Professional Agricultural Workers Journal

Volume 5
Number 2 *Professional Agricultural Workers Journal (PAWJ)* 5

3-14-2018

The Effect of Two Planting Dates and Methods on Snap Bean (Phaseolus Vulgaris) Production in a Tunnel House

Edward Sparks
Tuskegee University, esparks@tuskegee.edu

Victor Khan
Tuskegee University, vkhan@tuskegee.edu

Ramble Ankumah
Tuskegee University, rankumah@tuskegee.edu

James E. Currington
Wiregrass RC&D Council

Nathaniel Ellison
Tuskegee University, nellison@tuskegee.edu

See next page for additional authors

The Effect of Two Planting Dates and Methods on Snap Bean (Phaseolus Vulgaris) Production in a Tunnel House

Authors
Edward Sparks, Victor Khan, Ramble Ankumah, James E. Currington, Nathaniel Ellison, George X. Hunter Jr., and Jeffery L. Moore

THE EFFECT OF TWO PLANTING DATES AND METHODS ON SNAP BEAN (*PHASEOLUS VULGARIS*) PRODUCTION IN A TUNNEL HOUSE

Edward Sparks[1], Victor A. Khan[1], Raymon Shange[1], Ramble Ankumah[1], James E. Currington[2], Nathaniel Ellison[1], George Hunter[1], and Jeffery Moore[1]
[1]Tuskegee University, Tuskegee; [2]Wiregrass RC&D Council, Ozark, AL
***Email of lead author: esparks@tuskegee.edu**
****Email of the corresponding author: vkhan@tuskegee.edu**

Abstract
The study was conducted to evaluate the impact of two planting dates and methods on snap bean yields in a tunnel house. The main plots included planting dates March 17 and 31, 2016 for first and second plantings. The sub-plots consisted of planting Method 1 where one seed per hill was planted every 4” apart, and planting Method 2 where three seeds per hill were planted every 12” apart; each treatment combination was replicated four times. The results of the study showed that it took 55 days for the snap beans to be ready for harvest for both planting dates. Also, there were no significant differences in yields between planting dates, and there were no significant differences in yields between planting methods. This notwithstanding, it may appear that Method 2 would better for weed control because the plants will be well spaced compared to Method 1.
Keywords: Tunnel House, Snap bean Planting Dates, Snap bean Planting Methods, Snap bean Yields

Introduction
Tunnel Houses (THs) are structures framed from wood or metal and covered with clear polyethylene plastic which are used by small producers to extend their growing season through the fall, winter, and early spring (Gent., 1990; Wells., 1993; Khan et al., 1994). These structures are inexpensive to construct and manage, and do not require cooling or heating during the growing season. THs offer many advantages such as protection from rainfall, high winds, and favorable soil temperatures, suitable for growing many cold and cool season crops. The THs also increase production per area of land space and provide a greater accumulation of heat units which increases earliness of production (Khan et al., 1994; Knewtson et al., 2010).

TH research by Khan et al. (1994) in East-Central Alabama has shown that when a TH was planted with cool-season crops, such as Kale (*Brassica oleracea var virdis*), Cabbage (*Brassica oleracea* var capitata), Mustard (*Brassica hirta*), Collards (*Brassica oleracea* var acephala), Turnips (*Brassica rapta*), Broccoli (*Brassica rapa*), and Rutabaga (*Brassica campestris* var rapobrassica) from December 1993 to April 1994, yields ranged from 2,000-3,000 lbs. /2,000 sq. ft. While when other crops, such as early potatoes (*Solanum tuberosum*), tomatoes (*Solanum lycopersicum*), garden peas (*Pisum sativum*), onions (*Allium cepa*), and snap beans (*Phaseolus vulgaris*) were planted, yields ranged from 1,100-3,000 lbs. /2,000 sq. ft.
Currently, the USDA Natural Resource Conservation Service [NRCS] is offering financial assistance to historically underserved producers and beginning farmers to implement various conservation practices, which include TH production (USDA NRCS, 2014a). This incentive program has–brought on a new set of emerging issues for applicants who have been awarded grants under this program, and Extension County Agents are requesting information on the type of crops, spacing distances, pest and disease problems, irrigation schedules, and expected yield for crops grown in THs. As part of meeting this demand for new information, this study was

undertaken. The main objective was to assess the effect of two planting dates and methods on snapbean production in a tunnel house. The specific objectives were to (1) determine the best planting dates for planting bush snapbeans, and (2) determine the best method of planting snap beans, which would increase yield and facilitate ease of cultivation.

Literature Review

Protected agriculture is a distinct, and a specialized form of agriculture, which emerged during the 1950s and it includes such protective measures as greenhouses, tunnel houses (THs), and row covers. The primary purpose in promoting protected agriculture is to adjust the natural environment to produce vegetables, obtain high yields, increase earliness, improve quality, and increase the supply of vegetables when outside production is not possible (Witter and Castilla, 1995). In 1999, there were approximately 800,000 hectares (nearly 2m acres) worldwide under plastic house production with China, Japan, and the Mediterranean, being the leading areas (Knewtson et al., 2010). Carey et al. (2009) surveyed the U.S. and reported that there were 10 THs in the state of Alabama occupying less than one acre of land.

Early protective agricultural work conducted at the George Washington Carver Agricultural Experiment Station, Tuskegee University, centered on the use of clear, black, and white plastic mulches with and without row covers (Wilson et al., 1987; Khan et al., 1994; Khan et al., 1996). The use of these protective measures led to increased yields and earliness of watermelons (*Citrullus lanatus*), cantaloupes (*Cucumis melo* var. cantalupensis), okra (*Abelmoschus esculentus*), and tomatoes (*Solanum lycopersicum*). However, there were limitations, which were not advantageous to the growers, such as annual removal and disposal of the plastic film, and failure to apply mulches if the weather conditions during early spring were unfavorable. These and other factors led researchers (Gent, 1990; Wells, 1993; Khan et al., 1994) to investigate the use of THs as an alternative method of combining the advantages of mulch/row cover systems but avoiding the pitfalls.

Both Gent (1990) and Wells (1993) reported early production and increased yields growing tomatoes (*Solanum lycopersicum)* in unheated THs in Connecticut and New Hampshire during the spring. Meanwhile, in East-Central Alabama Khan et al. (1994) assessed the yields of several crops planted in an unheated TH during the winter of 1992-93 at the George Washington Carver Experiment Station, Tuskegee University. They reported that, of the crops evaluated, snap beans had the highest projected gross income and the highest yield when spaced 4 inches apart compared to 2 and 6 inches. These structures were unheated and not cooled like greenhouses; however, the clear plastic sheeting transmits sunlight which creates the "Greenhouse Effect"; thus, warming the soil to 65-70˚F and raises the ambient temperature within the TH to 15-20˚F above that of the outside ambient temperature (Khan et al., 1994; Blomgren and Frisch, 2007; USDA NRCS., 2014b).

The recommended planting dates for snap beans (*Phaseolus vulgaris*) in Alabama are April and August for fresh market uses (Smith et al., 2013). In a TH study conducted in early March, snapbeans (*Phaseolus vulgaris*) were evaluated at three spacing distances where the seeds were placed at 2, 4, and 6 inches apart. The highest yields were obtained at the 4 inches spacing yielding 387lbs/2,000 sq. ft. of planting area (Khan et al., 1994). Brown et al. (1993) reported that snap beans responded differently when planted in spring compared to fall plantings, when poultry litter was applied versus a commercial fertilizer mixture. Poultry litter treated plots in the spring had lower yields compared to those plots which received the commercial fertilizer. However, in the fall, plots that received poultry litter did better than those receiving the commercial fertilizer.

Snap bean seeds germinate best when the soil temperature ranges between 60-84°F. At the lower spectrum of this range, the seeds will germinate more slowly. However, as the temperature increases above 90°F the flowers would abscise and fall off the plants (University of Tennessee, 1995; University of Georgia, 2013). Degree growing days (DGD) is also important. It is the measure used to determine the time it will take the beans to reach maturity, and it is estimated to range from 1,050-1,150 DGD. This range would vary from year to year depending on the prevailing weather conditions (University of Georgia, 2013).

Materials and Methods

Tunnel House

This study was conducted during the summer of 2016 in a TH located in the Guerryton Community in Bullock County, AL. A TH is a low cost Quonset structure made from wood or metal, polyethylene pipes, and covered with clear greenhouse plastic film, without any supplemental heat or cooling. All planting is done directly in the soil and not in raised beds or containers.

The TH has several unique characteristics, including (1) it is framed entirely of wood with black polyethylene tubing for rafters; (2) it does not have roll up canvas curtains for the sides to allow ventilation; (3) it has swing doors, and (4) it is covered with 6 mils clear greenhouse plastic. The dimensions are 78 ft. long x 22 ft. wide, giving a net planting area of 1,716 sq. ft.

Soil Type

The soil type at the study site is characterized as Norfolk sandy loam (fine, siliceous, thermic Typic, Paleudults). Recently, the soil has been reclassified as Kinston fine-sandy loam (fine-loamy, siliceous, semiactive, acid, thermic Fluvaquentic Endoaquepts) (USDA, 2004).

Tunnel House Site Preparation

The site was rototilled with a mechanical rototiller. Afterwards, the soil was raked and leveled. Each plot was 10 ft. x 1 ft. in dimension. At the time of preparation, a NPK (13-13-13) mix of fertilizer was banded in each plot, based on soil test recommendations. All rows were orientated in a North/South direction, and plastic drip tube irrigation lines (Chapin Drip Tape) were then placed in the center of each row to provide irrigation water to the plants. All plots were irrigated on a two-hour schedule three times per week up to 45 days after planting (DAP) according to the method described by Khan et al. (1996).

Experimental Planting Materials

Snap bean seeds of the variety "Contender" were planted one seed per hill every 4" apart under Method 1, and three seeds per hill every 12" apart under Method 2. This gave a plant density of thirty plants per plot for both methods of planting. All weeds growing between rows were manually controlled.

Field Experimental Design and Data Collection
All plots were arranged into a randomized complete block design with a split-plot arrangement and four replications per treatment (Snedecor, 1966). The main plots were comprised of planting dates (March 17 and 21, 2016), while the sub-plots consisted of planting Method 1 and planting Method 2. Data collected were number of days before seed germination, first blooms, and first harvest.

Harvest Procedure and Statistical Analysis
At 55 DAP, the first harvest of green pods began for both planting dates and methods of planting. This initial harvest was then followed by a second harvest at 62 DAP for both planting dates and methods; thus, giving a total of two harvests. Total yield was obtained by summing the totals from the two harvests. All data were analyzed using Factorial Analysis of Variance with mean separation by Fisher's F test (Snedecor, 1966).

Results and Discussion

Table 1 shows that there were no differences in days to germination, first bloom, and first harvest, based on planting dates. Earlier TH research (Khan et al., 1994) showed that the internal air temperature can be 20˚F warmer, and the soil temperature ranged from 65-70˚F. These temperature regimes were ideal for seed germination, and seedling growth, since the soil and air temperatures reported in the TH were within the ranges recommended by the University of Tennessee (1995), and University of Georgia (2013) for outside field plantings. During the course of this study, daily maximum and minimum temperature were not tabulated; therefore, degree growing days could not be calculated for this study. However, 100% seed germination rate for both planting dates was achieved approximately one month earlier than the recommendations for open field plantings. Generally, in open field plantings there is seldom 100% seed germination because of the existing cool damp conditions, which can give rise to damping-off disease which in severe cases may require some growers to replant their entire fields within a very narrow window of time (University of Tennessee, 1995; University of Georgia, 2013). The other implications of this research point to the fact that for small producers' protective agricultural systems such as THs can reduce risks associated with outside planting by providing near to ideal growing conditions for snap bean production.

Table 2 shows that there were no significant differences in yield for the two planting methods and date of planting. However, irrespective of planting methods, there was an overall reduction of yield at the second planting date. This result could be attributed to the increasing ambient temperature in the TH (Khan et al. 1994), which resulted in flower drop and poor pollen production (University of Tennessee, 1995; University of Georgia, 2013). Also, yields were higher when seeds were spaced 4" apart compared to 12" apart at both planting dates but yields were not significantly different. This finding points to the fact that when seeds were spaced closer (Method 1 vs. Method 2) irrespective of planting dates, yield tended to be slightly higher. This result suggests that if yields were the only consideration, then Method 1 (4" where seeds were 4" apart) would be desired; however, Method 2 (where seeds were space 12" apart) may be preferred, because it allowed for better weed control in spite of the slight reduction in yield.

Table 1. Days to Germination, First Bloom and Harvest of "Contender" Snapbeans Planted in a Tunnel House at Two Planting Dates

Planting Dates	Days to Germination	Days to First Bloom	Days to First Harvest
First Planting (3/17/16)	7 Days (3/24/16) 100%	42 Days after Planting 4/28/16	55 Days after Planting 5/11/16
Second Planting (3/31/16)	7 Days (4/7/16) 100%	42 Days after Planting 5/12/16	55 Days after Planting 5/25/16

The results in Table 2 further indicated that there was a 35% drop in yield between the first and second planting dates under planting Method 1. There was also a 28% drop in yield between the first and second planting dates under planting Method 2 for the first and second planting dates. This drop in production at the second planting date seems to indicate that planting snap beans in TH at the end of March should not be recommended to prospective growers, because of the

Table 2. Mean Yield (lbs./ac) of 'Contender' Snap beans Planted on Two Different Dates and Planting Methods

Planting Methods	Planting Dates		
	15-March (lbs./ac)	31-March (lbs./ac)	Percent reduction in yield (%)
Method 1 (1 Seed/Hill 4" Apart)	1,316	861	35
Method 2 (3 Seeds/Hill 1" Apart)	1,168	838	28
<u>Sig. of F test from ANOVA</u>			
Planting Dates	NS		
Planting Methods	NS		
Date X Methods	NS		

NS = Not significant

increasing ambient and soil temperatures. Additionally, the results suggest that in East-Central Alabama the latest planting date for snap beans should be the middle of March in a TH. Based on the results from this trial in the TH earlier planting dates would be more appropriate for further research.

Conclusion

The results from this study indicated that the yields of snap beans were not significantly affected by planting dates which were two weeks apart. Also, the two methods of planting did not result in any significant yield differences. However, the high reduction in yield between planting dates irrespective of method of planting, strongly suggests that planting snap beans in a TH later than March 17, would not be advisable for prospective TH growers. Also, although planting Method 1 had a tendency to produce slightly more snap beans compared to planting Method 2, in terms of weed control, planting Method 2 will be preferred, since it offers more space between plants to manually control weeds within the TH. Further research utilizing earlier planting dates is recommended to determine the earliest planting date growers should use to plant snap bean in their THs.

Acknowledgement

This study was funded by USDA National Institute of Food and Agriculture (NIFA), Food Research Initiative Competitive Grant, Number 35.31244158; USDA/NIFA/Extension Grant, Number 36.22091431; USDA/NIFA/Evans/Allen Research Grant, and Alabama/ANGA Grant, Number 80.22090210. The authors would like to thank the Carver Integrative Sustainability Center, Tuskegee University, AL for supporting the study.

References

Blomgren, T. and T. Frisch. (2007). High Tunnels: Using Low-Cost Technology to Increase Yields, Improve Quality and Extend the Season. Center for Sustainable Agriculture, University of Vermont, Burlington, VT.

Brown, J. E., C. H. Gilliam, and R. L. Shumack. (1993). "Commercial Snap Bean Response to Fertilization with Broiler Litter." *Hortscience* 28 (1): 29-31.

Carey, E.E, L. Jett, W. J. Lamont Jr., T. T. Nennich, M. D. Orzolek, and K. A. Williams. (2009). "Horticultural Crop Production in High Tunnels in the United States: A Snapshot." *HorTechnology* 9 (1): 37-43.

Gent, P. N. (1990). "Early Tomato Production in Unheated Polyethylene Hoop Houses in Connecticut: Effects of Air and soil Temperatures." *National Agricultural Plastics Congress* 22: 135-140.

Khan, V.A., C. Stevens, M.A. Wilson, D.J. Collins, E.G. Rhoden, and J.Y. Lu. (1996). "Effects of clear and black polyethylene mulches on vine production of two cultivars of sweet potatoes." *Proceedings 26th National Agricultural Plastics Congress*. 26: 87-92.

Khan, V.A., C. Stevens, M.A. Wilson, J.E. Brown, D.J Collins, J.Y. Lu, and E.G. Rhoden. (1994). "Walk-in-Tunnels as an Alternative Method of Extending the Growing Season for Small Scale Vegetable Producers in Alabama". *American Society for Plasticulture* 25: 117-121.

Knewtson, S.J.B, E.E. Carey, and M.B. Kirkham. (2010). "Management Practices of Growers Using High Tunnels in the Central Great Plains of the United States". *HorTechnology* 20: 629-645.

Smith, K., M.B. Musgrove, J. Kemble, E. Bauske, D. Williams, and D. Bond. (2013). Planting Guide for Home Gardening in Alabama. Publication Number ANR-0063, Alabama Cooperative Extension Service, Auburn, AL.

Snedecor, W. G. (1966). *Statistical Methods*. Ames, IA: Iowa State University Press.

USDA NRCS. (2014a). "Environment Quality Incentive Program." http://www.nrcs.usda [Retrieved August 27, 2017].
USDA NRCS. (2014b). Planting in a High Tunnel. USDA NRCS, Washington D.C.
USDA. (2004). Soil Survey Manual. USDA Handbook 19. USDA, Washington D.C.
University of Georgia. (2013). "Commercial Snap Bean Production in Georgia." Bulletin 1369, Cooperative Extension Service, Athens, GA.
University of Tennessee. (1995). "Commercial Bush Snapbean Production." Publication Number PB-897, Agricultural Extension Service, Knoxville, TN.
Wells, O. S. (1993). "High Tunnels for Early Spring or Late Fall Production of Tomatoes and Other Crops." *Proceedings American Society of Plasticulture*. 24: 76-82.
Wilson, M.A., P. Molahlane, V.A. Khan, and C. Stevens. (1987). "Influence of Earliness and Yield of Watermelons and Muskmelons on Row Covers and Black Plastic." *Proceedings National Agricultural Plastics Congress*. 20: 264-269.
Witter, S.H., and N. Castilla. (1995). "Protected Cultivation of Horticultural Crops Worldwide." *HorTechnology* 5 (1): 6-23.