The Pharma Innovation Journal 2022; 11(6): 740-744

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(6): 740-744

www.thepharmajournal.com
Received: 02-04-2022
Accepted: 10-05-2022

A Jaffer Sadhik
Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

S Kavitha
Department of Plant Genetic Resources, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

J Renugadevi
Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

R Umarani
Seed Centre, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

V Manonmani
Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

M Ananthi
Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Corresponding Author:
S Kavitha
Department of Plant Genetic Resources, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

High density planting on flowering, seed filling, seed yield and quality of cotton

A Jaffer Sadhik, S Kavitha, J Renugadevi, R Umarani, V Manonmani and M Ananthi

Abstract

Field Experiment was conducted to study the different plant spacing *viz.*, wide (90 x 45 cm), medium (60 x 30 cm) and closer spacing (45 x 15 cm) on crop growth, flowering, seed filling, yield and resultant seed quality in cotton revealed that a closer spacing of 45 x 15 cm produced more number of plants plot^{-1} (177) and taller plants (85.6 cm) when compared to medium (60 x 30 cm) and wider spacing (90 x 45 cm). The wider spacing (90 x 45 cm) has taken lesser number of days for flower initiation (47 days) and 50 per cent flowering (57 days). The same spacing had also recorded higher chlorophyll content, more number of monopodial branches (2.2) however; maximum number of sympodial branches per plant (10.7) was recorded by closer spacing (45 x 15 cm). More number of flowers and bolls plant^{-1}, highest kapas and seed yield plant^{-1} were recorded in wider spacing of 90 × 45 cm (68, 18.8, 64.78 g and 45.77 g, respectively) than the other two spacings. However, higher kapas and seed yield ha^{-1} (5709.1 kg and 3741.6 kg, respectively) was recorded in closer spacing because of more number of plants due to closer spacing. The resultant seed quality analysis revealed that 100 seed weight, seed germination, dry matter production and vigour index were higher in wider plant spacing of 90 x 45 cm (7.89 g, 80%, 4.77 g seedling^{-10} and 2584, respectively) than medium (60 x 30 cm) and closer spacing (45 x 15 cm).

Keywords: Cotton, plant spacing, seed yield, quality

1. Introduction

Cotton (*Gossypium sp.*) is an important fibre crop cultivated in tropical and sub-tropical regions of more than seventy countries (Ali *et al.*, 2009) [2]. Cotton has a unique name and fame as "King of Fibers" and "White Gold" because of its high economic value among cultivable annual crops. It provides employment opportunities to about 70 million people and contributes nearly 75 per cent of total raw material to the textile industry in India. It is the backbone of the flourishing textile industry in India (O'Brien *et al.*, 2005) [13]. The production and productivity of cotton remained low until recent years. Further improvements in cotton yields are possible only through changes in agronomic management and cropping systems. Due to mobilization of nutrients to the developing bolls the vegetative growth is restricted and the canopy size reduced, offering scope for planting cotton at higher planting densities in India (Balkcom *et al.*, 2010) [5]. The manipulation of row spacing, plant density and the spatial arrangements of cotton plants for obtaining higher yield have been attempted by scientists for several decades in many countries. The concept of high density cotton planting, more popularly called as Ultra Narrow Row (UNR) cotton (Briggs *et al.*,1967) [7]. High Density Planting Systems (HDPS) are commonly followed to obtain high yields with straight varieties across the world especially in the major cotton growing countries (Anjum *et al.*, 2010) [4]. The availability of compact genotypes, acceptance of weed and pest management technologies including transgenic, development of stripper harvesting machines and widespread application of growth regulators have made these high density cotton production systems.

The obvious advantage of this system is earliness and UNR needs less bolls per plant to achieve the same yield as conventional cotton and the crop does not have to maintain the late formed bolls to mature. The UNR cotton plants produce fewer bolls than conventionally planted cotton but retain a higher percentage of the total bolls in the first sympodial position and a lower percentage in the second position (Vories and Glover, 2006) [17]. The other advantages include better light interception, efficient leaf area development and early canopy closure which will shade out the weeds and reduce their competitiveness (Wright *et al.*, 2011) [18]. The early maturity in soils that do not support excessive vegetative growth can make this system ideal for shallow to medium soils (Jost and Cothren, 2001) [10].

Hence, the performance of cotton crop with reference to different spacing needs to be studied well in order to understand the effect of plant density on crop growth, seed yield and quality (Basanagouda and Patil, 2007) [6]. High Density Planting System (HDPS) is now being conceived as an alternate production system having a potential for improving the productivity and profitability, increasing input use efficiency, reducing input costs and minimizing the risks associated with the current cotton production system (Brodrick *et al*., 2012) [8]. Keeping the above facts in the view, the present study was carried out to determine the influence of plant spacing on flowering, seed filling, yield and resultant seed quality of cotton *cv.* MCU 12.

2. Materials and Methods

Seeds of cotton *cv*. MCU 12 were obtained from the Department of Cotton, Tamil Nadu Agricultural University, Coimbatore. Field experiments and laboratory experiments were conducted at the Department of Seed Science and Technology, Tamil Nadu Agricultural University, Coimbatore. The University campus and the experimental site is geographically situated in the North Western agro-climatic zone of Tamil Nadu at 11° N latitude and 77° E longitude and at an altitude of 426.7 meters above mean sea level (MSL). The nutrient status of soil at the beginning of experiment was low in available nitrogen (192 kg ha^{-1}), medium in available phosphorus (17.2 kg ha^{-1}) and high in available potassium (520 kg ha^{-1}). The cotton crop was raised at different plant spacing of wider 90 x 30 cm (T_1), medium 60 x 30 cm (T_2) and closer 45 x 15 cm (T_3) spacing with seven replications in a Randomized complete Block Design (RBD) having a net plot area of 4 x 3 m. The crop was given 6-7 irrigations whereas phosphorous and nitrogenous fertilizer was applied at recommended dose of 112 and 56 kg / ha, respectively. Phosphorus was applied in the form of DAP at the time of sowing and nitrogen in the form of urea was incorporated in three splits i.e., during 2nd, 3rd and 4th irrigations. All the required cultural operations were adopted throughout the crop growing period uniformly in all the treatments. For recording biometric observations five plants were selected randomly from each treatment for recording crop growth, flowering, seed yield and yield attributing characters and resultant seed quality. The data was collected from various experiments were analyzed statistically adopting the procedure (Panse and Sukatme, 1985) [14].

3. Results and Discussion

3.1 Effect of plant spacing on plant growth parameters

The study to determine the effect of various plant spacings (90 x 45 cm, 60 x 30 cm and 45 x 15 cm) on crop growth, seed yield and quality in cotton *cv.* MCU 12 revealed that among the plant spacing, a wider spacing (90 x 45 cm) produced more number of plants per plot (177) than medium (60 x 30 cm) and closer spacing (45 x 15 cm) which produced 66 and 29 plants, respectively. Increase in plant population with decrease in plant spacing. The number of monopodial and sympodial branches per plant is a key factor which contributes to the final yield. The minimum number of monopodial branches (1.2) was obtained with plant spacing of 45 x 15 cm whereas the maximum (2.2) was achieved in wider spacing of 90 x 45 cm. The reduced number of monopodial branches in closer spacing of could be attributed due to competition for space. The results are in line with those who reported lower number of monopodial branches with closer spacing (Alfaqeih *et al*., 2002; Ali *et al*., 2009) [1, 2]. The yield is directly related to the number of sympodial branches $plant^{-1}$. More the number of sympodial branches per plant more will be the yield. The closer spacing of 45 x 15 cm gave the maximum number of sympodial branches per plant (10.7) and the minimum (1.2) was registered by 90 x 45 cm (wider spacing). A closer and medium spacing of 45 x 15 cm and 60 x 30 cm produced taller plants (85.6 cm and 79.4 cm, respectively) than a wider spacing of 90 x 45 cm (76.2 cm) (Table 1). In general the plant height increased with decrease in plant spacing. This might be due to competition for light. Earlier studies have also revealed an increase in plant height due to high plant density (Ali *et al*., 2011; Nehra and Yadav, 2012) [3, 12].

Significant advancement in the phenological stages of cotton was observed due to the effect of plant spacing. Among the plant spacings, wider spacing and medium spacing of 90 x 45 and 60 x 30 cm, respectively required lesser number days for flower initiation (47 days) and it attained 50 per cent flowering two and three days earlier (57 and 58 days in 90 x 45 and 60 x 30 cm, respectively) than closer spacing of 45 x 15 cm (60 days). This might be due to the less competition for resources. The plants sown at wider spacing reduced cropping time due to earlier flowering. More number of days to attain 50 per cent flowering due to closer spacing might be due to the insufficiency of source and transformation of reproductive phase, as sufficient photosynthates would not have been supplied for the developing sinks. The plant spacing of 90 × 45 cm had more number of flowers and bolls (68 and 18.8, respectively) than 60 x 30 cm (66 and 16.3, respectively) and 45 x 15 cm spacing (64 and 11.9, respectively) (Table 1). This might be to the better assimilation of nutrients and optimum plant density without any population pressure. The enhanced availability of nutrients to the crop at optimum density helped in improved growth and expression in terms of yield (Buttar and Sudeep Singh, 2007, Jaffer Sadhik *et al*., 2022) [9, 11].

Table 1: Effect of plant spacing on crop growth, flowering and boll production in cotton *cv*. MCU 12

Treatments	No. of plants/plot	No. of monopodial branches $plant^{-1}$	No. of sympodial branches $plant^{-1}$	Plant height (cm)	Days to flower initiation	Days to 50% flowering	No. of flowers $plant^{-1}$	No. of bolls $plant^{-1}$
T_1 (90 X 45 cm)	29	2.5	11.0	103.2	47	57	68	18.8
T_2 (60 X 30 cm)	66	2.1	12.3	105.9	47	58	66	16.3
T_3 (45 X 15 cm)	177	1.3	15	116.6	48	60	64	11.9
Mean	90.7	2.0	12.8	108.5	47	58	66	15.7
S.Ed	0.436	0.031	0.088	0.504	0.41	0.53	0.74	0.47
CD (P=0.05)	0.950**	0.062**	0.176**	1.003**	0.910**	1.16**	1.62**	1.04**

Chlorophyll is an important primary pigment which absorbs solar energy and converts into chemical energy. It consists a major portion of both the pigment system-I and pigment system-II, the increase of chlorophyll would be advantages for efficient exploitation of the available radiant energy. The chlorophyll content was found to increase from 30 to 90 days after sowing (DAS). This indicated that the chlorophyll synthesis as well as the photosynthetic activity was more at flowering to boll formation stages in cotton (Rhoads and McIntosh, 1991) [15]. Among the spacings, higher chlorophyll content (35.68 mg/g^{-1}) was recorded under 90 x 45 cm (T_1). Interaction between plant spacing and growth stage showed that wider spacing (90 x 45 cm) at 90 DAS recorded maximum chlorophyll content of 45.53 mg/g^{-1}. The minimum chlorophyll content of 24.27 mg/g^{-1} was recorded in closer spacing (T_3) at 30 DAS (Fig 1). The total chlorophyll content determines the photosynthetic capacity of the crop and influences the rate of photosynthesis, dry matter production and yield (Krasichkova *et al*. 1989; Akhteruzzaman *et al*. 2021) [1, 11].

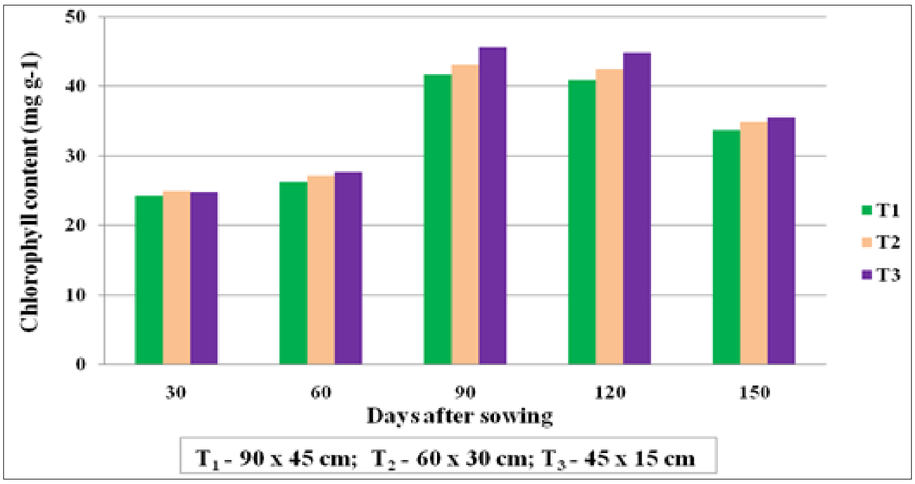

Fig 1: Effect of plant spacing on chlorophyll content (mg g^{-1}) at various stages of crop growth in cotton *cv.* MCU 12

3.2 Effect of plant spacing on seed yield and yield attributes: The plant spacing also exhibited significant differences for number of seeds, filled and ill filled seeds per plant. More number of seeds of 738 was recorded in wider spacing (90 x 45 cm) and followed by 625 in medium spacing (60 x 30 cm) and less number of seeds of 449 was recorded in closer spacing (45 x 15 cm). Similarly, more number of filled seeds plant^{-1} were recorded in wider spacing (90 x 45 cm). Hundred seed weight is the key factor contributing to the seed yield. The perusal of the data on 100 seed weight indicated that it differed significantly with respect to plant spacing. The seeds obtained from the plant spacing of 90 x 45 cm recorded maximum 100 seed weight (7.89 g) followed by 60 x 30 cm (7.53 g). The minimum 100 seed weight (7.27 g) was recorded by the seeds obtained from the closer spacing of 45 x15 cm (Fig 2).

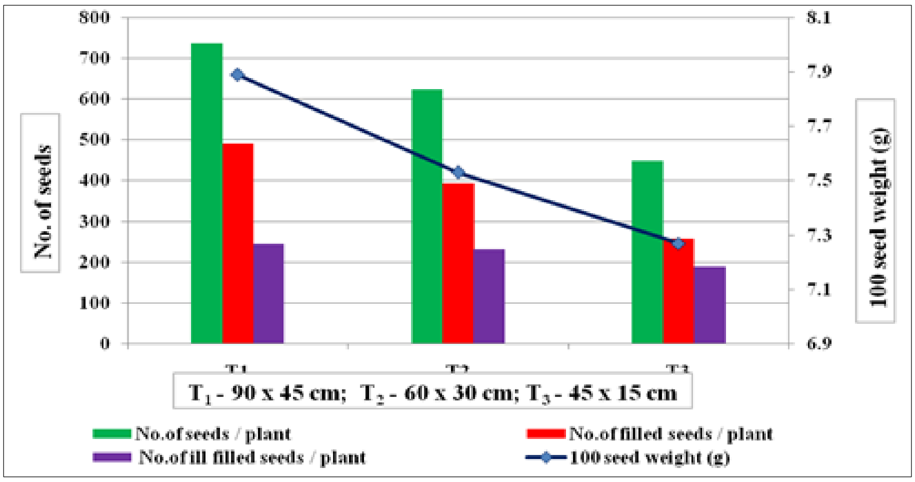

Fig 2: Effect of plant spacing on no. of seeds plant^{-1}, no. of filled seeds plant^{-1}, no. of ill filled seeds plant^{-1} and 100 seed weight (g) of resultant seed in cotton *cv.* MCU 12

The final yield is the function of combined effect of all the yield components. The highest kapas yield of 64.78 g was recorded in wider plant spacing (90 x 45 cm) and the lowest kapas yield (38.71 g) was recorded in closer spacing of 45 x 15 cm. With respect to seed yield, the highest seed yield of 45.77 g was recorded in wider spacing of 90 x 45 cm followed by 60 x 30 cm (38.90 g) and the lowest seed yield (25.37 g) was recorded in closer spacing of 45 x 15 cm (Table 2). This is in conformity with the findings that maximum seed cotton yield was recorded with 75 cm row spacing followed by 60 cm row spacing (Anjum *et al*., 2010) [4]. From the generated data it is clearly understood that in optimum plant density, the competition between the plants are also found to be lesser. Another factor is that wider spacing paved a way for enhanced availability of nutrients to the crop and increased the nutrient uptake which helped in improved crop growth, which in turn was expressed in terms of yield (Saleem *et al*., 1989, Leena *et al*., 2018) [13, 16].

Closer spacing (high density planting) of 45 x 15 cm recorded higher kapas and seed yield per hectare (5709.1 kg ha^{-1} and 3741.6 kg ha^{-1}, respectively). The wider spacing (90 x 45 cm) recorded lower kapas and seed yield of 1565.8 kg ha^{-1} and 1105.8 kg ha^{-1}, respectively. The plant spacing of 60 x 30 cm remained midway between the treatments 90 x 45 cm and 45 x 15 cm (Table 2). The increase in yield ha^{-1} in closer spacing might be due to more plant population over wider spacing in the experiment (Pradeep Kumar *et al*., 2017) [17].

Table 2: Effect of plant spacing on Kapas yield, seed yield and resultant seed quality in cotton *cv*. MCU 12

Treatments	Kapas yield plant^{-1} (g)	Kapas yield ha^{-1} (kg)	Seed yield plant^{-1} (g)	Seed yield ha^{-1} (kg)	Resultant seed quality characteristics			
					100 seed weight (g)	Seed germination (%)	Dry matter production (g seedling^{-10})	Vigour index
T_1 (90 X 45 cm)	64.78	1565.8	45.77	1105.8	7.89	80 (63.4)	4.77	2584
T_2 (60 X 30 cm)	54.05	2972.5	38.90	2139.1	7.53	76 (60.6)	4.42	2378
T_3 (45 X 15 cm)	38.71	5709.1	25.37	3741.6	7.27	72 (58.0)	4.36	2224
Mean	52.51	3415.8	36.68	2328.8	7.56	76.09 (60.6)	4.52	2395
S.Ed	0.46	1.02	0.28	0.68	0.48	0.293	0.010	38.26
CD (P=0.05)	1.00**	2.23**	0.61**	1.48**	0.105**	0.616**	0.022**	80.39**

3.3 Effect of plant spacing on resultant seed quality
The maximum germination, dry matter production and vigour index of 80%, 4.77 g seedling^{-10} and 2584, respectively was recorded in the resultant seeds obtained from wider spacing (90 x 45 cm) while it was 76%, 4.42 g seedling^{-10} and 2378, respectively in medium spacing (60 x 30 cm) and 72%, 4.36 g seedling^{-10} and 2224, respectively in closer spacing (45 x 15 cm). (Table 2). This might be due to wider spacing paved a way for enhanced availability of nutrients to the crop because of lesser competition for resources and increased the nutrient uptake which helped in improved crop growth, seed filling, 100 seed weight, which in turn was expressed in terms of yield and resultant seed quality.

4. Conclusion
Cotton sown at wider spacing of 90 x 45 cm recorded the higher number of monopodial branches, early flowering, more number of flowers, bolls, higher percentage of filled seeds, more kapas and seed yield plant^{-1} over medium (60 x 30 cm) and closer spacing (45 x 15 cm). On the contrary, closer spacing of 45 x 15 cm (high density planting) has helped to maintaining more number of plants per unit area that enable to increase the kapas and seed yield per ha over wider spacing in the experiment.

5. References

1. Akhteruzzaman, Mong Sanue Marma, Fahinur Rahman Shatil. Influence of Various Plant Spacing on Plant Population and Yields of Cotton (*Gossypium Arboreum* L.). International Journal of Progressive Sciences and Technologies. 2021;29(1):84-88.
2. Alfaqeih FM, Ali AM, Baswaid AS. Effect of plant density on growth and yield of cotton. University of Aden Journal of Natural and Applied Sciences. 2002;(6):279-285.
3. Ali A, Tahir M, Ayub M, Ali I, Wasaya A, Khalid F. Studies on the effect of plant spacing on yield of recently approved cotton varieties. Pakistan Journal of Life and Social Sciences. 2009;7(1):25-30.
4. Ali H, Afzal MN, Ahmad F, Ahmad S, Akthar M, Atif R. Effect of sowing dates plant spacing and nitrogen application on growth and productivity on cotton crop. International Journal Science and Engineering Research. 2011;2(9):1-6.
5. Anjum SA, Saleem MF, Wang L, Xue L, Shahid MQ, Ali S. Growth, lint yield and earliness index of cotton (*Gossypium hirsutum* L.) Cultivars under varying row spacing. Journal of Cotton Science. 2010;22(6):611-616.
6. Balkcom KS, Price AJ, Santen EV, Delaney DP, Boykin DL, Arriaga FJ, Bergtold JS, Kornecki TS, Raper RL, Row spacing, tillage system and herbicide technology affects cotton plant growth and yield. Field Crops Research. 2010;117:219-225.
7. Basanagouda, Patil C. Performance of compact cotton genotypes (*Gissypium hirsutum*) at three spacing and two moisture levels. The World Cotton Research Conference-4, Seminar proceedings. Lubbock, 2007 September 10-14.
8. Briggs RE, Patterson LL, Massey GD. Within and between-row spacing of cotton. Arizona Annual Report. University of Arizona Agricultural Extension Service, Arizona, 1967, 6-7pp.
9. Brodrick R, Bange MP, Milroy SP, Hammer GL. Physiological determinants of high yielding ultra-narrow row cotton: Biomass accumulation and partitioning. Field Crops Research. 2012;134:122-129.
10. Buttar GS, Sudeep Singh. Effect of date of sowing and plant spacing on growth and yield of desi cotton (*Gossypium arboreum* L.). Journal of Cotton Research Development. 2007;21(1):49-50.
11. Jaffer Sadhik A, Kavitha S, Renugadevi J, Ananthi M. Effect of Plant density and Branching pattern on Cotton Seed Yield Components and quality. Biological Forum – An International Journal. 2022;14(1):502-507.
12. Jost PH, Cothren JT. Phenotypic alterations and crop maturity differences in ultra-narrow row and conventionally spaced cotton. Crop Science. 2001;41:1150-1159.
13. Krasichkova GV, Asoeva LM, Giller Yu E, Singinov BS. Photosynthetic system of G. barbadense at the early stages of development. Nauk Imen V.I. Lenina. 1989;12:9-11.
14. Leena Parihar B, Rathod TH, Paslawar AN, Kahate NS. Effect of High Density Planting System (HDPS) and Genotypes on Growth Parameters and Yield Contributing Traits in Upland Cotton. Int. J Curr. Microbiol. App.

Science. 2018;7(12):2291-2297.
15. Nehra PL, Yadav PS. Effect of spacing and fertilizer levels on *Hirsutum* cotton variety H 1300 in canal command area of North West Rajasthan. Journal of Cotton Research and Development. 2012;26(2):207-208.
16. O'Brien RD, Jones LA, King CC, Wakelyn PJ, Wan PJ. Cotton seed oil. In: F. Shahidi (ed.). Bailey's Industrial Oil and Fat Products. 6th Edition. John Wiley & Sons, Inc, 2005, 173-279pp.
17. Panse VG, Sukatme PV. Statistical methods for agricultural workers. ICAR Publication, New Delhi, 1985, 359.
18. Pradeep Kumar, Karle AS, Deshraj Singh, Lalita Verma. Effect of High Density Planting System (HDPS) and Varieties on Yield, Economics and Quality of Desi Cotton. Int. J Curr. Microbiol. App. Science. 2017;6(3):233-238.
19. Rhoads DM, McIntosh L. Isolation and characterization of a cDNA clone encoding an alternative oxidase protein of *Sauromatum guttatum*. In: (Schott). Proceedings of the National Academy of Sciences. United States of America. 1991;88:2122-2126.
20. Saleem MF, Anjum SA, Shakeel A, Ashraf MY, Khan HZ. Effect of row spacing on earliness and yield in Cotton. Pakistan Journal of Biological Sciences. 2009;41(5):2179-2188.
21. Vories ED, Glover RE. Comparison of growth and yield components of conventional and ultra-narrow row cotton. Journal of Cotton Science. 2006;10:235-243.
22. Wright DL, Marois JJ, Sprenkel RK, Rich JR. Production of ultra narrow row cotton. University of Florida (UF), IFAS Extension. SSAGR-83, 2011.