COMPARATIVE YIELDS OF FOUR BERSEEM CLOVER VARIETIES IN RESPONSE TO THREE FALL 2000 PLANTING DATES

M. D. Rethwisch, J. Nelson, W. L.Graves, M. Reay, P. Hayden, L. Berger, B. Hayden and B. J. Griffin

ABSTRACT

Four berseem clover varieties were planted on three dates (Oct. 2 and 16, Nov. 2) in the fall of 2000. Data for plant heights and yields were obtained during the following winter and spring. Varieties differed widely in their initial stages of growth in terms of green coloration, indicating differences in bacterial nodulation and nitrogen fixation. 'Tabor' was a uniform rich green in coloration with vigorous growth, while 'Saidi' and 'Serw 3' were somewhat green. 'Joe Burton' was very reddish in coloration, especially in the later plantings, and no nodules were noted during examination of roots of this variety during the fall of 2000. Forage yields for the most part reflected planting date, with the earlier plantings having the highest yields. One exception was the Oct. 16 planting of 'Tabor', which had the highest overall individual yield. Lowest yields were noted with 'Joe Burton'.

INTRODUCTION

Berseem clover (*Trifolium alexandrinum* L.) is a cool season annual clover used for forage and hay. Interest in berseem clover has recently increased in the low desert valleys for several reasons such as crop rotation with cotton as well as potentially increasing economic returns via the hay crop and/or nitrogen fixation and lowering fertilizer inputs for subsequent crops. Berseem clover has been documented to fix up to 350 lbs. of nitrogen/acre in California (Graves et al., 1996). Maximum fixation amounts occur when seasonal soil available nitrogen is less than 150 lbs. per acre. Differences exist among berseem clover varieties in the amounts of nitrogen fixation per acre (Williams et al., 1990). Berseem clover cultivars also differ in number of harvests, with cultivars being grouped into three types: single cut, intermediate, and multiple cut (Putnam et al., 1999).

Variety trials conducted at the University of California Desert Research and Extension Center near El Centro, CA, in recent years had provided excellent stand establishments and yields. Experimentation conducted further north in the Palo Verde Valley near Blythe, CA, had resulted in very mixed results in stand establishment and growth, with large differences between varieties noted for nodulation and other factors (Rethwisch and Graves, 2000). Growers in the Palo Verde Valley who had planted fields of berseem clover (variety unknown) in the fall of 1998 had also reported crop failure.

This study was initiated to determine the effects, if any, of various fall planting dates and/or associated temperature on berseem clover establishment, growth and subsequent yields, and to further investigate varietal differences.

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METHODS AND MATERIALS

Four varieties of berseem clover ('Joe Burton', 'Saidi', 'Serw 3', 'Tabor') were planted on each of three dates (October 2, Oct. 17, Nov. 2) in the fall of 2000. Of these varieties, 'Tabor' is a single cut variety. Single cut varieties are distinguished from multiple cut varieties by location of regrowth nodes, with regrowth nodes for single cut varieties located at axillary nodes above cutting height, allowing only a single harvest. 'Saidi' is an intermediate variety (some regrowth from crowns, some from axillary buds) with 2-3 harvests expected. 'Joe Burton' is a multiple cut variety (regrowth from base of plant = crown), with 4-6+ harvests possible under optimum conditions (Putnam et al., 1999).

Each variety was planted at a rate of 36 lbs. of seed/acre. Prior to planting, five ml of a glue solution (Nitragin Pelgel nutrient adhesive) was added to 120 g. seed, and innoculant (Nitragin *Rhizobium leguminosarum* var. trifolii, culture "R/WR", manufacturer = LiphaTech Inc., Milwaukee, WI) was added and evenly dispersed on seed. Innoculated seed was then hand sown onto plots and raked into the soil. Soil surfaces were then lightly packed to increase seed/soil contact and to assure germination. Plots were five ft. wide x 16 ft. long with four replications for each variety at each planting date. Plots were flood irrigated after planting and throughout the study.

Plant heights were measured on Jan. 8., Feb. 5., and March 8th by recording the height of 10 plants per plot, with the exception of Feb. 5 when 12 plants per plot were utilized. Mean plant heights were obtained from three replicates of 'Tabor' from the October 17th planting at harvest on Feb. 20 using ten plants per plot.

Plots of 'Tabor' were harvested at 1/10th bloom (Feb. 5, Feb. 20, and March 9, respectively, for the three fall planting dates). The entire plot was harvested with a Troy Built cycle-bar mower, and fresh weights obtained and recorded. A small (approximately 350 g.) sub-sample was then secured and oven-dried to approximately 0%moisture for dry matter measurements and subsequent plot dry matter yield calculations.

Plots of the other three varieties were harvested on March 12, April 26, and May 24. They differed from the previously listed procedure in that only a 42 inch cutting width was used instead of the entire plot width. All weeds were removed from the plot harvest on the first harvest date (March 12, 2001) after cutting and prior to fresh weights being obtained so that data would represent that of only berseem clover. Weeds present in subsequent harvests were also removed.

RESULTS

Variety Establishment

Varieties differed widely in their initial stages of growth in terms of green coloration, indicating differences in bacterial nodulation and nitrogen fixation. 'Tabor' was a uniform rich green in coloration with vigorous growth, while 'Saidi' and 'Serw 3' were somewhat green. 'Joe Burton' was very reddish in coloration, especially in the later plantings, and no nodules were noted during examination of roots of this variety during the fall of 2000. The reason for this observed difference for initial nodulation between varieties is unknown and has not been previously reported. The results mirror cultivar harvest types (single harvest "Tabor' = rich green; intermediate harvest 'Saidi' = somewhat green, multiple harvest 'Joe Burton' = reddish).

Data collected in April 1999 of a berseem clover variety planted at the same site in October 1998 indicated that less than 15% of the 'Joe Burton' plants were nodulated although some multiple cut varieties were as high as 65% (Rethwisch and Graves, 2000). In the 1998-1999 study only 16.7% of the 'Saidi' were nodulated in April, but this variety (as well as 'Serw 3') had greater nodulation than 'Joe Burton' in the fall of 2000.

'Joe Burton' did nodulate and 'green up' several months after planting however. These observations suggest that this variety may be sensitive to cold temperatures. 'Joe Burton' had significantly fewer nodulated plants (14.3%) than did 'Bigbee' (65.3%) in the 1998-1999 variety trial (Rethwisch and Graves, 2000). As 'Bigbee' was developed for frost tolerance (Knight, 1985) it may be better adapted for cooler temperatures than 'Joe Burton'.

The results noted for 'Joe Burton' differ widely from those recorded from University of California Desert Research and Extension Center experimentation near El Centro, CA, however, leaving the authors at a loss to explain the cause(s) for nodulation differences noted between the varieties in this experiment.

'Joe Burton' was also the only variety with any noticeable growth (albeit not economical) following the May 24 harvest when temperatures were above 100° F. 'Joe Burton' also had the highest percentage of cover in the 1998-1999 variety trial (Rethwisch and Graves, 2000). This is consistent with the differences previous noted between intermediate and multiple cut varieties (Putnam et al, 1999), although the 1998-1999 variety trial also indicated that differences also exist among multiple cut varieties for warm temperature growth (Rethwisch and Graves, 2000).

Air temperatures decreased (Figure 1) during the planting period from Oct. 2nd (high air temperature = 99° F, average = 83.5° F), to Oct. 17 (high of 96° F, average of 75° F) and cooling further by Nov. 2nd (high = 75° F, average = 59.5° F). Soil temperatures at 15 cm of depth ranged from 76-86° F on Oct. 2, 67-7 ° F on Oct. 17, and 61-64° F on Nov. 2. Soil temperature at the soil surface where seed was located probably was closer to or higher than air temperatures than the temperature at the 15 cm soil depth.

Plant Heights

Plant heights obtained in January 2001 of some berseem clover varieties reflected differences in fall planting dates and temperatures (Table 1, Figs. 2-4). The earlier that varieties were planted in the fall resulted in taller berseem clover heights in January. Height differences between the different planting dates for 'Saidi' and 'Serw 3' were almost equal for the planting date, but a large height reduction was noted for 'Tabor', the tallest variety, for the Nov. 2 planting compared with the other two planting dates. Data for 'Joe Burton' did not follow either of these patterns and this may have been partially due to lack of robust growth and associated lack of nodulation.

Height increases between January and March were almost identical for each of the planting dates of the multiple cut varieties. This was not true for 'Tabor' however, as mean plant for this variety for the Oct. 17 planting was taller than the Oct. planting in February. This planting also resulted in the highest yields.

Hay Yields

'Tabor' had the highest yields (2.36 tons/acre) for the first planting (Oct. 2)of the varieties tested (Fig. 5), however this was exceeded by the Oct. 17 planting date (3.98 tons/acre). A large decrease was noted for 'Tabor' between the Oct. 17 and Nov. 2 planting dates (yield of 2.72 tons/acre), indicating that this variety may well be affected by planting date. Additional succinct data on planting date effect on yields is not available from the lower desert. Available yield data from Imperial County plantings (1997) measured a 'Tabor' yield of 5.42 tons/acre when planted on Oct. 15, but only 2.35 tons when planted in 1998 on October 21st (Putnam et al., 1999).

Accumulative yields from three harvests of Oct. 2 'Saidi' did exceed the Oct. 17 planting of 'Tabor'. This was the only variety and planting date to do so. Yields of 'Saidi' and 'Serw 3' were similar throughout the experiment although yields were slightly higher in 'Saidi' (Fig. 6).

IMPLICATIONS AND FUTURE CONSIDERATIONS

Herbicides

Although herbicides were not used in this experiment, results indicated that herbicide usage will probably be necessary for the non-single cut varieties (especially for the later planting dates) for winter weeds. All planting dates for these varieties (Saidi, Joe Burton, Serw 3) would have benefited from an

effective herbicide application, although the earliest planting provided best weed competition. Several herbicides are registered for current usage on clovers (Table 3). A potential herbicide in addition to those listed is Raptor™ (BASF Corporation; active ingredient = imazamox). This product has not been tested under local growing conditions to quantify effects on berseem clover growth however. High weed content may also affect time to cure forage intended for hay.

Curing

One of the major concerns of berseem clover production in the low desert with typical winter conditions will be the time necessary for curing. Varieties that are multiple-cut in growth habit are expected to have problems properly curing for hay due to the very rapid regrowth of the berseem clover plant and the longer curing period associated with the cooler winter temperatures. These factors will make exclusion of very moist, fresh green plant material from bales very difficult. These varieties may be better harvested as green-chop or grazed.

For winter hay production, a single cut variety such as 'Tabor' may provide the best opportunity for hay production due to the lack of regrowth. However, certain questions such as "How long will it take for 4 tons/acre to dry if cut in mid February?" and "What will quality be like after turned several times for curing?" need to be answered.

Data from this experiment indicated that forage at cutting consisted of about 80% moisture and 20% dry matter (similar to that of alfalfa forage). A yield of 4 ton/acre at 15% moisture when baled (=3.47 tons at 100% dry matter) would contain about 13.9 tons/acre of moisture at cutting, requiring air dry removal of almost 10 tons/acre of water from the forage. The amount of time necessary to remove this amount of water will depend on the moisture holding capacity of the air, which is a function of primarily of temperature and relative humidity, as well as air movement.

Chemical drying agents may also be effective and probably necessary when handling large amounts of tonnage to preserve forage quality for hay. Kallenbach (1996) found that usage of potassium carbonate on 1.5 tons/acre yield of alfalfa forage achieved 18% moisture than any other treatment tested, reducing drying time by 11.6 hours (average of 23% less time) compared with untreated alfalfa. Details on evapo-transpiration (ET) levels nor moisture holding capacities of the air were not provided in the experimental report, however. With the relatively short drying time and higher yields per acre, there is a higher probability that this experiment took place later in the spring (March-May) rather than in February. Further testing on berseem clover will probably be necessary to quantify expected curing times, as well as effects on quality.

Quality

Allowing the variety 'Tabor' to gain maximum tonnage may be detrimental to quality, as is noted to occur with alfalfa hay production. Putnam et al. (1999) noted that an extremely high yield of 5.4 tons per acre of 'Tabor' from Imperial County from an Oct. 15, 1997, planting contained lower levels of crude protein, and higher acid detergent fiber and neutral detergent fiber levels than multiple cut varieties when cut on Feb 26, 1998. This variety may have been in full bloom by this harvest date. Although the best tonnage/quality trade off has not yet been established for 'Tabor' under local conditions, it may be similar to that of alfalfa ($1/10^{th}$ bloom). Another factor will be the drying times necessary for various hay densities in relation to potential molding and quality loss.

Economics

As alfalfa hay prices often exceed $100/ton in the late February/early May time period for supreme or premium grade alfalfa hay in the Blythe area (USDA, 2002), similar prices should be expected for similar grade berseem clover hay. If a four ton per acre hay yield of premium or better hay is produced, the opportunity for a crop worth about $440 per acre exists. This also allows growers the opportunity to rotate with cotton or other spring crop after hay harvest as well as having supplied nitrogen to the soil for the crop immediately following berseem clover.

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FALL 2000 TEMPERATURES, BLYTHE, CA
(OCTOBER-NOVEMBER 15)

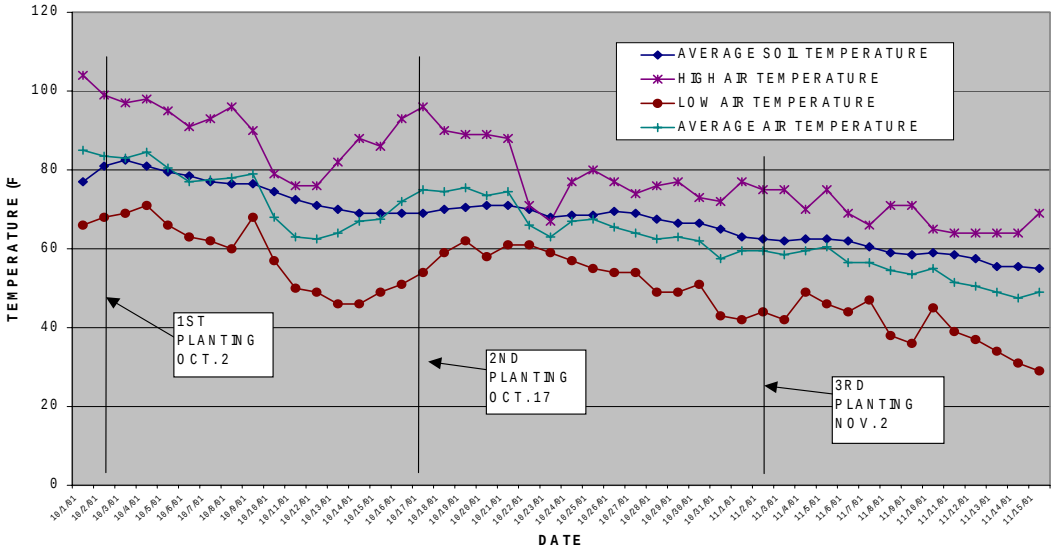
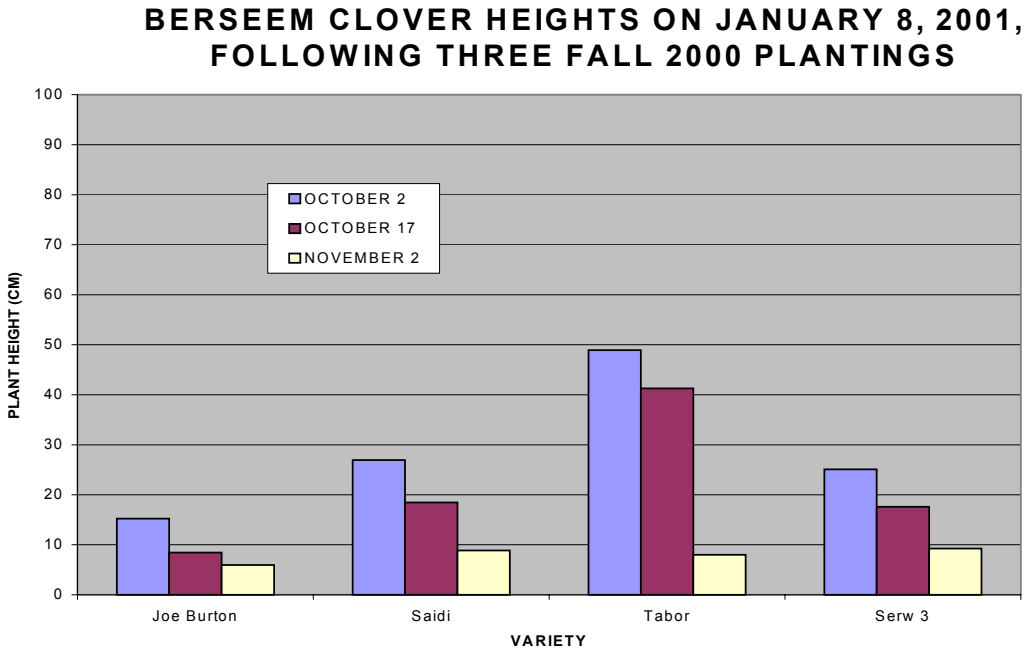


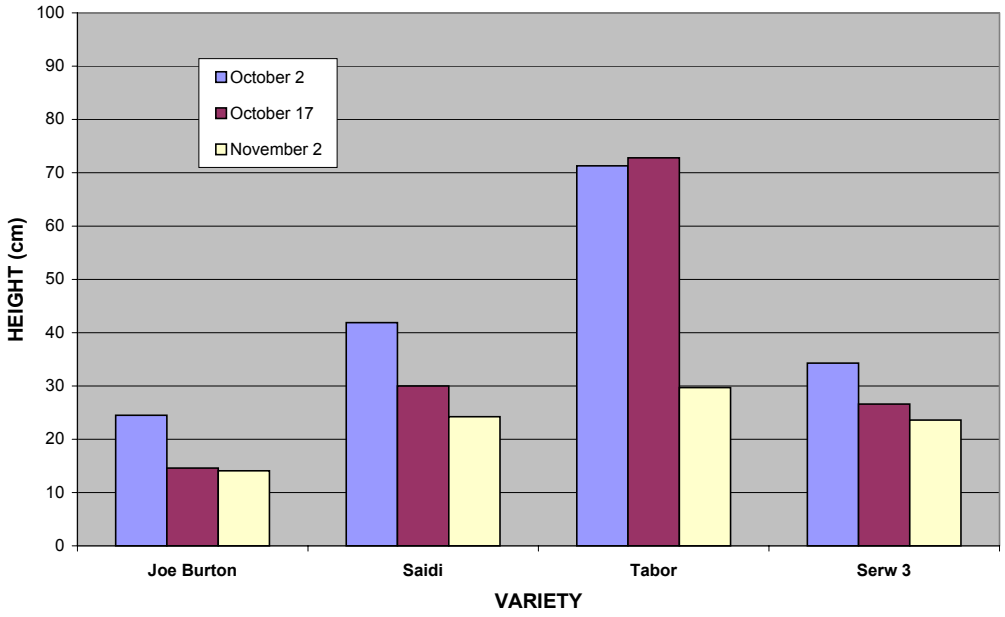
Table 1. Mean plant heights (cm) of four berseem clover varieties on Jan. 8, Feb. 5, and March 8, 2001, as affected by fall 2000 planting date.

Variety	Planting date	Jan. 8	Feb. 5	March 8	Increase (cm) Jan. 8– Mar.8
Tabor	Oct. 2	48.9a	71.3a		
Tabor	Oct. 17	41.3a	72.8a		
Tabor	Nov. 2	8.0 fg	29.7 cd	87.7a	79.9a
Joe Burton	Oct. 2	15.2 def	24.5 cde	47.1 c	31.9 c
Joe Burton	Oct. 17	8.5 fg	14.6 ef	40.1 c	31.6 c
Joe Burton	Nov. 2	6.0 g	14.1 f	38.7 c	32.7 c
Serw 3	Oct. 2	25.1 bc	34.3 bc	66.4 b	41.3 bc
Serw 3	Oct. 17	17.6 cde	26.6 cd	61.9 b	44.3 b
Serw 3	Nov. 2	9.3 efg	23.6 def	46.2 c	36.9 bc
Saidi	Oct. 2	26.9 b	41.9 b	66.4 b	39.5 bc
Saidi	Oct. 17	18.5 cd	30.0 cd	59.0 b	40.5 bc
Saidi	Nov. 2	8.9 fg	24.3 de	46.6 c	37.7 bc

Means in columns followed by the same letter are not significantly different at the $p \leq 0.05$ level (Fishers LSD)



BERSEEM CLOVER PLANT HEIGHT AS AFFECTED BY PLANTING DATE ON FEBRUARY 5, 2001, BLYTHE, CA



BERSEEM CLOVER HEIGHT ON MARCH 8, 2001, AS AFFECTED BY FALL PLANTING DATE

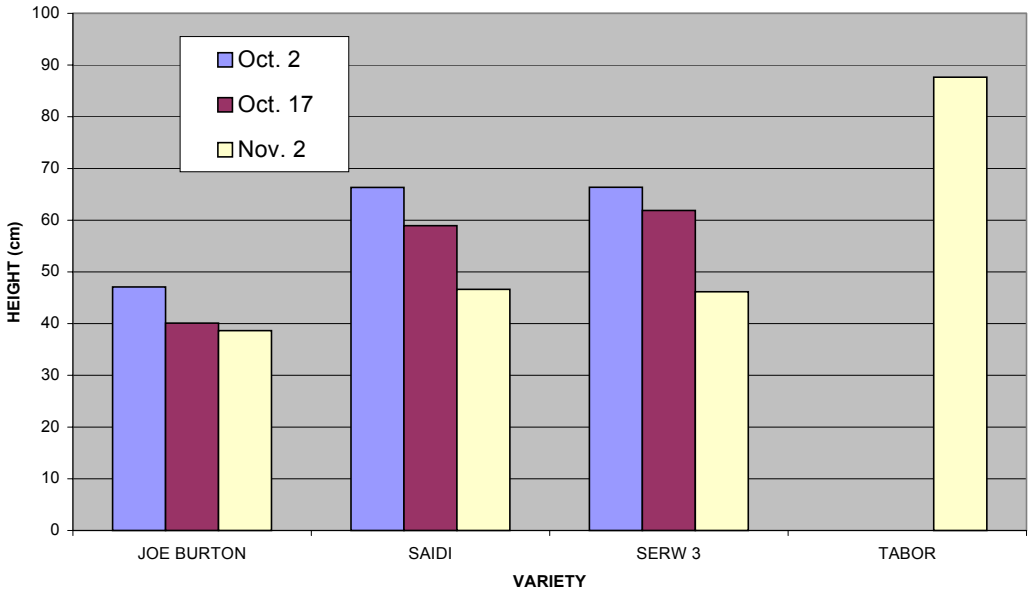
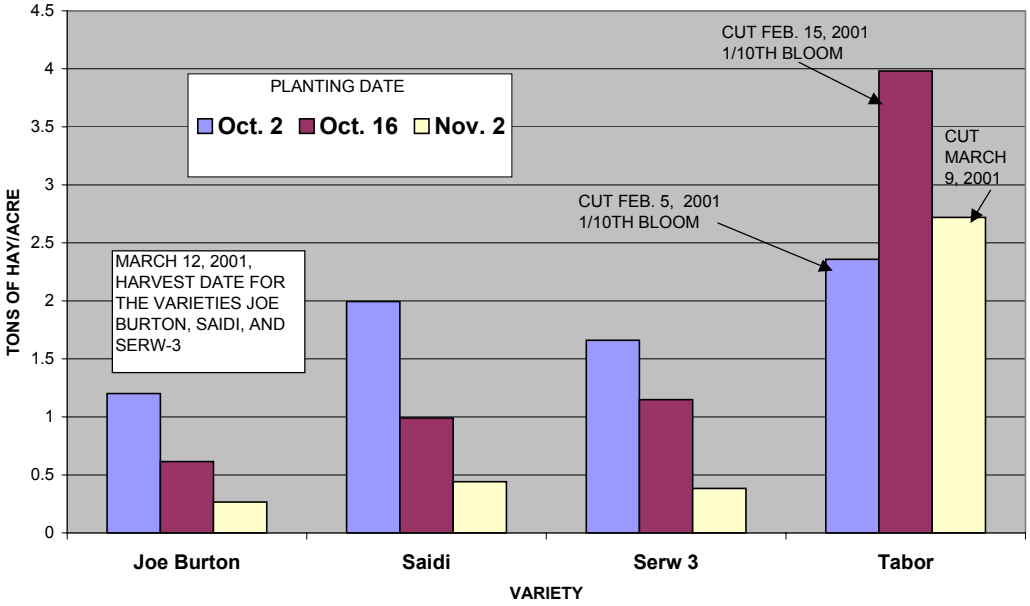


Table 2. Hay yields of four berseem clover varieties as affected by fall 2000 planting date.

Variety	Planting date	1st harvest Jan. 8	2nd harvest Feb. 5	3rd harvest March 8	Accumulated yields
Tabor	Oct. 2	2.36 bc			2.36 efg
Tabor	Oct. 16	3.98a			3.98ab
Tabor	Nov. 2	2.72 b			2.72 cdef
Joe Burton	Oct. 2	1.20 de	1.11 cde	0.90a	3.20 bcd
Joe Burton	Oct. 16	0.61 e-h	1.28 bcd	0.97a	2.87 cde
Joe Burton	Nov. 2	0.27 h	0.99 e	0.79ab	2.05 fg
Serw 3	Oct. 2	1.66 cd	1.32 bc	0.91a	3.89ab
Serw 3	Oct. 16	1.15 def	1.36ab	0.82ab	3.32 bc
Serw 3	Nov. 2	0.38 gh	0.87 e	0.55 b	1.81 g
Saidi	Oct. 2	1.99 c	1.57a	0.96a	4.52a
Saidi	Oct. 16	0.99 d-g	1.37ab	0.89a	3.25 bcd
Saidi	Nov. 2	0.44 fgh	1.05 de	0.97a	2.46 defg

Means in columns followed by the same letter are not significantly different at the $p \leq 0.05$ level (Fishers LSD)

BERSEEM CLOVER VARIETY FIRST HARVEST HAY YIELDS AS AFFECTED BY PLANTING DATE



BERSEEM CLOVER HAY VARIETAL HAY YIELDS AFFECTED BY PLANTING DATE

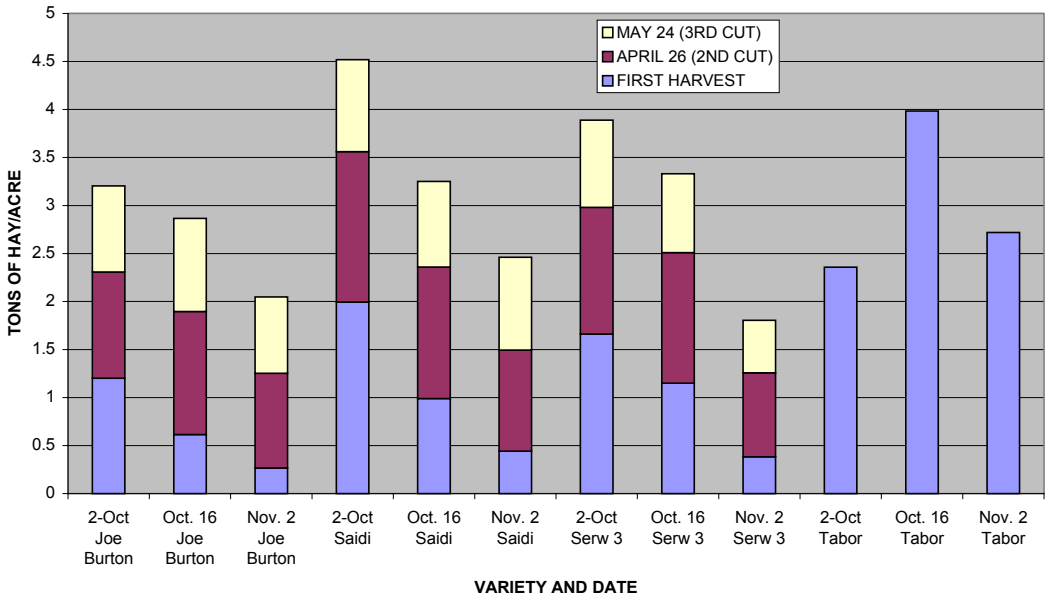


Table 3. Herbicides registered for usage on berseem clover during crop establishment.

Trade name	Comments about product/usage
Eptam 20-G, 7E	Recommended for use on mineral soils (less than 10% organic matter) as a pre-emergence material , will not control established weeds. Do not use if a grass or grain nurse crop is to be planted with clover.
Balan DF	Apply within 3 weeks prior to planting. Incorporate with 4 hours of application.
Kerb	120 day pre-harvest interval. See label for rotation restrictions, often 365 days.
Poast, Poast Plus	For control of emerged grasses. Poast not registered for usage in California.
Prism, Select	For control of emerged grasses. Prism registered for usage in California, Select registered for usage in Arizona