANTS/ SQ FOOT & HEIGHT	PLANTS/ SQ FOOT & HEIGHT	PLANTS/ SQ FOOT & HEIGHT	PLANT HEIGHT & GROUND COVER %
	33 DAYS (1/5/94)	60 DAYS (2/1/94)	112 DAYS (3/15/94)	157 DAYS (5/8/94)
'Hykon' rose clover Strawberry clover Subclover	19:<1 cm 15:<1 cm 5:<1 cm	24:1.3cm 13:<1 cm 14:1.2cm	17: 3cm 15: 1cm 9: 2cm	11cm: 10% 3cm: 5% 4cm: 5%
'Blando' brome 'Cucamonga' brome 'Zorro' annual fescue 'Regreen' Common barley 'Wimmera 62' annual ryegrass	19:1.5cm 23:4.5cm 64:1.4cm 6:2.5cm 25:7.5cm 39:2.0cm	28:3.0cm 29:10 cm 106:3.5cm 9:7.5cm 20:14 cm 73:6.0cm	27: 10cm 26: 20cm 108: 8cm 11: 14cm 21: 21cm 52: 15cm	43cm: 70% 33cm: 30% 30cm: 50% 49cm: 8% 30cm: 70% 40cm: 60%
'Berber' orchardgrass Purple stipa Blue wildrye	188:1.5cm 1:2.0cm 37:2.5cm	247:3.0cm 8:4.0cm 50:4.0cm	248: 7cm 9: 14cm 45: 13cm	18cm: 90% 38cm: 12% 30cm: 45%
'Luna' pubescent wheatgrass 'Covar' sheep fescue Pine bluegrass	3:2.0cm 51:1.5cm 132:1.5cm	17:4.0cm 68:2.5cm 120:3.0cm	19: 7cm 75: 13cm 66: 6cm	30cm: 15% 14cm: 15% 7cm: 6%
'Molate' red fescue California barley 'Scaldis' hard fescue California fescue	26:1.5cm 23:3.0cm 3:2.5cm 6:3.0cm	59:5.0cm 24:4.5cm 4:4.0cm 28:5.5cm	70: 11cm 33: 7cm 5: 13cm 25: 19cm	9cm: 20% 11cm: 40% 18cm: 2% 22cm: 20%
Squirreltail Idaho fescue California brome	9:2.5cm 44:1.5cm 39:2.5cm	10:5.0cm 40:3.0cm 45:7.0cm	5: 9cm 36: 5cm 31: 16cm	20cm: 2% 8cm: 30% 45cm: 10%

that the drop in plant population was due to increased demands on soil moisture, space, and nutrients caused by the rapid spring growth. Other factors which may have affected plant population were: a consistently low plant population for the length of the study, plant stature within a species, and the growth characteristics of a species. A plant population which remained consistently low, in general, did not have a loss in population, while species with a large population, in general, did have a loss in population. The loss in plant population did not always occur in species with a large population when plant stature remained small. In other words, the rate of growth and the physical characteristics of a species appears to affect the plant population.

Competition between Species: Idaho fescue was planted with one of six annual or perennial species in individual plots. The seeding rate for Idaho fescue remained at 15 lbs, the same as when planted independently, while the seeding rate for the associate species was reduced. The data indicates that Idaho fescue was able to successfully compete with 'Hykon' rose clover, common barley, and 'Blando' brome. Although there may have been a loss in plant population or a reduction in growth, these losses appeared to have been mutual and comparable.

However, 'Zorro' annual fescue appears to have out-competed Idaho fescue. When blue wildrye and 'Luna' pubescent wheatgrass were planted with Idaho fescue, the Idaho fescue was able to out-compete both species. Since the seeding rate of companion species was reduced when present with Idaho fescue, the competitiveness of the companion species can not be stated as a fact based on this data.

Ability of study species to reduce weed population: Each plot was evaluated on February 1, 1994 to determine the weed population per square foot. After this evaluation grass species were treated with 2,4-D and the legumes were hand weeded. The weed population ranged from 21 plants per square foot in the 'Berber' orchardgrass to 46 plants in the control plot (refer to Tables 4,5,6,7,& 8). If the mean value of 30 weedy plants per square foot is considered, it is found that as a group, 83 percent of the annuals, 22 percent of the native perennials, 50 percent of the introduced perennials, 67 percent of the legumes, and 83 percent of the Idaho fescue with selected species had a weed population below or equal to the mean value. The fact that 78 percent of the native perennials and 50 percent of the introduced perennials had a weed population greater than the mean, may point to the need for chemical application to establish perennial grasses. The difference between all categories may be considered insignificant since the mean value for each group is within two weedy plants per square (plus or minus) of the mean value for the study.

Annuals and weed Population	Weeds/ sq. ft.
'Blando' brome	26
'Zorro' annual fescue	23
'Regreen'	37
Common barley	30
'Wimmera 62' annual ryegrass	26
'Cucamonga' brome	30

Table 5

"Native" Perennials & Weed Population	Weeds/ sq. ft.
Purple stipa	26
Blue wildrye	37
Pine bluegrass	28
California barley	34
California fescue	34
Squirreltail	35
Idaho fescue	31
'Molate' red fescue	31
California brome	33

Introduced Perennials & Weed Population	Weeds/ sq. ft.
'Berber' orchardgrass	21
'Luna' pubescent wheatgrass	35
'Covar' sheep fescue	31
'Scaldis' hard fescue	30

Legumes and Weed Population	Weeds/ sq. ft.
'Hykon' rose clover	24
Subclover	34
Strawberry clover	29

Table 8

Idaho fescue Planted with Selected Species & Weed Pop.	Weeds/ sq. ft.
With / 'Hykon' rose clover	26
With / 'Zorro' annual fescue	31
With / Common barley	29
with / blue wildrye	28
With / Blando' brome	26
With / 'Luna' pubescent wheatgrass	30

Conclusion

It is difficult to separate growth, plant population, and competition into individual units for evaluation without realizing the complex network which weaves them together. The statement "for every action there is an equal and opposite reaction" would appear to best describe the results of this study.

As the data from this study was reviewed, it became clear that any change in plant growth or plant population could have an adverse effect on the plant community. For example, an increase in plant growth could cause a decrease in plant population, while an increase in plant population could retard plant growth. Any factor or combination of factors which place additional demands on the resources: water, nutrients, space, light, etc., will result in the reduction in some component of the plant community, i.e. in the loss of plant numbers, retarded growth, vigor, etc.

Both 'Cucamonga' brome and common barley were found to have a good plant population and growth at the end of 33 days. California barley was the only perennial to have these attributes at 33 days. At the end of 60 days the annuals with good plant populations and growth were 'Regreen', common barley, 'Wimmera 62' annual ryegrass, and 'Cucamonga' Brome. While California brome was the only perennial to have these attributes at 60 days.

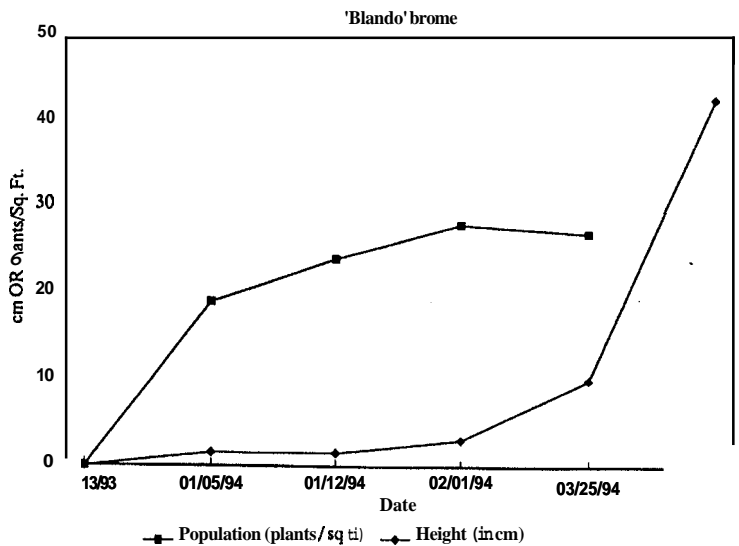
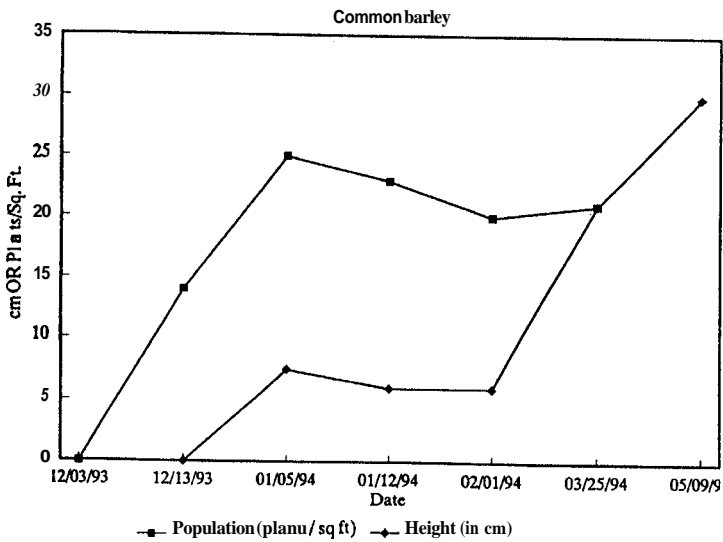
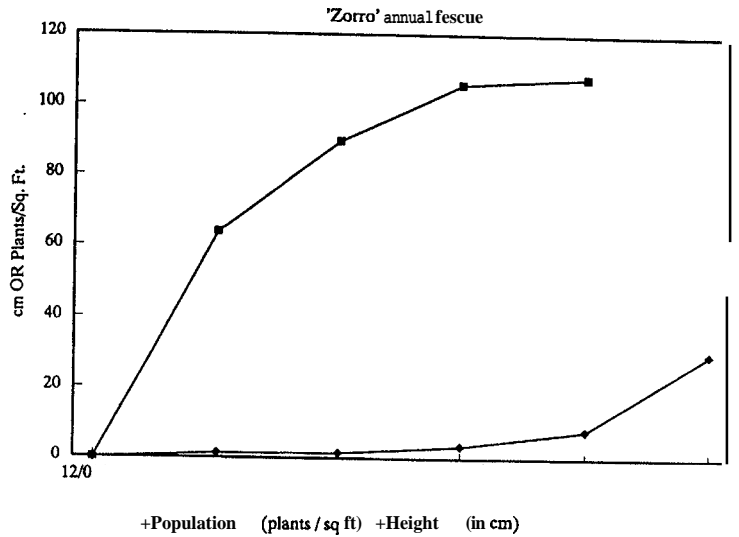
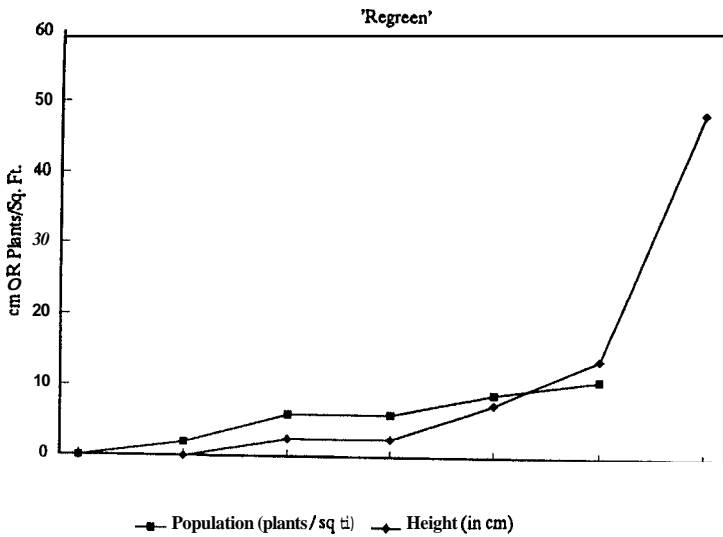
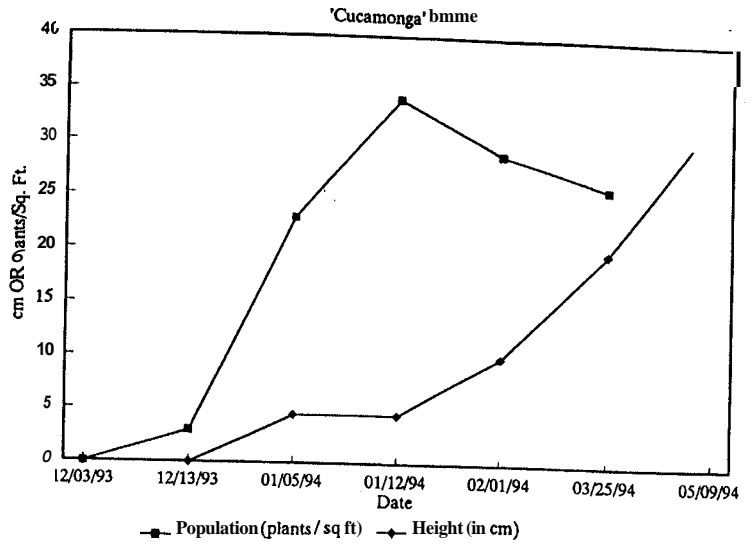
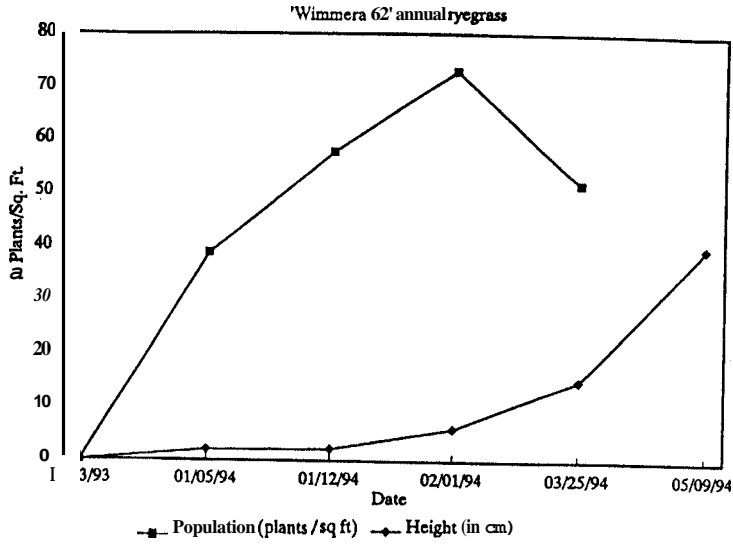
Based on the preliminary data from this study, 'Regreen', at the current seeding rate had a weed population greater than the mean for the study. Perennials which had a weed population greater than the mean for the study were: blue wildrye, California brome, California fescue, California barley, squirreltail, 'Luna' pubescent wheatgrass. Subclover was the only legume to have a weed population greater than the mean for the study. All of the Idaho fescue with associate species had a weed population below or near the mean for the study.

The effect the soil pH and soluble salts may have had on seedling survival and growth was not determined (refer to Table 9).

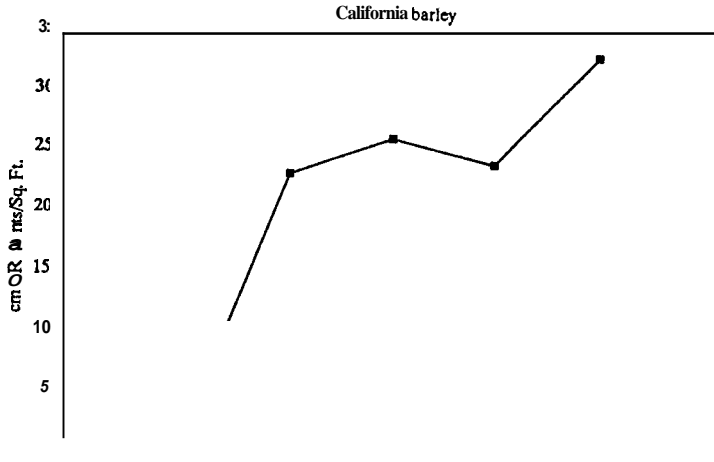
Table 9

SOIL ANALYSIS						
<u>ANALYSIS RESULTS</u>	<u>UNIT</u>	<u>VERY</u>	<u>LOW</u>	<u>NORMAL</u>	<u>HIGH</u>	<u>VERY HIGH</u>
pH	4.9	XXXXXXXXXX				
E.C.e. (mmhos)	3.20	XXXXXXXXXXXXXXXXXXXXXXXXXXXX				
<u>ELEMENT</u>	<u>PPM</u>					
Nitrate Nitrogen	70.60	XX				
Ammonia Nitrogen	106.00	XX				
Phosphorus	80.90	XX				
Potassium	75.00	XXXXXXXXXXXXXXXXXXXX				
Calcium	2260.00	XXXXXX				
Magnesium	282.00	XXXXXXXXXXXX				
Sodium	45.00	XX				
Boron	0.05	XXX				
Zinc	17.50	=====				
Iron	43.60	=====				
Copper	11.60	XX				
Maganese	33.00	=====				
Sulfate sulfur	30.00	XX				
<u>Soluble Salts</u>	<u>Percolation</u>	<u>Cation Exchange Capacity</u>				
2048 ppm	high	27.56 meg/100 gm				

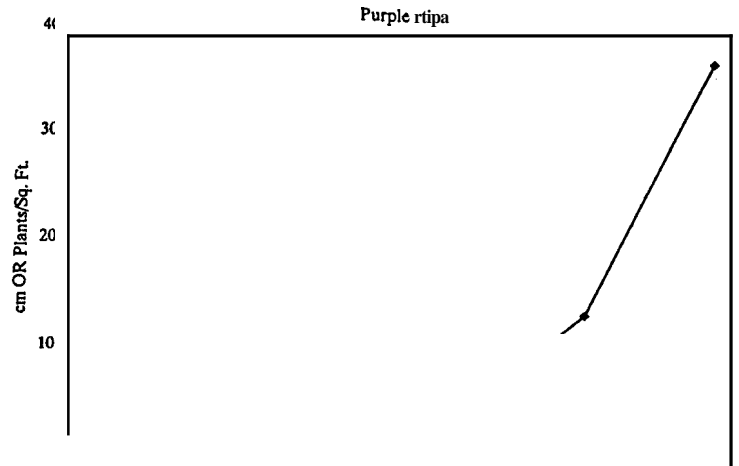
Annual Species - Species Used in Study



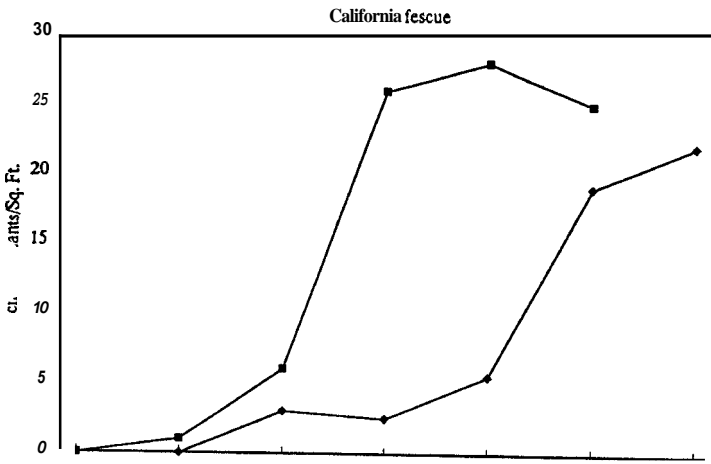
Native Perennial Species - Species Used in Study



■ Population (plants / sq ft) ◆ Height (in cm)



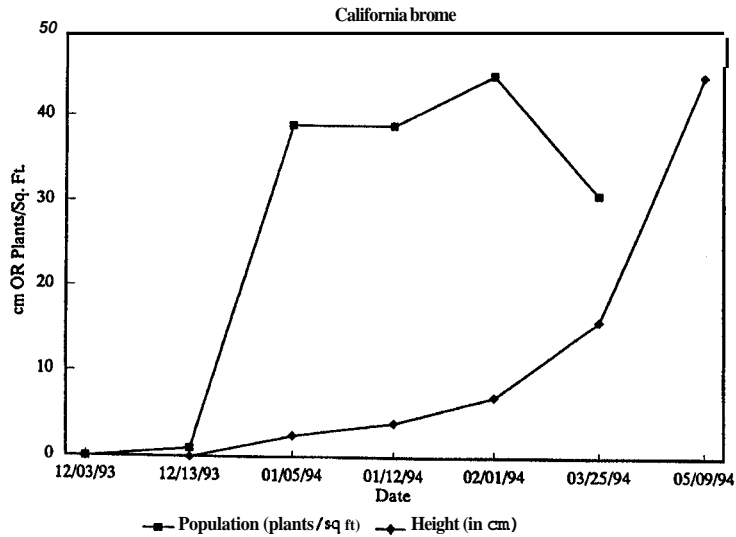
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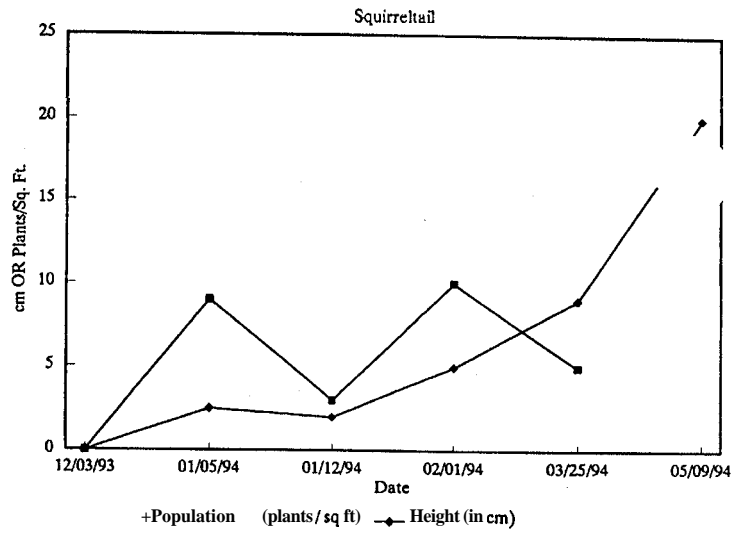
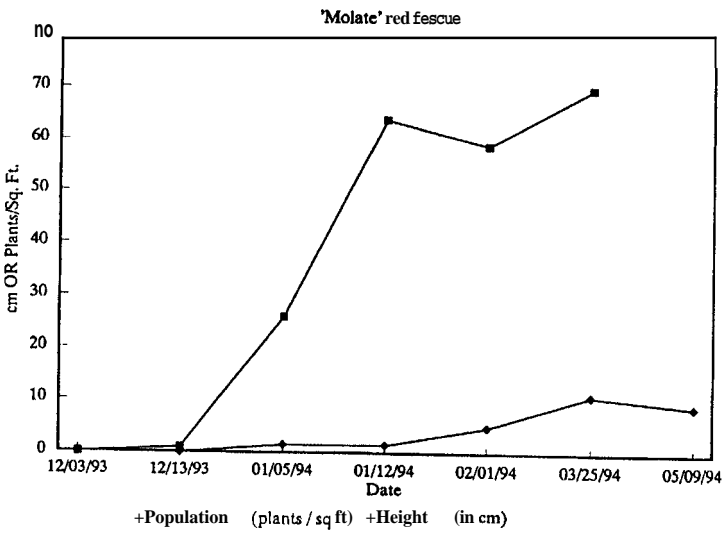
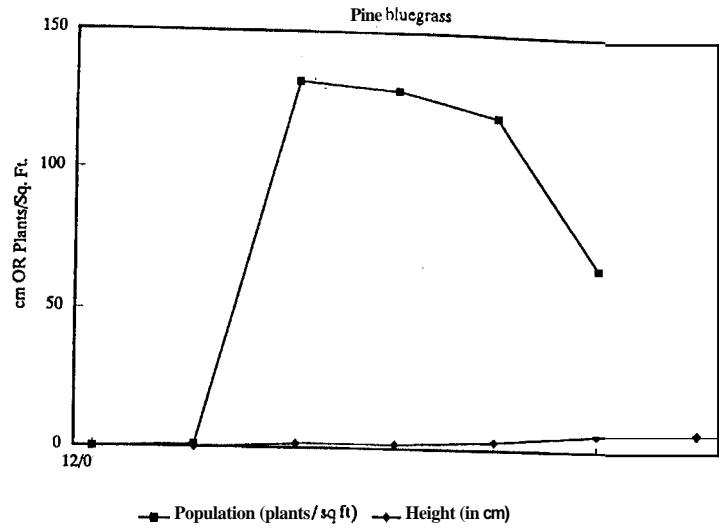
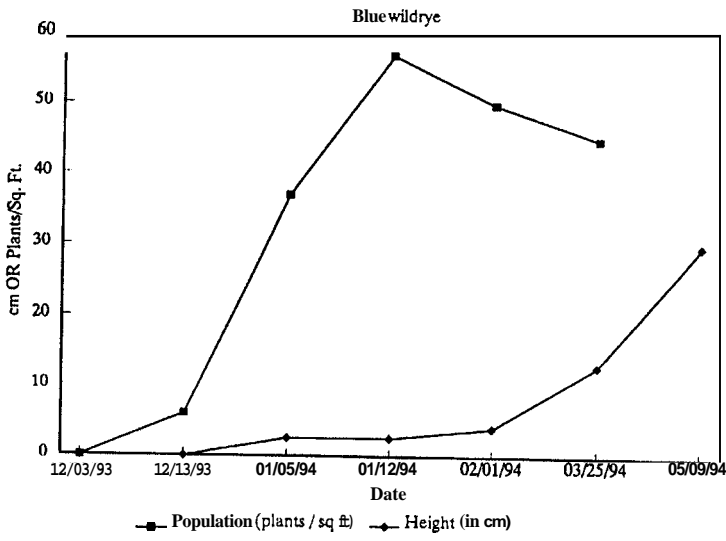


■ Population (plants / sq ft) ◆ Height (in cm)

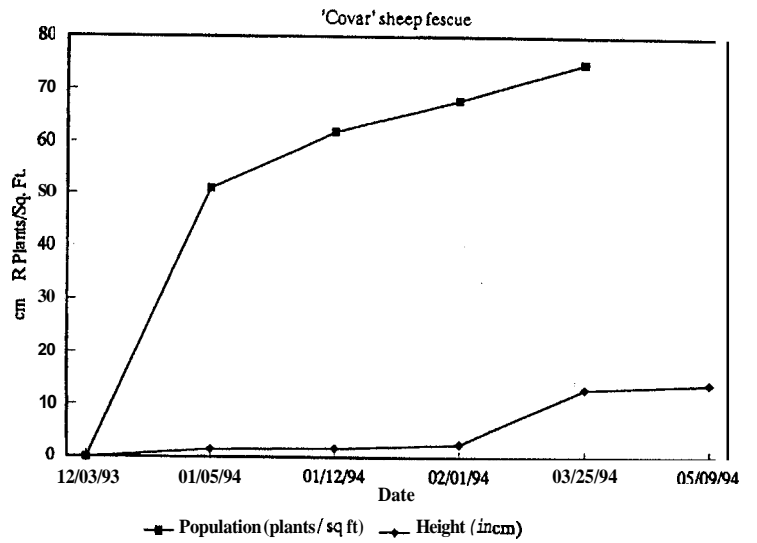
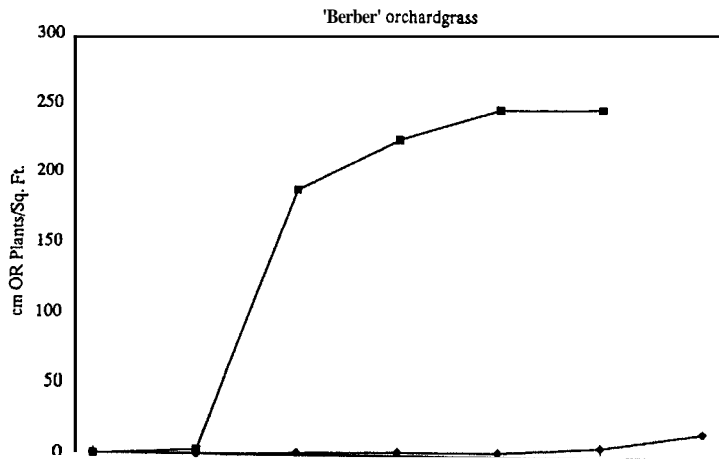
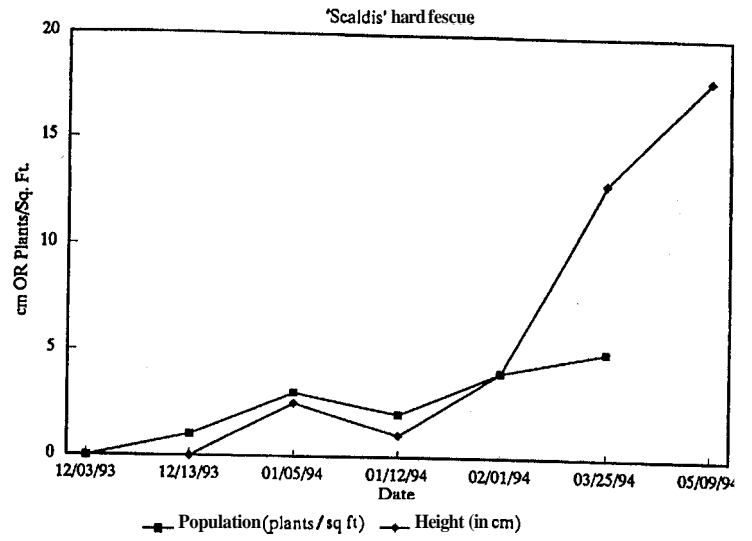
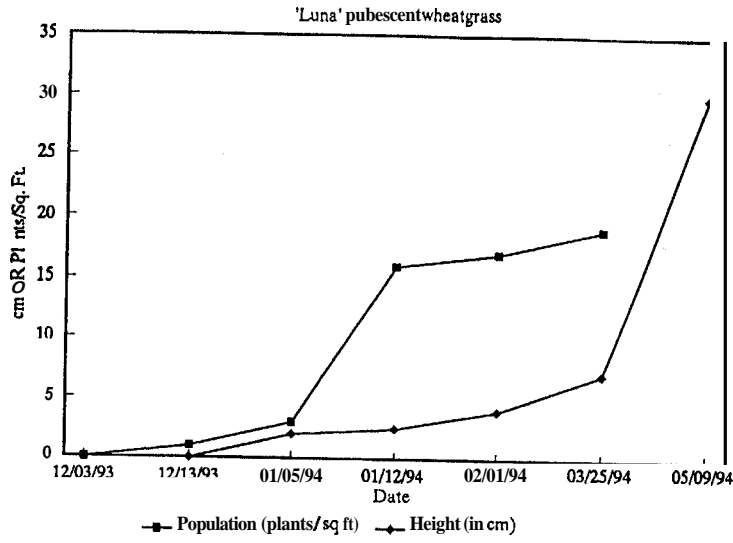


■ Population (plants / sq ft) ◆ Height (in cm)

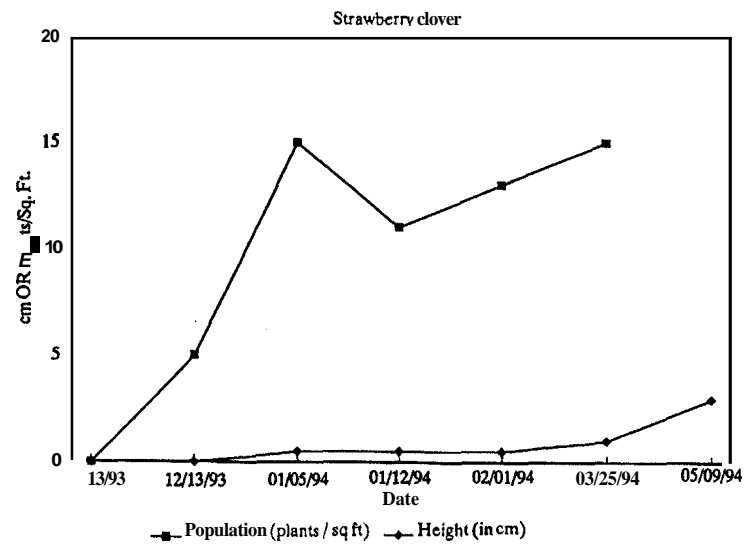
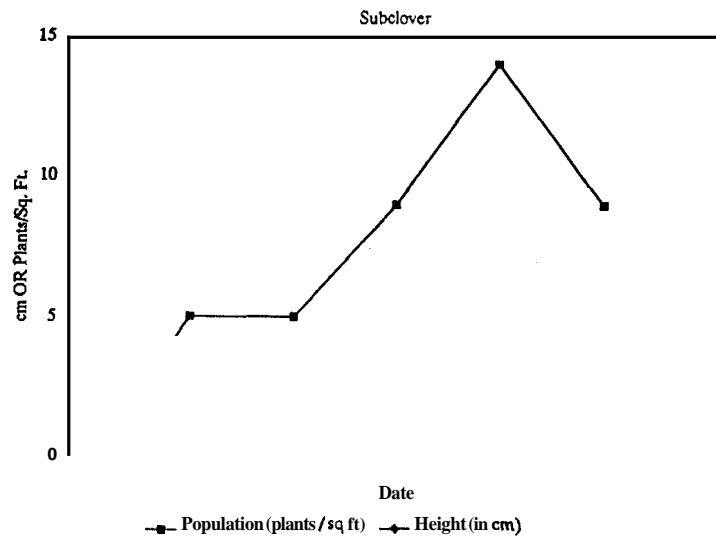
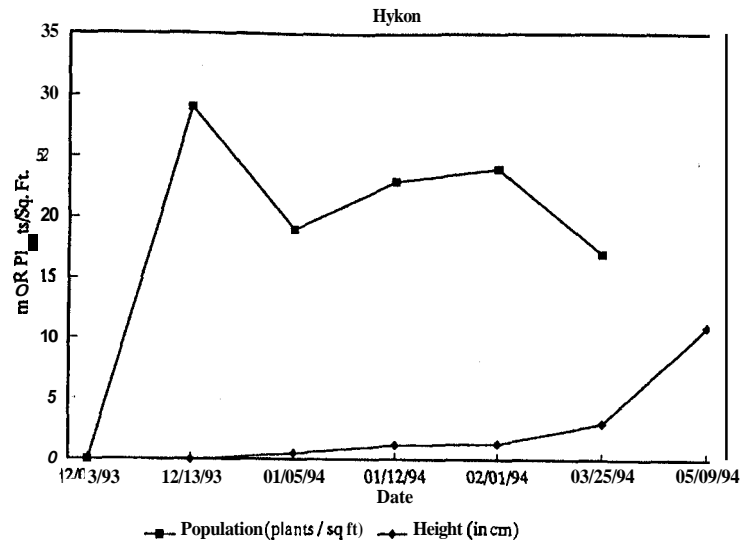
Native Perennial Species - Species Used in Study



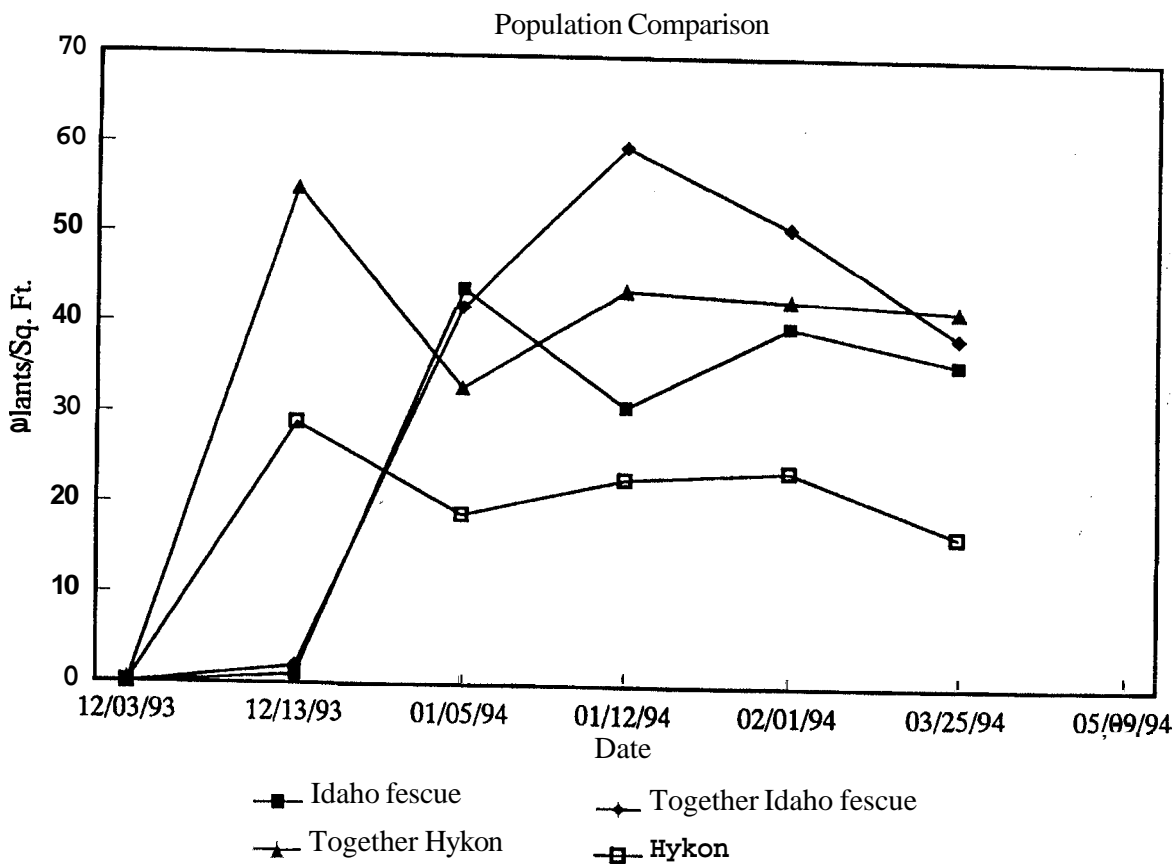
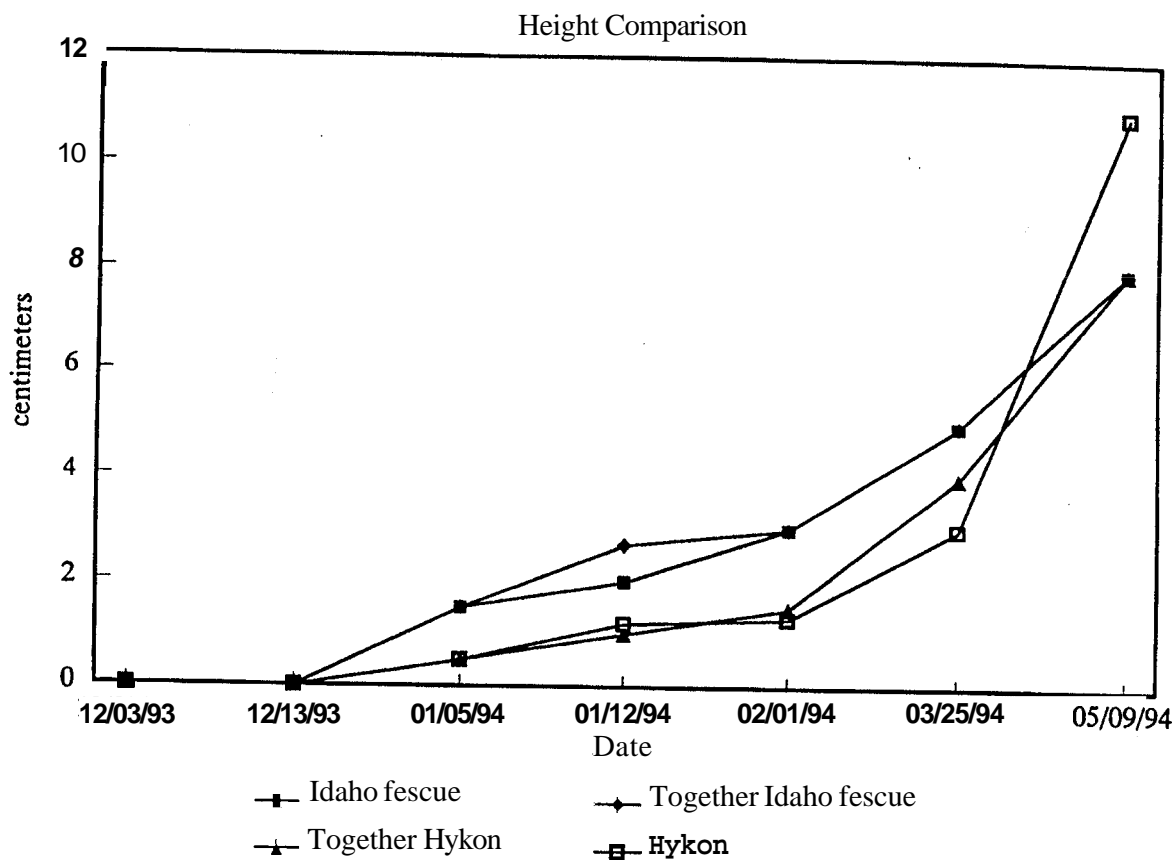
Introduced Perennial Species - Species Used in Study



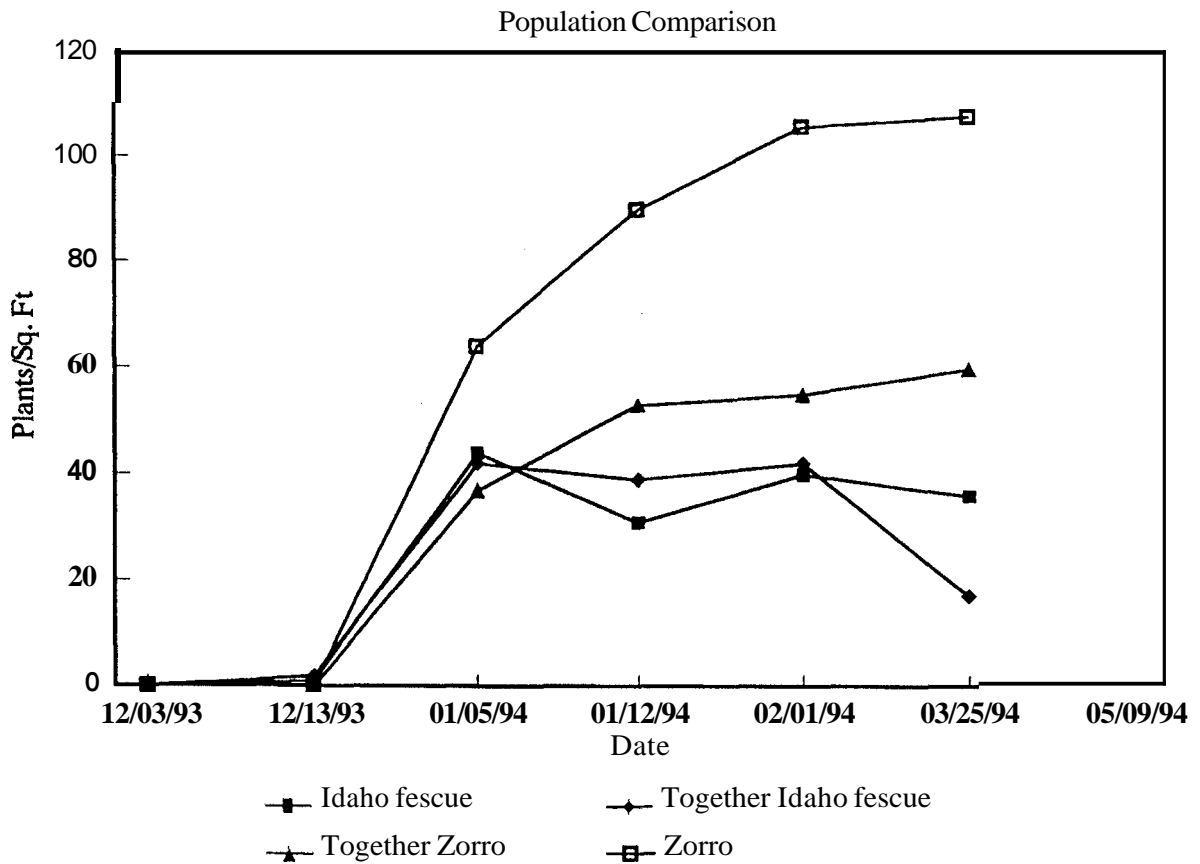
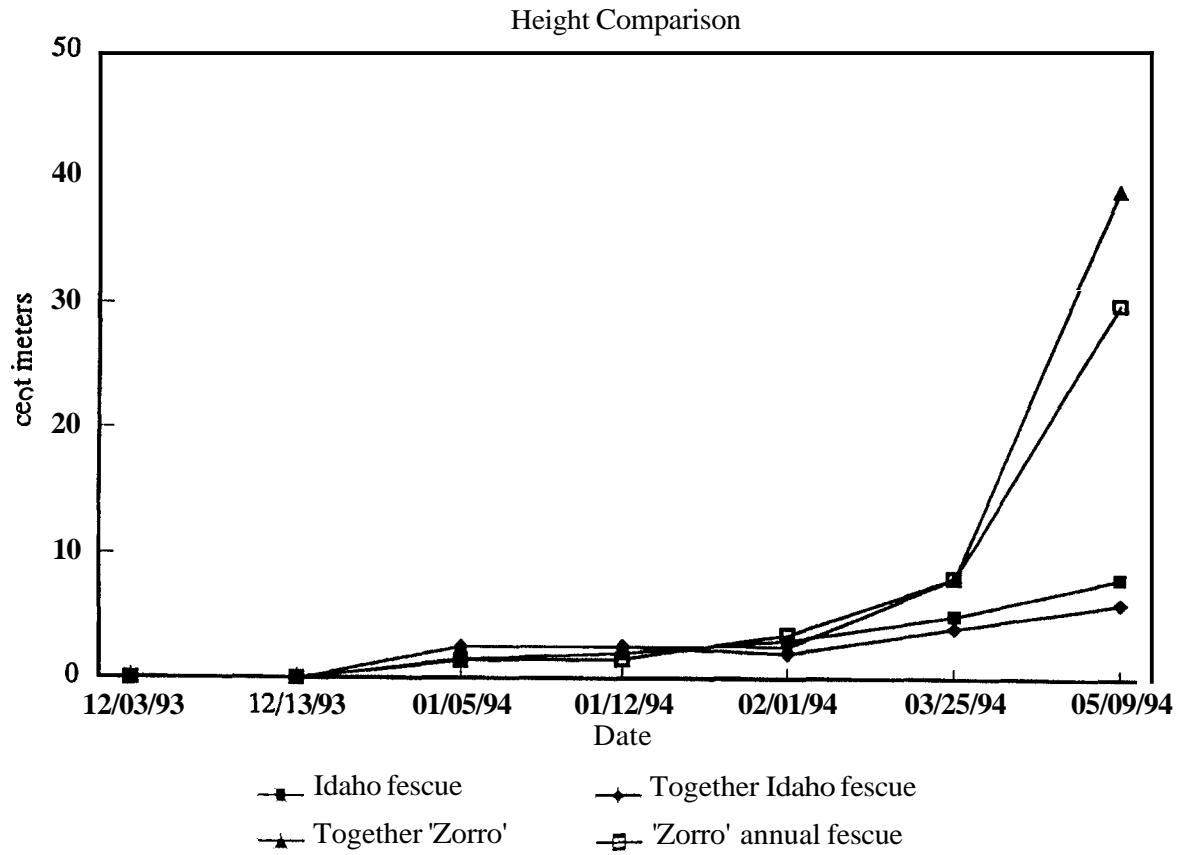
Legumes - Species Used in Study



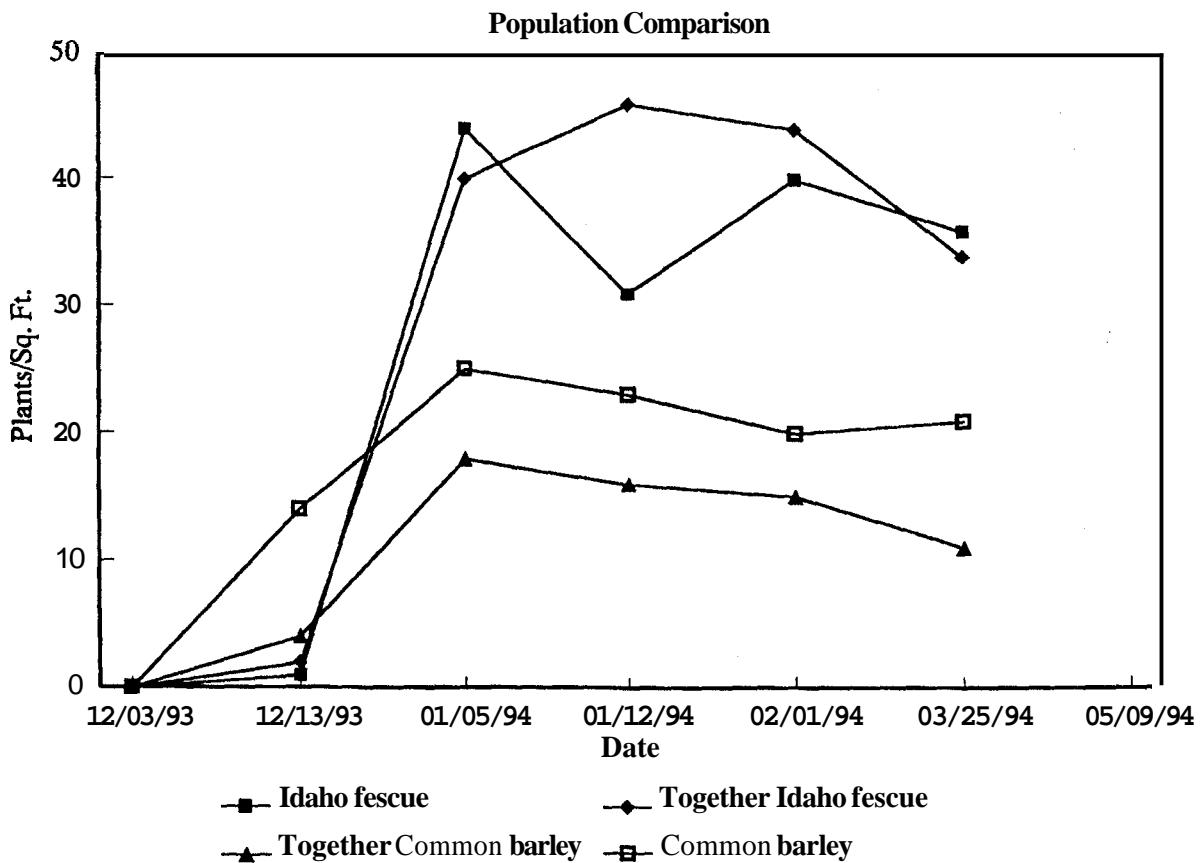
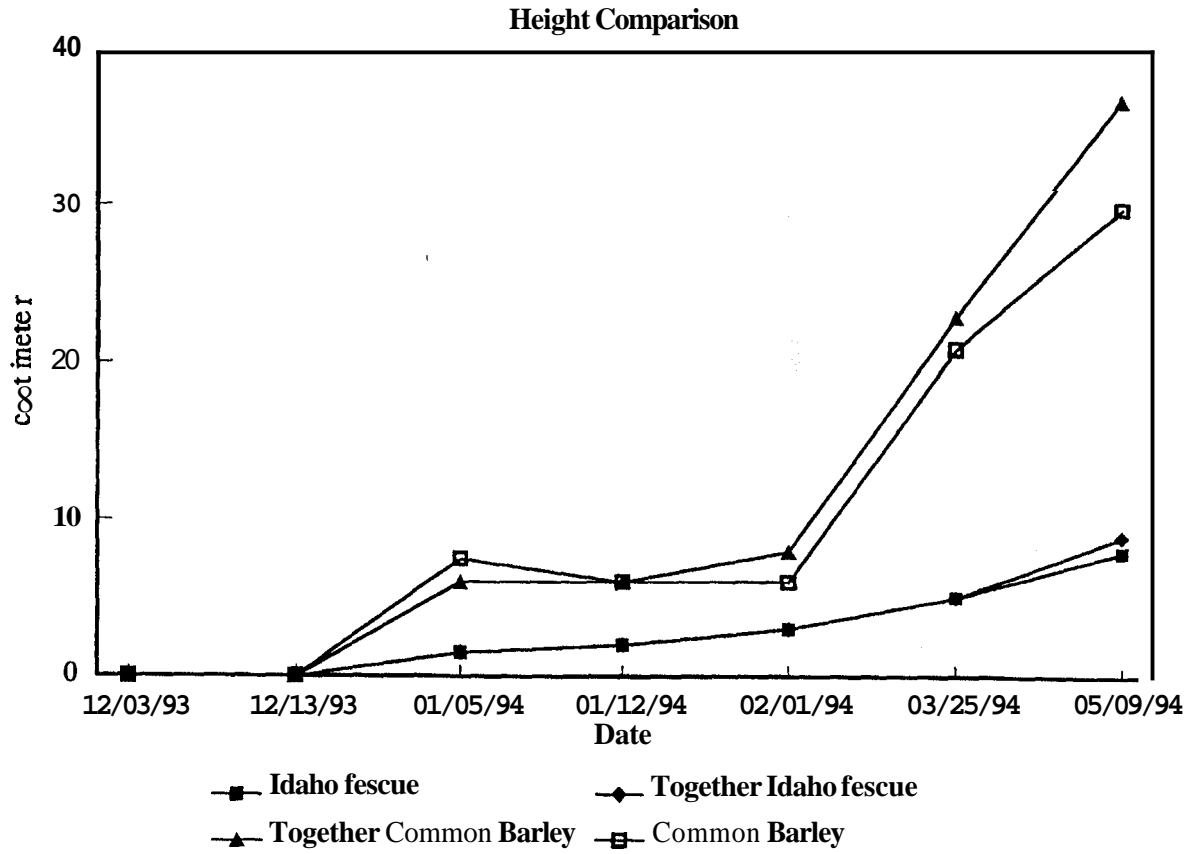
Comparison on Idaho fescue & Hykon Species when planted together and individually



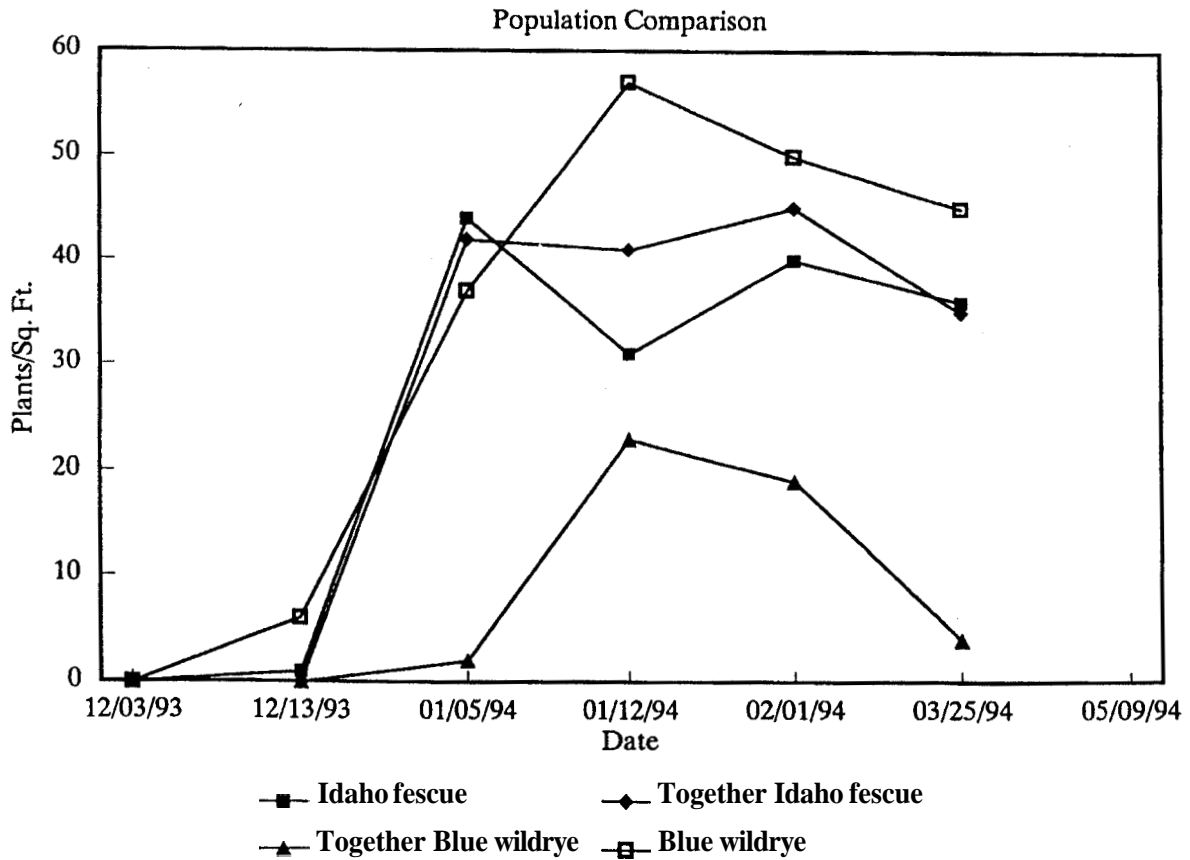
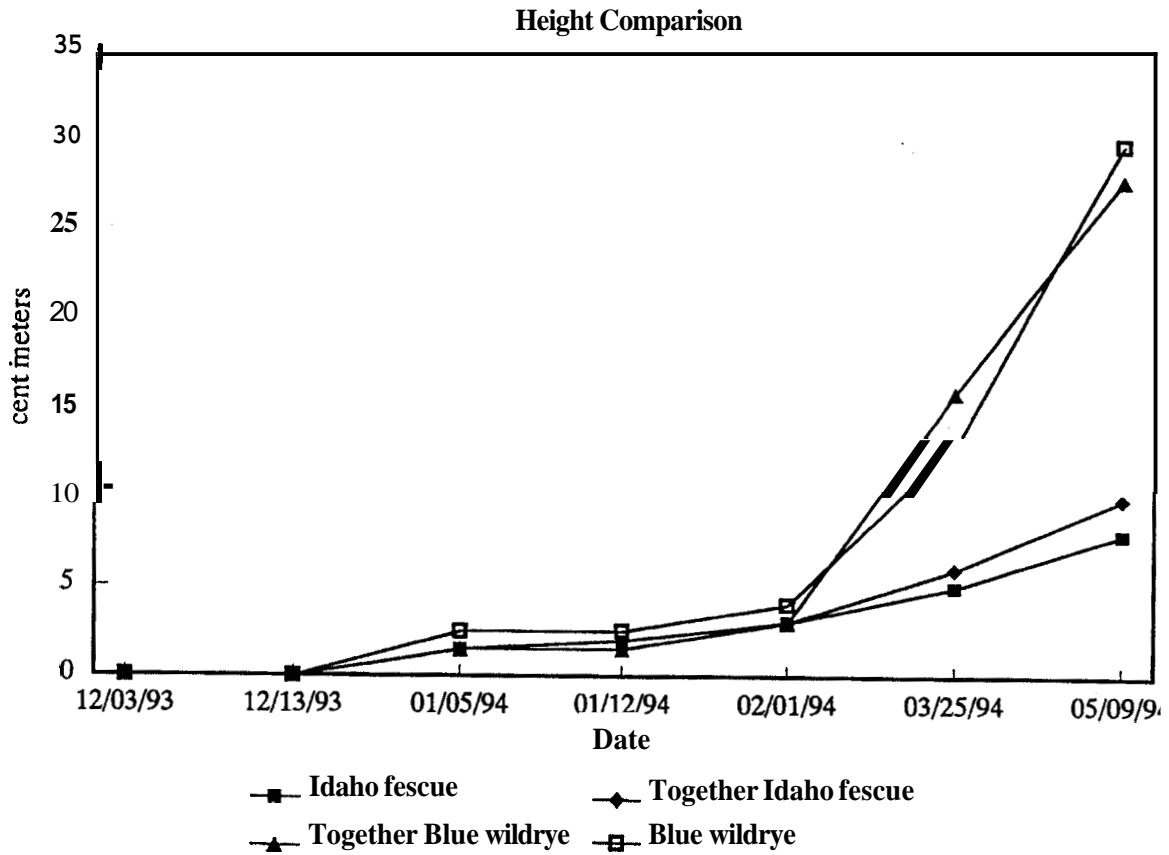
Comparison on Idaho fescue & Zorro Species when planted together and individually



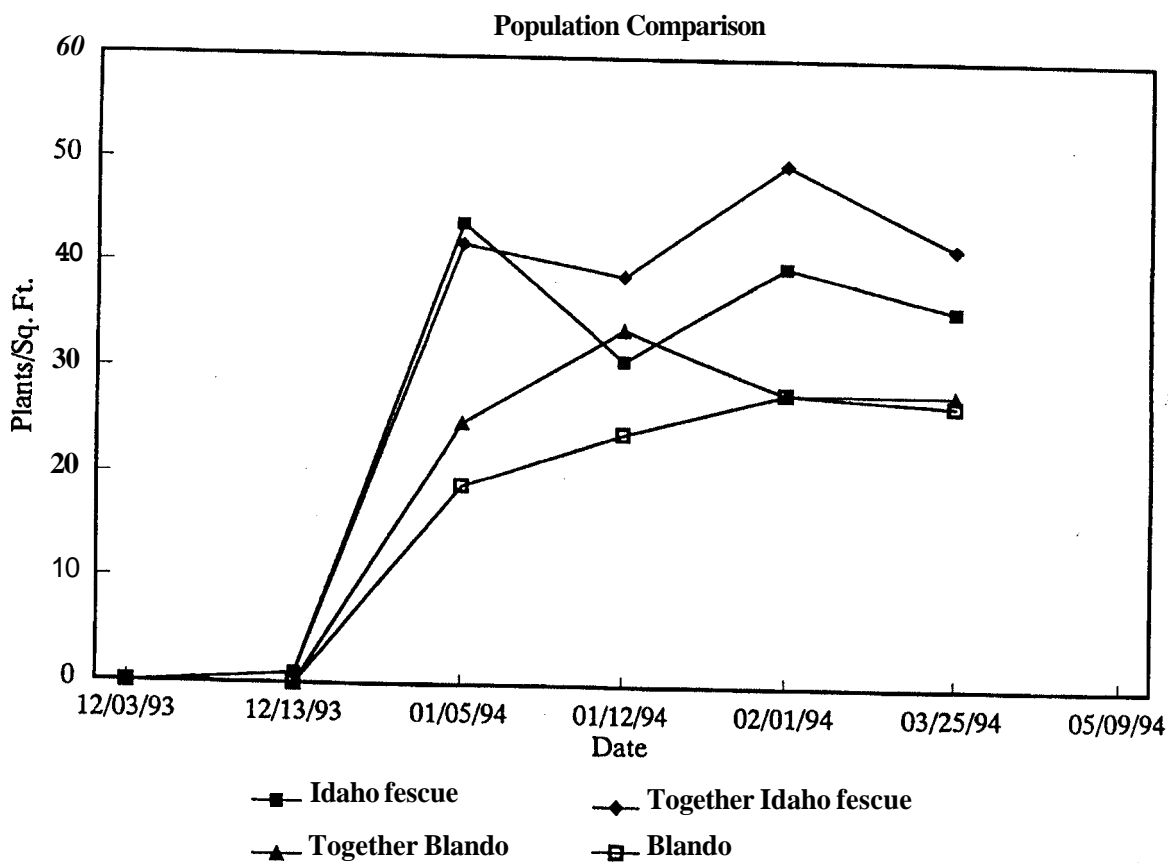
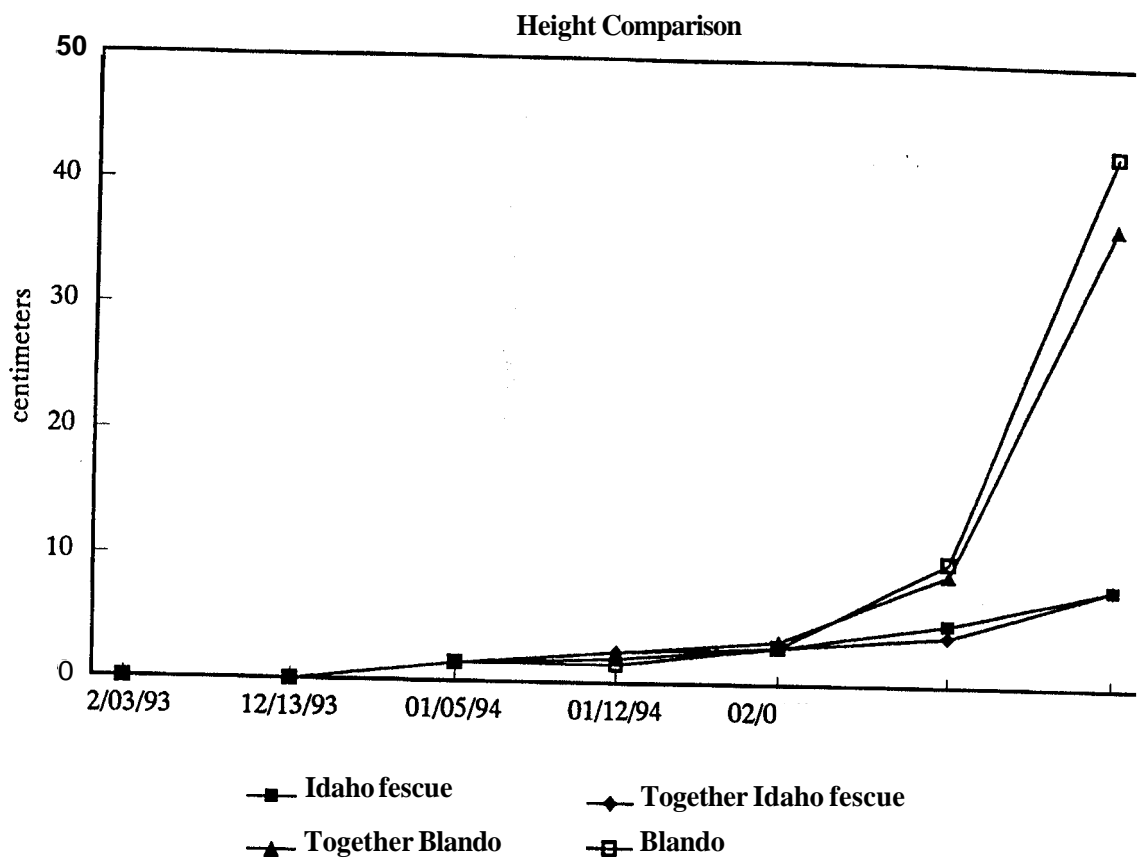
Comparison on Idaho fescue & Common Barley Species when planted together and individually



Comparison on Idaho fescue & Blue wildrye Species when planted together and individually



Comparison on Idaho fescue & Blando Species when planted together and individually



Comparison on Idaho fescue & Luna Species when planted together and individually

