RESEARCH ARTICLE

Optimal timing for fava bean planting, pod harvesting, and termination in Northern California

As fava bean grows in popularity as a vegetable and cover crop, optimal harvesting options depend on consumer demand and available labor.

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Abstract

Fava bean has been cultivated as a grain, vegetable, and cover crop in California for more than a century. Despite a decline in popularity as a grain, many growers are taking a second look to satisfy demands for vegetable fava bean (pod) and to provide plant-derived nitrogen (N) to grow summer cash crops. This paper presents the results of a series of experiments aimed at quantifying fava bean biomass and N at planting date and termination, as well as pod production in response to the harvest scheme. Sowing before the end of October resulted in the highest biomass and N in Northern California. Termination of fava bean cover crops in early April between the flowering and first pod stage increased the forage yield of the following crop (sudangrass), compared to termination at the earlier branching stage, which is typically in late February. Delaying vegetable pod harvest until late May lowered marketable fresh-pod yields. The results provide a starting point for growers interested in incorporating fava bean into their farming operation.

Fava bean (*Vicia faba*) has been cultivated around the world for grain, fresh pod, and green manure since its domestication in the Middle East 10,000 years ago (Caracuta et al. 2015). Also known also as faba bean, broad bean, and horse bean, fava bean is the third-most important feed grain legume in the world. Major producers are China, Ethiopia, Egypt, and parts of Latin America, where fava bean is grown for grain and fresh pod. During the past 60 years, the global cultivation area of fava bean grain crop has declined from 13.4 M acres (5.4 million hectares [Mha]) in 1961 to 6.7 M acres (2.7 Mha) in 2021 (fig. 1, FAOSTAT 2023). In comparison, fava bean fresh pod cultivation and production have steadily increased during the same period, suggesting a consistent global interest in fava bean fresh pod consumption. In 2021, a total of 1.90 M U.S. tons (1.7 million metric tons [Mt]) of fresh fava bean pods were harvested from 700,000 acres (approximately 280,000 ha) of land, with an average yield of 5,500

A fava bean field at flowering stage. Fall-planted fava bean in Northern California starts flowering as early as January. Because of its indeterminate growth nature, fava bean flowering continues until pod-harvest in April. *Photo*: SylvieBouchard, iStock.

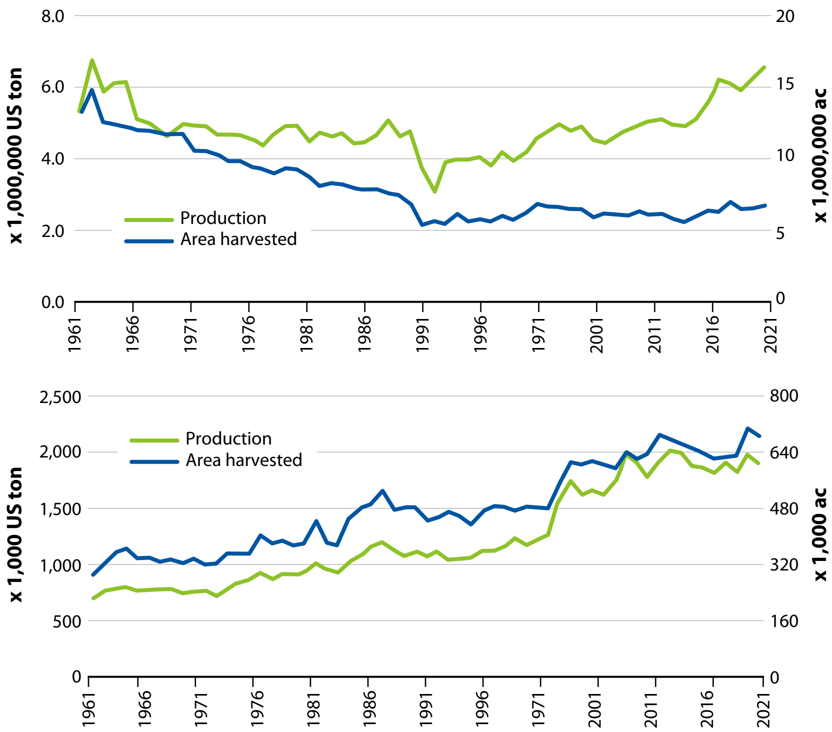

FIG. 1. Global cultivation and production of fava bean (horse bean) for grain yield (top) and fresh pod (bottom) production (FAOSTAT 2023) from 1961 to 2021.

pounds (lbs) fresh pod per acre (ac^{-1}). Fresh fava bean pods, immature seeds, and young leaves are commonly prepared as cooked and salted vegetables, brewing and baking adjuncts, a protein source in bean dips, spreads on toasted breads, a companion to carbohydrates, fried bean cakes, meat substitutes, cooked or raw sprouts, and components of salads, soups, and stir fry (Dhull et al. 2021).

The United States agricultural databases lack clear records of fava bean cultivation. Existing information suggests that fava bean has been grown for pods and green manure in California since 1903 (Hickman and Canevari n.d.). In the early 20th century, Kennedy (1923) published *The Small-seeded Horse Bean*, which indicates that "horse beans are extensively grown as cover crop in southern California . . . and green pods are frequently seen in vegetable markets . . .. [S]eeds are shelled from pods and eaten the same way as green peas." The book provides detailed information about fava bean cultural practices and outlines important research topics about the crop, some of which have re-emerged in the United States after a century (Etemadi, Hashemi, Zandvakili, Mangan 2018; Sharma et al. 2022; Tallman 2017). Despite the popularity, fava bean cultivation vanished from much of California and the United States, possibly due to factors such as abundant N fertilizers (Mikkelsen and Bruulsema 2005), favism (a disease caused by fava consumption) (Hedayat et al. 1981), and costs and time associated with processing of fava bean pods and immature seeds (Dhull et al. 2021).

Along with increasing global interest in fava bean cultivation (Martineau-Côté et al. 2022), as well as ongoing efforts to eliminate the health risks of fava bean consumption (Khazaei et al. 2019), growers and researchers have attempted to reestablish this N-fixing legume crop in U.S. cropping systems. Research experiments are rapidly emerging throughout the country to test the feasibility of reestablishing this valuable legume in different cropping systems (Etemadi et al. 2018; Etemadi, Hashemi, Zandvakili, Mangan 2018). In California, researchers have demonstrated the potential of fava bean as a cover crop (Boots-Haupt et al. 2022; Brasier et al. 2021) and dual-purpose cash and cover crop (Brasier et al. 2023; Zakeri 2023), and provided information about public interests and seasonal availability of fava bean fresh pods across California farmers markets (Avetisyan et al. 2023). These studies and similar efforts (Smither-Kopperl 2019) show that winter-grown fava bean for vegetable production or cover cropping can benefit the plant-soil system by providing soil coverage and N contribution, which results in increased yield potential of following crops and helps in the development of alternative legume-based rotations to increase on-farm crop diversity.

The use of fava bean in cover cropping is largely linked to its high biological N fixation (60–200 pounds nitrogen per acre [lbs N ac^{-1}]) and upright plant structure, which allows companion vining species to climb, resulting in greater biomass production (Brasier et al. 2021; Jensen et al. 2010). The high quantity of N derived from fava bean as a cover crop has been shown to improve the quality and yields of the subsequent melon (*Cucumis melo*) (Stagnari and Pisante 2010) and sweet corn (*Zea mays*) (Etemadi et al. 2018) crops. Renewed interest in fresh fava bean has arisen in niche culinary scenes, which target both international consumers valuing fava bean as a culturally significant food and domestic consumers interested in niche food experiences and sustainable agricultural practices (Avetisyan et al. 2023; Black et al. 2019). Despite fava bean's resurging popularity, limited information on fresh pod production and cultivation techniques limits the crop's potential as a valuable component of diverse cropping systems.

California growers could benefit from information about agronomic practices during key decision-making periods, such as cover and cash crop target planting and termination dates. Growers also need to know about the extent of fresh pod harvests on N contribution of fava bean residues. To date, these questions remain largely unexplored. This study aims to fill some of these gaps.

A whole-system approach

Growers who are considering the use of fava bean must establish a whole-system approach to determine management factors that optimize economic returns and the amount of N incorporated into the plant-soil system. For example, a previous study by Lupwayi and Soon (2015) demonstrated this point by comparing

N release of fava bean grown as a cover crop to fava bean that was grown over a longer duration for grain production. Here, the authors reported that 80% of the cover crop fava bean N was released in the first 12 months compared to 50% N released from the remaining biomass of the harvested fava bean. Similarly, growers are cautioned to consider the potential impact of excessive N supplied by fava bean to the following crop in cases where excessive N can lead to a reduction in the crop's fruit yield and increase in vegetative biomass (e.g., indeterminant tomato [*Solanum lycopersicum*]) (Elia and Conversa 2012). Because fava bean is grown in California for fresh pod production, our study aims to address the effects of planting and harvesting time on fava bean fresh pod production and N accumulation, which can benefit the succeeding crop in rotation.

A case study of intercropping fava bean and barley in Chico, Calif. Alternate rows of fava bean and barley were established for weed control and proper land and water use. Both crops were sown in early November but barley matured much earlier than fava bean. *Photo*: Hossein Zakeri.

Crop output and cover crops

Three experiments were conducted in two locations in the northern Central Valley of California to assess (1) the effects of planting date on fava bean biomass production (in Lockeford and Chico, California), (2) the effects of termination of fava bean cover crop for optimization of following sudangrass (*Sorghum sudanense*) yield and quality (in Lockeford, California), and (3) the effects of vegetable harvest scheme for fava bean pod production and N benefits (in Chico, California).

Fava bean planting date

The first experiment was conducted to assess the impacts of planting date on fava bean biomass at the first-pod stage. This stage was selected because it represents a period when winter cover crops are generally terminated in the region. The experimental crop was sown on four dates (October 16, October 30, November 13, and November 27) in 2020 at two locations at the Chico State University Farm near Chico, California (39°41' N, 121°49' W), and at the USDA-NRCS Plant Materials Center near Lockeford, California (38°10' N, 121°10' W). One medium-seeded cover crop fava bean variety (Bell bean) and two large-seeded vegetable fava bean varieties (Windsor and Vroma) were used in this experiment to compare the available fava bean varieties for biomass production. Seeds were hand-planted in two-row plots measuring 10 feet long and 5 feet wide with 0.5 foot in-row seed spacing. The trial was arranged as a randomized complete block design with three replications per testing site. It was given supplemental irrigation to establish a good stand and maintain growth during periods of low rainfall. Soils were Chico loam at the Chico site and Vina fine sandy loam at the Lockeford site. From planting to termination, the Chico site received 12.8 inches of precipitation, while the Lockeford site received 8.0 inches of precipitation.

At termination, 0.75 square meters (m^2) of each plot was cut at ground level, fresh weight was immediately measured in the field, and a single plant was sub-sampled and dried at 140°F (60°C) until it reached a constant weight to calculate the moisture percentage of each sample. Total dry mass of each sample was then calculated, using the equation below to determine dry biomass yield for each fava bean variety and planting date combination. Data was analyzed in the R Statistical Computing Platform (R Core Team 2021). Means and standard errors were calculated for each variety and planting date combination per testing site.

$$DM_{plot} = FW_{plot} * \left[1 - \left(\frac{FW_s - DW_s}{FW_s}\right)\right]$$

in which DM_{plot} is dry mass of each sample from individual plots, FW_{plot} is fresh weight of sample from individual plots taken in the field at sampling time, FW_s is fresh weight of a sub-sample taken in the field at sampling time, and DW_s is dry weight of the sub-samples after drying at 60°C to reach constant weight.

Cover crop termination

The second fava bean experiment was hand-planted on October 30, 2020, at the USDA-NRCS Lockeford Plant Materials Center in Lockeford, California (38°10' N, 121°10' W), to determine the effect of fava bean termination date on fava bean biomass and N, and on the yield and quality of the following crop. Soil was Vina fine sandy loam and the site received 8.0 inches of precipitation from planting until the last termination. Two fava bean varieties (Bell bean and Windsor) were grown as four-row plots measuring 20 feet long and 10 feet wide with 1 foot in-row seed spacing. The trial consisted of four termination dates in 2021 at the fava bean branching (February 20), flowering (March 16), first-pod (April 3), and full pod (April 24) stages. Each variety was planted in a randomized complete block design experiment, in which four termination dates (treatments) were randomized within the experiment. Thus, the experiment consisted of a total of 32 plots (16 per variety), each allocated to a variety by termination date treatment. At each termination date, a 10-square-foot area of corresponding plots was first cut from the ground to measure the above-ground biomass. After sampling, the entire plot was mowed down and biomass was left on the soil surface.

After the last termination date at full pod, the entire field was disked and sudangrass was planted over the terminated fava bean plots using a grain drill on May 16 and irrigated. Plots were grown without added fertilizer or pesticide. To assess forage yield and protein yield, sudangrass was sampled on August 4 by cutting a 10-square-foot area of each plot for biomass measurement. All samples (fava bean and sudangrass) were dried as described for Experiment 1 to estimate the aboveground dry biomass of fava bean and the forage yield of sudangrass. The dried samples were then ground and processed for combustion analysis using a Leco CNS 2000 (LECO Corp., St. Joseph, Missouri) for N analysis of sudangrass. Fava bean samples were analyzed for N and $\delta^{15}N$ composition in an Elementar vario MICRO cube elemental analyzer interfaced on an Elementar VisION isotope ratio mass spectrometer (Elementar Analysensysteme GmbH, Langenselbold, Germany). The data were used to calculate sudangrass N yield, fava bean N yield, and the proportion of plant N derived from atmospheric fixation (%Ndfa). Nitrogen yield was calculated as above-ground biomass × N concentration (N%), and %Ndfa was calculated as the difference of fava bean $\delta^{15}N$ from a non-legume reference plant, as described in Brasier et al. (2021). Data from each experiment (variety) was subjected to analysis of variance to find the effect of fava bean termination date on fava bean and sudangrass biomass and N yield. Data were analyzed in the R Statistical Computing Platform (R Core Team 2020) to calculate means and standard error for fava bean variety and termination date combinations. Tukey's HSD test ($P < 0.05$) was used to test significant differences between treatments within individual experiments.

Vegetable harvest scheme

This experiment was conducted in two growing seasons, 2019–2020 and 2020–2021, in Chico, California. In this experiment, Windsor was hand-planted on four-row plots measuring 20 feet long and 10 feet wide with 1 foot in-row seed spacing in October 2019 and October 2020 at the Chico State University Farm (39°41' N, 121°49' W). The trial was arranged as a randomized complete block design with four replications; each plot was subjected to one of four harvest schemes (table 1).

A Chico State student harvests fresh fava bean pods in Chico. *Photo*: Hossein Zakeri.

The harvest schemes represented four approaches that a grower could utilize, ranging from a first-to-market harvest scheme with continued harvesting throughout the season (harvest scheme 1) to a single harvest at the end of season, to reduce labor requirements (harvest scheme 4). Soils were Chico loam, and the site received 23.5 inches of precipitation in the 2019–2020 season and 12.8 inches of precipitation in the 2020–2021 season. The field was under another fava bean trail in the previous year, where fava bean was grown to full pod and incorporated after sampling and data collection. Plots were hand-weeded, grown without fertilizer or pesticide, and irrigated after the end of the rainy season as needed.

Whole plots were harvested for fresh pod yield and above-ground biomass. Biomass and pods were then dried to determine dry pod yield before grinding samples for combustion analysis using a Leco CNS 2000 (LECO Corp., St. Joseph, Missouri) to estimate N concentration for the calculation of pod N removal (dry pod yield × pod N%) and biomass N return (dry biomass yield × biomass N%). Data were analyzed in the R Statistical Computing Platform (R Core Team 2020)

TABLE 1. Harvest schemes, harvest number, and dates used in the third experiment

Harvest scheme	Harvest 1		Harvest 2		Harvest 3		Harvest 4	
	2020	2021	2020	2021	2020	2021	2020	2021
1	April 22	April 23	April 29	April 30	May 12	May 7	May 26	May 14
2	None	None	April 29	April 30	May 12	May 7	May 26	May 14
3	None	None	None	None	May 12	May 7	May 26	May 14
4	None	None	None	None	None	None	May 26	May 14

The harvest schemes represented four approaches of first-to-market harvest with continued harvesting throughout the season (scheme 1) to that of only a single harvest at the end of season (scheme 4). "None" refers to discountinuation of pod harvest.

to calculate means and standard errors for harvest schemes per growing season.

Early planting boosts biomass

Fava bean above-ground biomass at the first-pod stage is shown for three varieties (Bell bean, Vroma, and Windsor) at four planting dates (fig. 2). Overall, fava bean varieties accumulated more biomass in Chico than in the Lockeford location. A consistent fava bean variety effect was observed in the Sacramento Valley (near Chico) and the north San Joaquin Valley (near Lockeford). Here, the standard vegetable variety, Windsor, produced an average of 184% more biomass than Bell bean across testing locations and planting dates. The response of three varieties to planting date treatments was inconsistent in both locations. In Chico, the biomass production of common California cover crop variety Bell bean declined as the planting date was delayed from mid-October to late November; however, the differences between the last two planting dates were not significant. In comparison, dry mass accumulation of Bell bean was similar across all planting dates in Lockeford, where fava bean had a poor performance compared to Chico. Similarly, the response of two large-seeded vegetable varieties to planting date was more apparent in the high-yielding environment (Chico) than in Lockeford. In Chico, Windsor's biomass declined as planting date was delayed from mid-October to mid-November, while Vroma produced similarly higher biomass in mid- and late October than both November planting dates.

Fava bean N yield generally followed the same pattern as biomass and the three varieties accumulated more N in early than late planting dates (fig. 3). In both locations, maximum N yield belonged to Windsor, which accumulated about 100 and 150 lbs N ac^{-1} in Lockeford and Chico, respectively. However, the effect of planting date on N yield was mainly observed in Chico. In this environment, Windsor's N yield declined as planting date was delayed from mid-October to late October and November. Also, Bell bean and Vroma accumulated more N in October planting dates than in November planting dates. Nevertheless, variations in N yield were independent of fava bean N fixation, as the %Ndfa was similar across varieties and throughout the planting dates, demonstrating that fava bean N is driven by biomass.

Terminate cover after first pod

The standard cover crop (Bell bean) and vegetable (Windsor) fava bean varieties were terminated at four growth stages (branching, flowering, first-pod, and full pod) to provide an N source to the following sudangrass. The two varieties of fava bean exhibited a standard growth pattern, which showed an increase in biomass and N yield over the course of the crop life cycle and significant growth at the reproductive stages

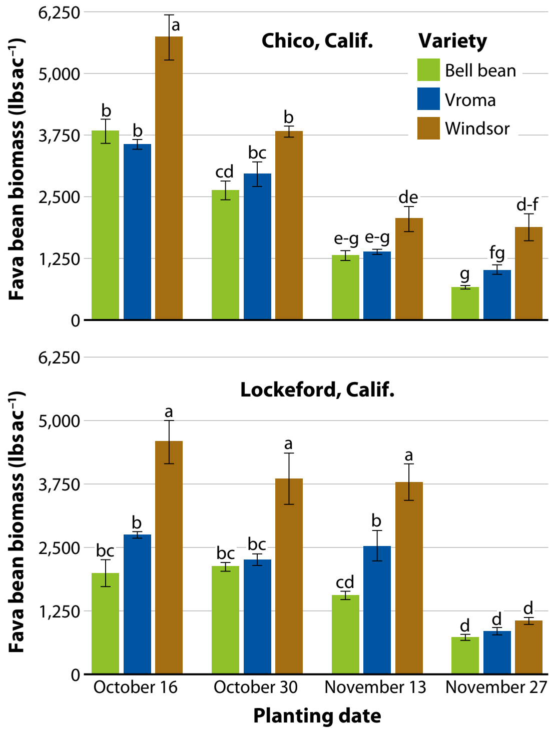

FIG. 2. Biomass production of three fava bean varieties at the first-pod stage in response to four planting dates in Chico, California, and Lockeford, California. Bars labeled by the same letter are not significantly different. Error bars represent standard error.

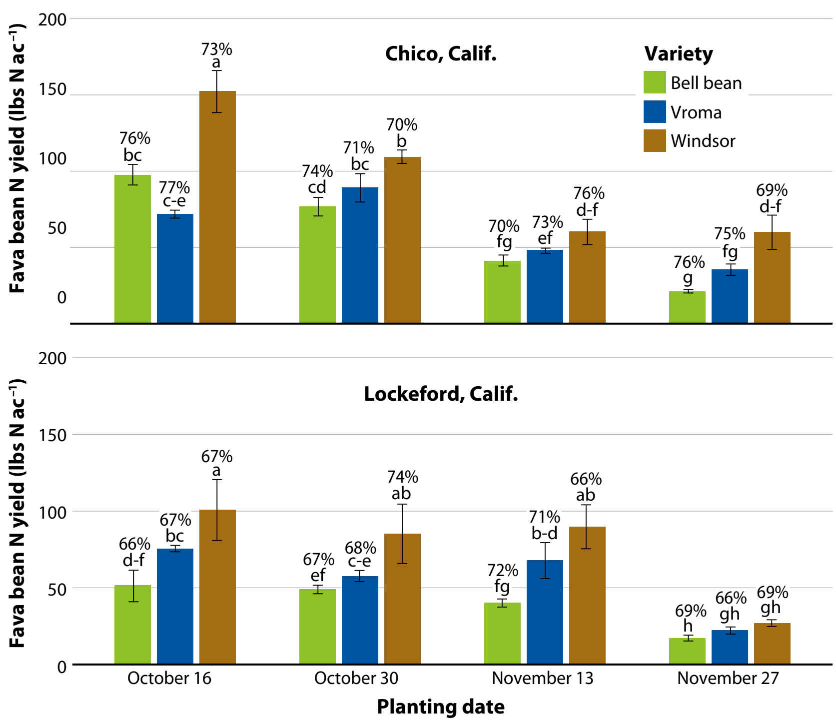

FIG. 3. Fava bean N yield at the first-pod stage for three varieties in response to four planting dates in Chico, California, and Lockeford, California. Bars labeled by the same letter are not significantly significant. Error bars represent standard error and the number above the error bar represents percentage of N derived from the atmosphere (%Ndfa). The variation of %Ndfa among the varieties and planting dates was not significant.

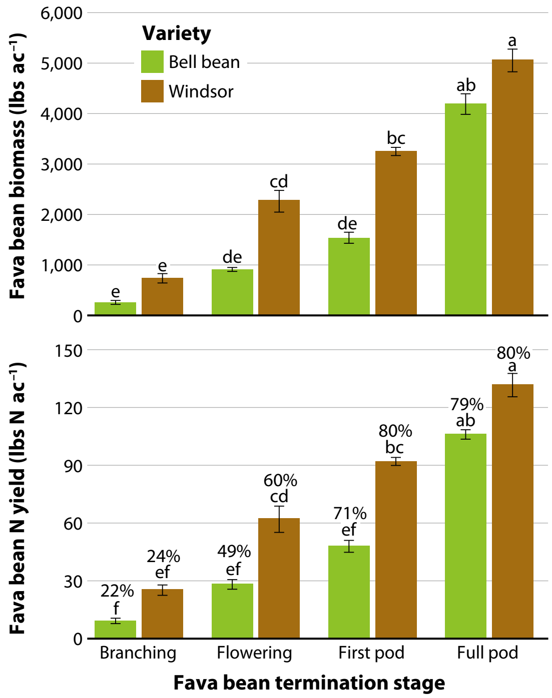

FIG. 4. Fava bean biomass and N yield curves for Windsor and Bell bean starting at the branching stage and ending at the full pod stage. Bars labeled by the same letter are not significantly different. Error bars represent standard error and the number above the error bar represents percentage of N derived from the atmosphere.

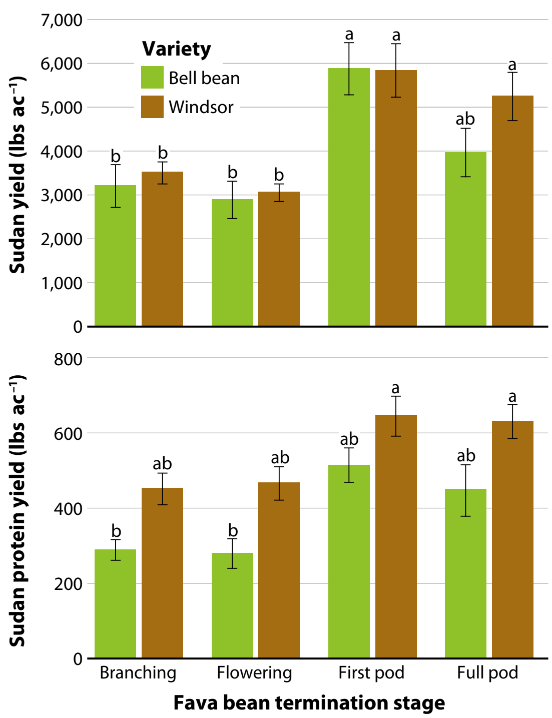

FIG. 5. Sudangrass forage yield and protein yield following termination of two cover crop fava bean varieties (Windsor and Bell bean) at four stages (branching, flowering, first pod, and full pod). Bars labeled with the same letter are not significantly different and error bars represent standard error.

(fig. 4). The average fava bean dry biomass across the two varieties was 485 lbs ac^{-1} at branching, 1,585 lbs ac^{-1} at flowering, 2,395 lbs ac^{-1} at first pod, and 4,651 lbs ac^{-1} at full pod. Following a similar pattern, fava bean N yield was 17.5 lbs N ac^{-1} at branching, 45.3 lbs N ac^{-1} at flowering, 70.1 lbs N ac^{-1} at first pod, and 118.7 lbs N ac^{-1} at full pod. The results suggest that termination at full-pod stage increases dry mass and N accumulation of fava bean. Both varieties accumulated significantly higher biomass and N in full-pod termination than in the earlier-stage termination treatments. Significant differences for fava bean variety were shown; the large-seeded vegetable variety, Windsor, tended to have higher biomass and N yield than the medium-seeded cover crop variety, Bell bean.

The growth pattern observed for fava bean was not directly reflected in the sudangrass yield and protein yield. Figure 5 shows that the highest dry forage yields were observed for the crop following a fava bean cover crop terminated after the first-pod stage, regardless of fava bean variety (5,891 ± 602 lbs ac^{-1} for sudangrass following Bell bean and 5,845 ± 619 lbs ac^{-1} for sudangrass following Windsor). The results suggest that termination of fava bean after flowering has significant impact on biomass (forage) of the succeeding crop in rotation. However, the impact of termination time on forage protein yield depended on the fava bean variety and was only significant for Windsor.

Late harvest reduces pod yield

Figure 6 shows that high fava bean fresh pod yield for the vegetable variety, Windsor, was achieved when the crop was harvested two, three, or four times before early to mid-May (harvest schemes 3, 2, and 1; see table 1 for details). Marketable fresh pod yield decreased by more than 50% under harvest scheme 4, which only a single harvest was performed after mid-May. By this time, early pod sets had begun to lose moisture and turn brown. Nitrogen removal due to single pod harvest in this treatment removed 90 lbs N ac^{-1}, which was 47 lbs ac^{-1} less than an average of 137 lbs ac^{-1} N removal when pods were harvested two, three, and four times in harvest schemes of 1, 2, and 3. However, this variation did not impact the biomass N return, which is added to soil after incorporation of residues.

Winter planting boosts biomass

This study demonstrated that planting should be conducted for winter fava bean before November to achieve high biomass yield by the flowering stage. Because plots were irrigated right after sowing, the higher biomass and N accumulation of fava bean in the early planting date appear to be associated with warm temperatures in the fall, which promoted growth. Average monthly temperature in October, November, and December in Chico is 63°F, 53°F, and 46°F, respectively, and in Lockeford is 64°F, 53°F, and 47°F, respectively (U.S. Climate

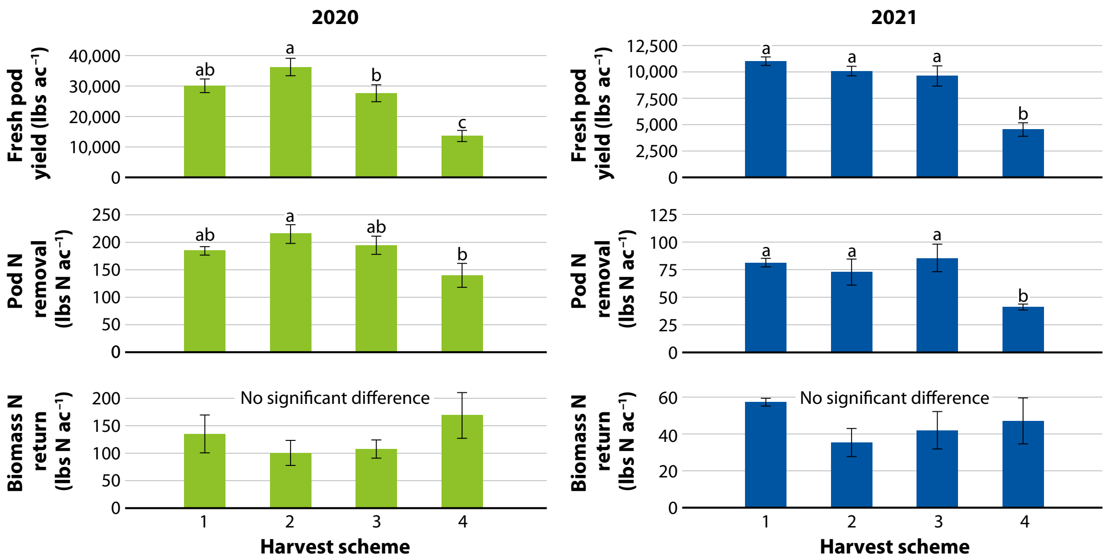

FIG. 6. Effects of harvesting Windsor fresh fava bean pods four times starting at the beginning of the season (harvest scheme 1), three times in early- to mid-season (harvest scheme 2), two times in mid-season (harvest scheme 3), and one time towards the end of season (harvest scheme 4) on fresh pod yield, pod N removal, and biomass N return. Bars labeled with the same letter are not significantly different and error bars represent standard error.

Data 2023). Burger et al. (2017) emphasized the importance of heat accumulation on cover crop performance.

Nevertheless, the effect of planting date on fava bean was more effective in the high-yielding environment (Chico) than in the low-yielding environment (Lockeford), and on the high-yielding variety (Windsor) than on Bell bean and Vroma. These results align with findings of similar studies, where the performance of large- and small-seeded fava bean were compared on different planting dates (Zalama and Leillah 2019).

Fava bean biomass does not significantly decrease when planting is delayed one or two weeks in California's Central Valley environments south of Sacramento. Further, planting can occur through the end of November in order to produce a smaller but impactful amount of fava bean biomass compared to earlier plantings. Similar results have been observed in the Mediterranean climates of Europe, where planting after mid-November was shown to significantly reduce biomass and fresh pod yield (Amalfitano et al. 2018). Other studies have emphasized the effect of heat accumulation on the performance of winter cover crops in California. However, our study is the first one to address planting dates as early as mid-October.

Because California growers don't sow cover crop until mid- to late November, the literature lacks information about planting dates prior to November. Nevertheless, recent rain and cold weather events during fall and winter have encouraged early cover crop planting in California (Light 2023) and other parts of the United States (Vollmer et al. 2023). However, early to mid-October planting of cover crops can be challenging because it may conflict with the harvest of a previous cash crop. Early planting also may be challenged by a lack of water for irrigation, as rain usually starts in November in most parts of California.

Late termination boosts yields

Cover crop fava bean termination time had a significant effect on forage yield and quality of the subsequent sudangrass. This effect was likely the product of balancing fava bean cover crop biomass yield at each growth stage with decomposition dynamics. Our results align with studies using pure hairy vetch (*Vicia villosa*) (Antichi et al. 2022) and mixtures of rye (*Secale cereale*) and hairy vetch (Lawson et al. 2015), which found that extending the date of cover crop termination resulted in higher cover crop biomass and yield of the following cash crop. In the Salinas Valley of California, Brennan and Smith (2005) demonstrated a significant biomass increase and weed suppression effect of three different cool-season cover crop mixes when they were terminated in February compared to terminating in December and January. The effect of cover crop on succeeding crop could be associated with soil water storage (Daigh et al. 2014), quantity of cover crop residues (Mitchell et al. 2015), soil organic matter and water holding capacity (Poeplau and Don 2015), and other soil quality measures such as hydraulic conductivity, aggregate stability, and porosity. The superior performance of sudangrass in response to late termination of fava bean (flowering and podding stages) most likely is associated with larger biomass and higher N of fava bean residues in this treatment (fig. 4).

Legumes, such as fava bean, are only added to cover crop mixes to improve soil N; therefore, any practice that increases their N benefit can be reflected in the performance of succeeding crop in rotation. Parr et al. (2011) studied a combination of legumes

A healthy fava bean grown for fresh pod production in an organic field in Pomona, California. *Photo*: Hossein Zakeri.

and rye (*Secale cereal*) and found that termination at mid-April compared to late May increased N content of some legume cover crops species and improved the performance of succeeding corn (*Zea maize*) crop. Others have demonstrated that legume N fixation is maximized from the end of flowering to pod formation stages.

N fixation of fava bean was maximized 80 days after sowing (after pod formation) and declined sharply thereafter (Herdina and Silsbury 1990). This suggests that fava bean completes its purpose as a cover crop and should be terminated. Under our experimental conditions, the similar biomass and N content of fava bean during flowering and pod termination suggest that fava bean cover crop should be terminated during full flower to early pod, when possible. This practice will allow maximum N accumulation, and likely will allow adequate time for residue decomposition and land preparation of succeeding summer crop.

Flexible harvest options

Fresh pod yield of fava bean in our study was similar in harvesting schemes 1, 2, and 3, suggesting that pod harvest can be scheduled based on labor availability. Here the growers must balance labor costs with the number and timing of harvests. This study shows that waiting until early May to complete a first harvest will give a high fresh pod yield. Avetisyan et al. (2023) showed that availability of fava bean fresh pods in California is low during March and April, peaks in May, and then gradually declines. Although there is scant research about the price of fava bean fresh pod during the season, our observations and communications with growers and gardeners suggest that fava bean price follows the same pattern as other fruits and vegetables, declining when markets are saturated with product (Valpiani et al. 2015).

In case of a lack of market demand or a labor deficit for pod harvesting, growers may consider dual-purpose fava bean production, where a single early vegetable pod harvest can give some economic return before the plant is terminated as a cover crop (Brasier et al. 2023). The use of an early maturing variety such as Vroma or Grano Violetta can provide an economic return through a single fresh pod harvest early in the season, while also providing biomass N returns similar to an unharvested cover crop variety, such as Bell bean.

Growers who are interested specifically in cover crop fava bean should rely on small-seeded varieties like Bell bean. These smaller-seeded varieties are traditionally used as a cover crop due to their small size and low cost per seed compared to large-seeded varieties such as Vroma and Windsor. The smaller seeds allow for more seeds to fit inside a low-cost 25- or 50-pound bag and are less likely to clog a planter than the larger seeds. Plant breeders are currently developing cover crop fava bean varieties that are smaller than Bell bean and can be produced at an economically viable scale to better support growers (Boots-Haupt et al. 2022; Maalouf et al. 2019). The smaller-seeded varieties do not have strong market value as a vegetable and should not be harvested. As such, the variety selection must be made at planting, with growers choosing large-seeded varieties only if they plan to harvest and sell pods.

We also investigated non-chemical approaches to crop management, which intersect vegetable production and cover cropping, by examining timing of planting and termination while also exploring pod harvests.

For more information, growers and gardeners can refer to Oregon State's *Beans, Fava* (2010) and the recently developed *Fava Bean Plant Guide* (NRCS 2021), and *Vegetable Fava Bean Growing Guide for Western United States* by WSARE (Brasier and Zakeri 2023). These provide resources for cultivation, cultural practices, and consumption of fava bean fresh pods. CA

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