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RESPONSE OF WINTER-TYPE WHITE LUPIN TO SEEDING RATE AND DATE OF PLANTING IN ALABAMA

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ABSTRACT

Basic agronomic studies are needed for white lupin, a promising new winter-grown protein crop for the southeastern United States. Among these, date of planting is important because of the effect on physiological maturity. Optimizing seeding rates will increase profitability because of the expense associated with establishment. In the autumn of 1991, the cultivars 'Lunoble' and 'Tifwhite 78' were planted at three locations in Alabama [Crossville (34°17'N, 85°58'W), Shorter (32°24'N, 86°54'W), Monroeville (31°35'N, 87°20'W)]. Planting dates for each location corresponded to the average date of the first 2.2°C frost in the autumn, and 4 and 8 weeks prior to that date. Seeding rates were 87,500, 175,000, and 350,000 seeds/ha. These rates bracket the recommended rate for winter-type lupin in France. Data were taken on biological yield, grain yield, and grain yield components. Biological yield declined for both cultivars with later seeding except for the northernmost location (Crossville). There, the first planting of Tifwhite 78, an early maturing cultivar, was severely damaged by a late winter frost during floral initiation. Grain yield reached a maximum at the intermediate planting date for the northern (Crossville) and southern location (Monroeville), whereas the first planting at the central location (Shorter) gave maximum yields. The contribution of the main axis to the total yield increased with later planting dates. This response was virtually linear at all three locations. The contribution of the basal lateral branches was highest at the first planting date and decreased linearly with delayed planting. This points to the importance of podset on the branches to achieving high yields. Of the nine location x planting date combinations, increasing seeding rates resulted in increased biological yield for all dates at all locations but for grain yield in only four combinations. Conditions for the increased grain yield response to increasing seeding rates were late planting and northern or central location. This research will lead to production recommendations optimized for different regions of Alabama.

INTRODUCTION

The Southern Region of the United States is fortunate in that the climate allows two effective cropping seasons per year. However, the choice of winter crops is rather limited. Traditionally, winter crops have been wheat (*Triticum aestivum* L.), oat (*Avena sativa* L.), and rye (*Secale cereale* L.) for livestock grazing or wheat as a grain crop. Due to increased production costs and decreasing prices, however, the acreage of wheat grown for grain has declined steadily over the last 10 years. One crop with potential to fill this void is white lupin (*Lupinus albus* L.), a winter grown annual legume. It is naturally adapted to well-drained, low-fertility, coarse-textured, neutral to acidic soils such as those in the Southern Coastal Plain of the U.S. (Reeves, 1991). Lupin as a cover crop would reduce erosion, improve soil quality and reduce ground and surface water pollution danger. Production and utilization of lupin (*Lupinus* spp.) in the South can be traced to the use of winter legumes as a source of nitrogen for cotton. The popularity of the crop rose rapidly but was not sustained. By 1950 over one million hectares (2.5 million acres) of lupin were being grown in the Southeast but the crop had essentially disappeared from the region by the 1960's. The scientific effort directed at lupin in the South also declined as production of the crop declined. Breeding efforts from the early 1950's until the end of the 1970's focused on increased disease resistance and freeze tolerance, and reduced seed shattering and alkaloid content for blue and white lupin (Wells and Forbes, 1980). 'Tifwhite-78' was developed by the USDA-ARS group at Tifton, Georgia and released in 1980 (Wells et al., 1980). The recent interest in sustainable agriculture and the suitability for double-cropping with winter grown lupin, however, have generated renewed interest in winter-hardy white lupin for the South. Basic agronomic studies are needed to develop the full potential of white lupin for the southeastern United States. Among these, date of planting is important because of the effect on physiological maturity. Optimizing seeding rates will increase profitability because of the expense associated with establishment. In France, early planting dates contributed to excessive vegetative growth which increased lodging problems (Huyghe and Papineau, 1990). However, early planting was necessary for good frost tolerance in lupin roots. Late sowing delays flowering; this would present problems for Alabama farmers who want to rotate lupin with a summer crop. Higher densities reduce spring weed problems through early canopy closure and increase yields. However, in a spring-planted study in the northeastern U.S., the number of pods per plant and the number of seeds per pod from higher order branches were reduced (Herbert, 1977). The objectives of this study were to determine the response of two diverse white lupin cultivars, Tifwhite-78 and 'Lunoble', to planting date and seeding rate.

MATERIALS AND METHODS

In the autumn of 1991, the cultivars Lunoble and Tifwhite 78 were planted in three- or four-row plots of 6-m length in North- [Crossville (34°17'N, 85°58'W)], Central- [Milstead (32°24'N, 86°54'W)], and South-Alabama [Monroeville (31°35'N, 87°20'W)]. Planting dates for each location corresponded to the average date of the first - 2.2 °C frost in the autumn, and 4 and 8 weeks prior to that date. Seeding rates were 87,500, 175,000, and 350,000 seeds/ha. These rates bracket the recommended rate for winter-type lupin in France. Stand counts were taken four weeks after planting and at harvest time. Biological yield and grain yield were measured from the center 4.5-m of the center row. Grain yield components were determined on a subset of 10 randomly selected plants per plot. Components investigated were grain yield of the main axis, higher order branches, and basal lateral branches.

RESULTS AND DISCUSSION

The 1991/92 growing season had far less precipitation than normal. This reduced disease pressure and record yields were obtained. The average yield over all locations and treatments was 1735 kg/ha. The single largest individual plot yield obtained was 3479 kg/ha. As expected, final stand counts increased with increasing seeding rates, but when evaluated as percent of the seeding rate, there were no consistent differences among seeding rates. The most northern location had the poorest stand percentage overall (mean = 33%) stand in relation to the initial seeding rate. Tifwhite-78 usually had slightly better stand than Lunoble. In general, the highest biological yield was obtained from the earliest planting at the highest seeding rate (Table 1). The exception was the most northern location, where a late March frost particularly damaged the early Tifwhite-78 planting. Similarly, the earliest planting also resulted in the highest grain yield at all locations, except the northernmost, for the reasons mentioned above (Table 1). The effect of seeding rate on grain yield differed from the effect of seeding rate on biological yield. A clear increase in grain yield in response to increasing seeding rates was obtained only at the latest planting date (Table 1).

Table 1.Total biological yield at 12% moisture and grain yield from winter type white lupin management study conducted in North-, Central-, and South-Alabama during the 1991/92 cropping season.

		Planting date								
		Early			Medium			Late		
		Seeding rate [1000 plants/ha]								
LOC	**Cultivar**	**87.5**	**175**	**350**	**87.5**	**175**	**350**	**87.5**	**175**	**350**
		Total biological yield [kg/ha]								
North	Lunoble	2576	6857	6869	1246	3316	7126	1157	1758	3862
North	Tifwhite-78	3693	3523	2851	2450	6894	5781	3802	4525	6790
Central	Lunoble	6700	7828	9345	4684	7286	6982	2819	3903	4705
Central	Tifwhite-78	8131	9671	8500	6462	8066	8521	4727	5854	7286
South	Lunoble	5882	7982	8997	4159	4176	5638	2554	2966	3899
South	Tifwhite-78	8220	8333	9633	4742	6034	6360	3808	4176	5245
		Grain yield [kg/ha]								
North	Lunoble	438	1411	1227	310	716	1906	134	411	1144
North	Tifwhite-78	769	739	525	922	2081	1684	530	1551	2665
Central	Lunoble	1924	1945	1923	1753	2369	2018	863	1381	1632
Central	Tifwhite-78	2393	2351	1993	2511	2613	2414	1808	2226	2520
South	Lunoble	2186	2418	2192	1990	1678	1842	1397	1233	1372
South	Tifwhite-78	3214	2719	2706	2384	2631	2272	1555	2013	2081

In South- and Central Alabama, increasing seeding rate at later plantings could not compensate for the yield reduction due to late planting. Grain yield component-determination allowed us to pinpoint physiological mechanisms for the changes in yield in response to rate and date of seeding (data not shown). The contribution of the mainstem to the overall yield of a plant increased from 5 - 45% for the first planting date to 28 - 75% for the last planting date; the most northern locations had the lower values. Correspondingly the contribution of the higher order branches and the basal lateral branches decreased with delayed planting. Unlike northern Europe, the climate in Alabama is characterized by a very rapid rise in temperature during the spring. High temperatures increase flower abortion and hasten maturation at the expense of growth. The effect of increasing seeding rates on the yield contributions of higher order branches changed with planting date. In five out of six location x seeding rate combinations at the first planting date, the largest yield contribution of higher order branches occurred at the highest seeding rate. For the second date, the largest contribution occurred in half the cases at the intermediate seeding rate; only in two out of six cases did the largest seeding rate result in the highest contribution. For the last planting date, the lowest seeding rate resulted in the largest contribution by higher order branches in four out of six cases. The contribution of basal laterals also changed in response to seeding rate and date. In no case did the highest seeding rate result in the largest contribution of basal laterals to the overall plant yield. At the first planting date, the maximum contribution by basal lateral branches occurred at the intermediate seeding rate. For the last two planting dates, the maximum contribution of basal lateral branches occurred at the lowest seeding rate.

SUMMARY

Based on a single test year at three locations throughout Alabama the following conclusions may be reached. Early planting is critical for high yield, but late winter freezes may be a problem in the northern part of the state. Maximum biomass yields require high seeding rates. For early plantings, a low seeding rate is adequate for maximum grain yield. Increasing seeding rate can partially compensate for delayed planting. The reduction in grain yield with delayed planting can be attributed to reduced yield of higher order branches and basal lateral branches. Production recommendations will have to balance maximum yield potential with the risks of loss due to late winter freezes.

REFERENCES

Herbert, S.J. 1977. Growth and grain yield of *Lupinus albus* at different plant populations. *N. Z. J. Agric. Res.* **20**:459-465.

Huyghe, C. and J. Papineau. 1990. Winter development of autumn sown white lupin: agronomic and breeding consequences. *Agronomie* **10**:709-716.

Reeves, D.W. 1991. Experiences and prospects for lupin in the South and Southeast. pp. 23-30. *In* Prospects for Lupin in North America, Proc. of Symposium sponsored by the Center for Alternative Plant and Animal Products, University of Minnesota, St. Paul, MN, Mar 21-22, 1991.

Wells, H. D. and I. Forbes. 1980. Genetics and breeding of lupines for winter production for the south of the United States. *In* R. Gross and E. S. Bunting (ed.) Agricultural and Nutritional Aspects of Lupines. *Proc. of the First Int. Lupin Workshop*, Lima-Cuzco, Peru, April 12-21, 1980.

Wells, H.D., I. Forbes, R. Burns, J.D. Miller, and J. Dobson. 1980. Registration of Tifwhite-78 white lupine. *Crop Sci.* **20**:824.