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HF Patel
Department of Horticulture
Polytechnic, Navsari
Agricultural University, Paria,
Gujarat, India

SK Attar
Department of Horticulture
Polytechnic, Navsari
Agricultural University, Paria,
Gujarat, India

AI Makwana
Department of Horticulture
Polytechnic, Navsari
Agricultural University, Paria,
Gujarat, India

JK Bana
Department of Horticulture
Polytechnic, Navsari
Agricultural University, Paria,
Gujarat, India

LJ Desai
Department of Horticulture
Polytechnic, Navsari
Agricultural University, Paria,
Gujarat, India

Corresponding Author:
HF Patel
Department of Horticulture
Polytechnic, Navsari
Agricultural University, Paria,
Gujarat, India

Effect of intra row spacing and weed management in cotton (*Gossypium hirsutum* L.) and their quality parameters and residual effect of summer green gram

HF Patel, SK Attar, AI Makwana, JK Bana and LJ Desai

Abstract
A field experiment was conducted at College farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) to evaluate the effect of intra row spacing and weed management in cotton and their quality parameter and residual effect of summer green gram. The results showed that treatments W_4 (weed free) recorded maximum plant height (125.0 cm), number of bolls (33.0), bolls weight (4.13g) and seed yield (2578kg/ha). Minimum in W_1 (Unwedded control) and at par with W_3 same as spacing. Availability of quality character was significantly not influenced during both years It was observe W_4 and W_5 treatments in cotton enhanced more yield, maximum weed control pooled basis was found in order of W_4< W_3< W_5< W_6<W_2< W_7<W_1 and their quality parameter Ginning percentage, seed index and lint index herbicide through spacing and weed management treatments were Non-significant results all the treatments.

Keywords: Weed management, cotton and yield

Introduction
Cotton is one of the momentous and an important cash crop exercising profound influence on economics and social affairs of the world. Any other fiber crop cannot compare with cotton for its fiber quality. It is one of the few crop species that were domesticated in both the old and new World possessing great importance as a multipurpose crop that supplies five basic products: lint, oil, seed meal, hulls and linters. India contributes 80% of total yield in the world. India ranks first in area and second in production of cotton in the World. Gujarat, Maharashtra, Haryana Na, Punjab, Rajasthan, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu are the major cotton growing states in India. It is planted 110 lakh hectares with 325 lakh bales (each of 170 kg) production and 503 kg/ha productivity. In Gujarat state, 26.20 lakh hectares area comes under cotton cultivation with 106.82 lakh bales production. The average productivity of cotton in Gujarat is 693 kg/ha which is higher than the national average (Anon., 2010-11) [2]. But lower than the world average. Looking to the world average productivity of this crop, there is huge scope for Gujarat.

The yield potential of this crop can be exploited by adopting high yielding Bt cotton varieties coupled with improved agro techniques, where proper spacing and weed management are the most importance practices in this regard. Optimum plant population through proper spacing provide sufficient space for better root proliferation as well as vegetative growth and development also minimize plant to plant competition only reflecting in better yield. Proper spacing not provide only optimum plant population but also helps in checking the weed growth which is one of the most yield limiting factor in cotton. In weed management, research evidences indicate that no one method found completely effective in controlling variety of weed growing in this crop. Though mechanical method are simple and effective they are not feasible every time looking to soil and crop conditions and also time consuming and laborious. In such circumstances integrated approach is one of the options where judicious combination of two or more than methods is adopted. According to Chander *et al.* (1994) [4] herbicide alone in combination with one hand weeding reduced the dry weight and nutrient uptake by weeds significantly. Spark (1997) [16] reported Pendimethalin, glyphosate, Quizalofop -p- ethayl and sodium Pyrithiobac as Promising herbicide in cotton. Shetly (1997) [14] reported that use of herbicide found beneficial where manual or mechanical weed control is difficult because of wet soil condition. Thus, it becomes essential to find out the optimum spacing and weed management for the specific Bt-cotton variety grown in the south Gujarat region.

Materials and Methods

The experiment was conducted at College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, and Gujarat during the kharif season. The cotton crop was fertilized with a basal dose of 10 t FYM ha $^{-1}$ and 240 N kg ha^{-1}.

Treatment details

Main plot treatments Spacing (S)S_1 - 120 cm x 30 cmS_2 - 120 cm x 45 cmS_3 - 120 cm x 60 cm Sub plot treatments Weed management (W) W_1- Unweeded control W_2- Glyphosate @ 1.0kg/ha protected spraying at 30 and 60 DASW_3- Pendimethalin @ 1.0 kg/hapre-emrgence + hand weeding at 30 and 60 DASW_4- Hand weeding and inter culturing at 20, 40 and 60 DAS (weed free)W_5 -Pendimethalin @ 1.0 kg/ha + quizalofop-p ethyl @ 0.05 kg/ha at 30 DASW_6- Pyrithiobac sodium @ 0.04 + hand weeding at 30 DAS W7- Pyrithiobacsodium (Hitweed 10% EC) @ 0.04 + quizalofop ethayl (Turga super 5% EC) @0.05 kg/ha at 30 DAS3.10.1Ginning ercentage Laboratory modelgin designed by the Cotton Technological Research Laboratory, umbai was used for ginning the seed cotton samples for estimation of ginning percentage. Bulk produce of seed cotton of each plot was ginned. Seed and lint were weighed separately and ginning percentage was calculated by using the following formula. Ginning Percentag = eight of lint (g)/ Weight of lint (g) + Weight of seed (g)*100. Seed index (g)From the seed cotton samples taken to determine ginning percentage, 100 matured healthy seeds from each individual sample were taken randomly and weighed in gr am on pan balance and recorded for each plot as seed index Lint index (g)The lint index represents the absolute weight of lint produced by 100 seeds in grams. It was computed using the formula of Hutchinson and Ramiah (1938) [21]. Lintindex (g) = Seed index (g) x Ginning percentage/100- Ginning percentage

Results and Discussion

Effect of spacing

Spacing has significant impact on plant height, Number of bolls, Boll weight seed yield and stalk yield during all growth stages of the crop during both the years and in pooled results. All treatments of spacing differed significantly among each other and independent in their effect on plant height, Number of bolls, Boll weight, seed yield and stalk yield in the year 2010-11 and in pooled results and they remain in S 3 > S2> S1 order of their significance while in the year 2011 - 12 treatments S3 (120 x 60 cm) and S2 (120 x 45 cm) were statistically on par but found significantly superior to S 1. Significantly the lowest plant height number of bolls, Boll weight, seed yield and stalk yield was observed under wider spacing of 120 x 30 cm (S 1) during all the crop growth stages during both the years and in pooled results. The results revealed that the Ginning percentage, seed index and lint index various treatments of spacing showed non-significant differences during both the years and in pooled results (Table-1).

Table 1: Number of bolls per plant and in cotton as influenced by various treatments of spacing and weed management

Treatments	Number of bolls per plant			Boll weight per plant		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled
Spacing (S)						
S_1-120 cm x 30 cm	18.95	18.83	18.89	4.09	4.10	4.09
S_2-120 cm x 45 cm	29.21	29.36	29.28	4.10	4.10	4.10
S_3-120 cm x 60 cm	40.57	40.57	40.57	4.10	4.10	4.10
S. Em±	0.84	0.83	0.83	0.10	0.09	0.09
C.D at 5%	2.92	2.86	2.89	0.28	0.28	0.28
C.V.%	13.07	12.80	12.93	10.66	10.66	7.84
Weed management practices (W)						
W_1- Unweeded control	24.56	24.56	24.56	4.03	4.05	4.04
W_2 - Glyphosate@1.0kg/ha protected spraying at 30 and 60 DAS	28.56	28.28	58.42	4.10	4.10	4.10
W_3- Pendimethalin@1.0kg/hapre-emrgence + hand weeding at 30 and 60 DAS	32.22	32.22	32.22	4.13	4.12	4.12
W_4- Hand weeding and inter culturing at 20, 40 and 60 DAS (weed free)	33.78	33.78	33.78	4.13	4.14	4.13
W_5 -Pendimethalin @ 1.0kg/ha + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	31.44	31.44	31.44	4.12	4.12	4.12
W_6- Pyrithiobac sodium @ 0.04 +hand weeding at 30 DAS	28.89	29.89	29.39	4.11	4.11	4.11
W_7- Pyrithiobac sodium @ 0.04 + quizalofop-p ethyl @ 0.05kg/ha at 30DAS	26.61	26.94	26.77	4.07	4.07	4.07
S.Em±	0.96	0.97	0.96	0.07	0.07	0.07
C.D at 5%	2.75	2.78	2.76	0.20	0.20	0.20
C.V.%	9.74	9.84	9.65	6.84	5.29	5.88
Interaction	NS	NS	NS	NS	NS	NS

Table 2: Stalk cotton yield and seed cotton yield in cotton as influenced by various treatments of spacing and weed management

Treatments	Stalk cotton yield (g)/plant			Seed cotton yield (kg)/ha		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled
Spacing (S)						
S_1-120 cm x 30 cm	136.54	139	137.78	3654	3717	3685
S_2-120 cm x 45 cm	208.57	216.7	212.65	3709	3737	3723
S_3-120 cm x 60 cm	282	285.50	283.7	3712	3749	3730
S. Em±	4.77	4.98	4.87	126	96	112
C.D at 5%	16.49	17.22	13.97	363	27	322
C.V.%	10.45	10.67	10.56	15	11	13
Weed management practices (W)						
W_1- Unweeded control	197.33	202.77	200.05	3220	3520	3370

W_2 - Glyphosate@1.0kg/ha protected spraying at 30 and 60 DAS	204.13	218.42	211.2	3632	3679	3656
W_3- Pendimethalin@1.0kg/ha pre-emergence + hand weeding at 30 and 60 DAS	214.48	216.02	215.24	3773	3804	3788
W_4- Hand weeding and inter culturing at 20, 40 and 60 DAS (weed free)	215.80	218.56	217.17	3883	3939	3911
W_5 -Pendimethalin @ 1.0kg/ha + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	215.37	217.20	216.28	3765	3774	3769
W_6- Pyrithiobac sodium @ 0.04 +hand weeding at 30 DAS	207.79	211.87	216.28	3673	3728	3700
W_7- Pyrithiobac sodium @ 0.04 + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	208.37	211.47	209.82	3623	3640	3631
S.Em±	5.12	5.11	5.11	230	145	192
C.D at 5%	14.69	14.66	14.67	660	417	276
C.V. %	10.44	10.63	10.54	18	11	15
Interaction	NS	NS	NS	NS	NS	NS

Effect on yield and yield attributes

Various parameter of yield *viz*; number of bolls per plant, boll weight per plant, seed cotton yield and stalk yield play a vital role in increasing the productivity of cotton crop. All the above mentioned yield attributing characters (Table 1 and 2) were significantly influenced by spacing. Higher spacing at 120 cm × 60 cm (S_3) recorded significantly higher value for all the above characters, which was closely followed by S_2 (120 cm × 45 cm). The better development of various yield attributes in wider to medium spacing levels might be due to low degree of inter plant competition for moisture, nutrients and solar energy reflecting in higher vegetative growth. Data in Table 1 to 2 showed that wider spacing S_3 (120 cm × 60 cm) recorded significantly highest number of bolls per plant. Wider spaced crop produced significantly higher number of bolls per plant by Guggari *et al.* (1992) [20] and Singh *et al.* (1981) [15] reported lowest spacing with lower number of bolls per plant and also similar result for boll weight per plants.

Data in Table 1 showed that spacing S_3 (120 cm × 60 cm) recorded significantly maximum number of bolls per plant and superior to remaining plant spacing i.e. S_2 and S_1. This might be due to wider plant spacing under the treatment S_3 provided better nourishment resulting in better growth and development of crop ultimately resulted in higher seed cotton yield. The results also showed that the highest seed cotton yield (2309, 2314, and 2311.5 kg ha^{-1}) and stalk yield (3 712, 3749 and 3730.5) kg ha^{-1} for first, second and in pooled results, respectively) were recorded under the wider spacing of 120 cm × 60 cm (S_3) being at par with treatment S_2 (120 cm × 45 cm). Higher value for almost all the yield attributes were observe d under the higher spacing (120 cm × 60 cm) S_3. Medium and lower spacing of 120 cm × 45 cm (S_2) and 120 cm × 30 cm (S_1) decreased yield (3.03% and 7.40%) than higher plant spacing 120 cm×60 cm (S_3), while stalk yield by 1% and 2% respect over S_3. These finding are in agreement with those of Yadav and Rajput (1996) [19], Narkhede *et al.* (2000) [11], Sharma *et al.* (2000) [13], Hellikere and Halemani (2002) [8].

The data on ginning percentage (%), seed index and lint index at harvest (Table -3) clearly indicated that the differences observed in ginning percentage seed index and lint index were found to be non-significant due to spacing practices duri ng both the years and in pooled results. These finding are in agreement with those of Abraham *et al.* (1991) [1], who reported that ginning percentage, seed index and lint index were unaffected by spacing level as well as Wankhede *et al.* (1992) [18] and Tower *et al.*, (2000) [17].

Table 3: Ginning percentage, seed index and lint index in cotton as influenced by various treatments of spacing and weed management

Treatments	Ginning (%)			Seed index			Lint index		
	1st year	2nd year	Pooled	1st year	2ndyear	Pooled	1st year	2nd year	Pooled
Spacing (S)									
S_1-120 cm x 30 cm	33.60	33.62	33.61	9.69	9.68	9.68	4.71	4.71	4.71
S_2-120 cm x 45 cm	33.72	33.73	33.72	9.72	9.73	9.72	4.72	4.72	4.72
S_3-120 cm x 60 cm	33.84	33.85	33.84	9.77	9.78	9.77	4.74	4.74	4.74
S.Em±	0.08	0.09	0.08	0.01	0.01	0.01	0.01	0.01	0.01
C.D at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	1.03	1.23	1.13	0.55	0.29	0.44	0.34	0.58	0.47
Weed management practices (W)									
W_1- Unweeded control	33.59	33.59	33.59	9.29	9.27	9.28	4.61	4.61	4.61
W_2 - Glyphosate @ 1.0 kg/ha protected spraying at 30 and 60 DAS	33.74	33.75	33.74	9.73	9.73	9.73	4.68	4.68	4.68
W_3- Pendimethalin @ 1.0 kg/ha pre-emergence + hand weeding at 30 and 60 DAS	33.85	33.85	33.85	9.92	9.94	9.93	4.81	4.81	4.81
W_4- Hand weeding and inter culturing at 20, 40 and 60 DAS (weed free)	33.92	33.94	33.93	10.01	9.98	9.99	4.85	4.85	4.85
W_5 -Pendimethalin @ 1.0 kg/ha + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	33.61	33.62	33.61	9.84	9.86	9.85	4.74	4.74	4.74
W_6- Pyrithiobac sodium @ 0.04 + hand weeding at 30 DAS	33.80	33.81	33.80	9.85	9.85	9.85	4.72	4.72	4.72
W_7- Pyrithiobac sodium @ 0.04 + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	33.54	33.57	33.55	9.46	9.46	9.46	4.65	4.66	4.65
S.Em±	0.08	0.10	0.09	0.02	0.02	0.02	0.01	0.01	0.01
C.D at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	0.67	0.88	0.78	0.61	0.46		0.34	0.41	0.38
Interaction	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 4: Grain yield in green gram as influenced by various treatments of spacing and weed management

Treatments	Grain yield kg/plot			Grain yield kg/ha		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled
Spacing (S)						
S_1-120 cm x 30 cm	0.67	0.68	0.67	523.14	528.57	526.35
S_2-120 cm x 45 cm	0.68	0.68	0.68	526.43	529.14	527.2
S_3-120 cm x 60 cm	0.79	0.70	0.74	529.29	530.95	529.15
S.Em±	0.02	0.02	0.02	13.86	16.25	9.57
C.D at 5%	0.06	0.06	0.06	39.77	46.63	
C.V.%	10.63	11.47	11.06	12.07	14.06	13.11
Weed management practices (W)						
W_1- Unweeded control	0.66	0.67	0.66	490.22	491.89	491.05
W_2 – Glyphosate @ 1.0 kg/ha protected spraying at 30 and 60 DAS	0.71	0.68	0.69	524.22	525.89	525.05
W_3- Pendimethalin @ 1.0 kg/ha pre-emergence + hand weeding at 30 and 60 DAS	0.75	0.71	0.72	549.33	551	550.16
W_4 - Hand weeding and inter culturing at 20, 40 and 60 DAS (weed free)	0.76	0.72	0.74	556.89	558.56	557.7
W_5 - Pendimethalin @ 1.0 kg/ha + quizalofop-p ethyl @ 0.05 kg/ha at 30 DAS	0.73	0.70	0.71	537.67	539.56	538.55
W_6 - Pyrithiobac sodium @ 0.04 +hand weeding at 30 DAS	0.72	0.68	0.70	529.33	531	530.16
W_7 - Pyrithiobac sodium @ 0.04 + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	0.67	0.66	0.66	496.33	509.11	502.16
S.Em ±	0.02	0.02	0.01	22.62	22.97	15.49
C.D at 5%	0.06	0.06	0.04	64.91	65.92	43.20
C.V. %	8.07	10.03	9.07	12.90	13.01	12.96
Interaction	NS	NS	NS	NS	NS	NS

Effect of weed management

A perusal of data presented in Table- 2 clearly indicated that different weed management practices significantly influence plant height, Number of bolls, Boll weight seed yield and stalk yield yield per hector Treatment W $_4$ (Weed free) first year, second year and in pooled results, respectively) but, statistically at par with W $_3$, W_5 and W_6 during the both the years. Significantly the lowest seed cotton yield per hectare was recorded in treatment W $_1$ (unweeded control) during both the years and in pooled results. Because of synergist effect among the yield attributes they benefited each other. These finding are in accordance with those of Kalaginamani, (1997), Brar *et al*. (1996) [3], Pagal *et al*. (1995), Chandi *et al.* (1993) [5] and Malik, (1991) [10]. Differences in ginning percentage Seed index and lint index due to various treatments of weed management was found to be non-significant during both year and in pooled.

Effect on yield and yield attributes: Various yield attributes *viz*., number of bolls per plant, boll weight per plant, seed cotton yield and stalk yield play a vital role in increasing the productivity of cotton crop. Almost all the yield attributing characters (Table 1 and 2) *viz*., number of bolls per plant, boll weight per plant seed cotton yield and stalk yield were significantly influenced by various weed management treatments. Treatment of weed free (W $_4$) recorded higher number of bolls per plant, boll weight per plant, seed cotton yield and stalk yield indicating least competition offered by weeds for nutrient and moisture at crucial growth stages under this treatment ultimately improved all yield attributes besides increase rate of N, P and K absorption as evident from nutrient uptake studies (Table 4) cumulatively helped the crop plants to produce more surface area for high photosynthetic rate as well as maximum translocation of photosynthesis from source to sink subsequently resulted in improvement of all yield attributes.

The data on ginning percentage (%), seed index and lint index at harvest (Table 4) clearly indicated that the differences observed in ginning percentage (%) seed index and lint index were found to be non-significant due to effect of weed management practices during both the years in pooled results that herbicide used alone or combination at different rate did not affect seed index in cotton reported that fibre length and lint index reported by E1-deen *et al.* (1982) [6].

Residual studies on green gram

Different spacing had exerted no significant effect on succeeding summer green gram crop with respect to initial plant population grain yield and straw yield (Table-4). This showed that different spacing to preceding cotton had no any adverse or favorable effect on growth and yield of succeeding summer green gram crop as well as on weeds indicating no residual effect. There was no explicit variation in weed population in succeeding summer green gram as affected by previous weed management practices during both the years of experimentation. This indicated that herbicides applied to cotton did not affect adversely the germination and emergence of green gram crop as well as weeds. Similarly the final plant population, grain yield and straw yields were also not markedly affected by previous weed management. This showed that different weed management practices applied to preceding cotton had no adverse or favorable effect on growth and yield of succeeding green gram crop.

Conclusion

Wider spacing of 120 cm x 60 cm (S_3) significantly influenced most of the growth attributes of cotton *viz*., plant height, number of branches per plant, and recorded higher values for these character s. Based on pooled results they remain in S_3>S_2>S_1 order of their significance. seed cotton yield (kg/ha) and stalk yield (kg/ha), spacing of 120 cm x 60 cm (S_3) and 120 cm x 45 cm (S_2) were found equally effective and significantly superior to lower spacing (S $_1$). The spacing level S_3 and S_2 increased the seed cotton yield significantly. different weed management practices, the maximum seed cotton yield (kg/ha) was reported under weed free (W_4), followed by pendimethalin @ 1.0 kg/ha pre emergence + hand weeding in 30 and 60 DAS (W $_3$) and being at par with pendimethalin @ 1.0 kg/ha + quizalofop-P-ethyl @ 0.05 kg/ha at 30 DAS (W_5) with respect to stalk yield (kg/ha). Based on number of boll per plant and increase in seed cotton yield (kg/ha) of cotton were in the order W_4, W_3, W_5, W_6, W_2,

W_7 and W_1 according to the merit. All quality parameters ginning percentage seed index and lint index herbicide through spacing and weed management treatments were Non-significant results all the treatments. None of the treatment s caused marked effect on various growths and yield attributes as well as grain and straw yields of succeeding green gram crop are not seen any herbicidal the residual effects experimental fields.

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