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Intra raw spacing and weed management on growth and yield attributes in cotton under South Gujarat condition

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Abstract
Field experiments were conducted at of Instructional Farm, Navsari Agricultural University, Navsari during *kharif* and summer seasons of 2010 -11 and 2011-12 to study the Effect of intra raw pacing and weed management in cotton and its residual effect on succeeding summer green gram under South Gujarat condition. Various growth and yield attributing characters of cotton were significantly affected due to different levels of spacing and weed management practices. Wider spacing of 120 x 60 cm (S_3) gave higher values of all growth and yield parameters followed by S_2. The spacing level at 120 x 60 cm (S_3) and 120 x 45 cm (S_2) increased the seed cotton yield and stalk yield. Likewise weed free (W_4) tended to give highest seed cotton yield and stalk yield, comparable yields were obtained with application of pendimethalin @ 1.0 kg/ha pre emergence + hand weeding in at 30 and 60 DAS.

Keywords: spacing weeds, management, cotton and stalk yield

Introduction
Cotton, the king of fiber, 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. Due to this significant importance cotton is also known as, "White Gold".

Cotton is grown in 75 countries across the world out of which United States, China and India contribute 80% of total yield in the world. India ranks first in area and second in production of cotton in the World. Gujarat, Maharashtra, Haryana, Punjab, Rajasthan, Madhya Pradesh, Andhra Pradesh, Karnataka and Tamil Nadu are the major cotton growing states in India. In India, cotton is planted in about 110 lakhs hectares of land and it occupies second position in production with 325 lakhs bales (each of 170 kg) among all cotton producing countries in the world i.e. next to China (2010 -2011). Average productivity of cotton in India is 503 kg/ha which is low as compared to world average of 733 kg/ha. Gujarat is the second largest cotton growing state with acreage of 26.20 while the largest cotton producing state.

Weeds are recognized as the most unique problem in cotton crop because they are naturally hardy, self sown and better competitive hence compete well with cotton crop for water, nutrients, light, space and C O_2 resulting in poor performance of this crop Sandhu *et al*. (1996) [8]. They also impair the quality of produced if allowed to grow. Looking to the wider spacing and slow initial growth of cotton weed control most important. Starting with hand man has tried stone tools, hand tools, bullock and tractor drawn implements. Chemical, bioagent, interagated weed management as the advancement of science. 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) [3] herbicide alone in combination with one hand weeding reduced the dry weight and nutrient uptake by weeds significantly. Spark (1997) [10] reported Pendimethalin, glyphosate, Quizalofop -p- ethayl and sodium pyriothiobac as Promising herbicide in cotton. Shetly (1997) [11] reported that use of herbicide found beneficial where manual or mechanical weed control is difficult because of wet soil condition.

Materials and Methods

The experiment was conducted on Plot No. D -15 of the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari (Gujarat) during the *kharif and* summer season of both the years 2010 -11and 2011-12. The experimental field during the course of experimentation was fairly leveled and uniform.

Geographically, the College Farm of Navsari Agricultural University, Navsari is situated at 20^0-27˝ North latitude and 72 ^{0}-54˝ East longitude with an elevation of 10 metre above the mean sea level. Navsari falls under Agro -ecological situation -III of South Gujarat heavy rainfall zone, which is characterized by fairly warm summer, mild winter and warm humid monsoon with heavy rainfall. The study involved twenty-one treatment combinations consisting of three spacing. S $_1$120 x 30 cm, S_2 120 x 45 cm and S_3 120 cm x 30 cm and seven weed management practices i.e. W_1 Un weeded control, W_2 Glyphosat @ 1.0kh/ha protected spraying at 30 and 60 DAS, W_3 pendimethalin @ 1.0 kg/ha pre emergence + hand weeding in at 30 and 60 DAS, W_4 Weed free, W_5 pendimethalin @ 1.0 kg/ha + quizalotop-P-ethyl @ 0.05 kg/ha at 30 DAS, W $_6$Pyrithiobac sodium @0.05 +hand weeding at 30 DAS and W $_7$Pyrithiobac sodium @0.05 + quizalofop -P-ethyl @ 0.05 kg/ha at 30 DAS were evaluated in split plot design with three replications the rainfall of this region is heavy and normally commences from the second fortnight of June and ends by the middle of September. Pre -monsoon rains in the last week of May or in the first week of June are not uncommon. Most of the precipitation is received from South -West monsoon concentrating in the months of July and August. The annual mean rainfall received during the monsoon was 1400 mm distributed in 50 rainy days. The winter season sets in usually towards the end of October. The temperature starts declining in first fortnight of November and becomes the lowest either in the month of December or January and hence, these two months are the coldest months of the season. The summer commences from the middle of February and prolongs up to first fortnight of June. From February onwards the temperature starts rising and reaches the maximum in the months of April and May which are the hottest months of the year. The soil of College Farm has been placed under the group Ustochrepts, sub group Vertiustochrepts, sub-order orchrepts and order Inceptisols with Jalalpur series and classified as “Deep Black” soils. Soil are deep, moderately drained having good water holding capacity. It also cracks heavily on drying and expands on wetting. The predominant clay mineral is montmorillonite. India with production of 106.82 lakh bales. The average productivity of cotton in Gujarat is 693 kg/ha which is higher than the national average (Anon., 2010 -11). But lower than the world average. Looking to the world average productivity of this crop, there is huge scope for Gujarat.

Results and Discussion

Effect of spacing on yield and yield attributes.

The data presented in previous chapter that spacing showed remarkable influence on crop growth from 90 DAS and harvest. The plant height recorded at various growth stages (Table-1) differed significantly among each other and independent in their effect in the year 2010 -11 and pooled results and they remained in S $_3$>S_2>S_1 order of their significance, while in the year 2011 -12, treatments S_3 and S_2 were statistically on par but found significantly superior to S $_1$. Maximum number of monopodial and sympodial branches per plant was also recorded in wider spacing (S_3) and it was statistically at par with treatment s $_2$. At initial growth stage 90 DAS and at harvest almost all the treatment of spacing differed significantly among each other and were independent in their effect on number of sympodial and monopodial branches per plant and they remained in S_3>S_2>S_1 order of their significance (Table 2). This might be due to enhanced growth of individual plant under the treatment of wider spacing i.e. S_3 followed by S_2 which provided adequate space, nutrients, water and sunlight. The probable reasons for higher plant height, number of sympodial and monopodial branches per plant might be due to wider spacing produced more number of branches than closer spacing. Jain and Jain, (1981) [6] and Bastia, (2000) [2] reported almost similar results. Various parameter of yield viz; number of bolls per plant, boll weight per plan t, 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 3) 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 3 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) and Singh *et al.* (1981) [4] reported lowest spacing with lower number of bolls per plant and also similar result for boll weight per plants Data in table 4 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 $_2$) and120cm × 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) [13], Narkhede *et al.* (2000) [7], Sharm *et al.* (2000) [9], Hellikere and Halemani (2002) [5].

Effect of weed management on yield and yield attributes

Spacing has significant impact on plant height 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 in the year 2010-11 and in pooled results and they remain in S_3 > S_2> S_1 order of their significance while in the year 2011-12 treatments S_3 (120 x 60 cm) and S_2 (120 x 45 cm) were statistically on par but found significantly superior to S_1. Significantly the lowest plant height 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.

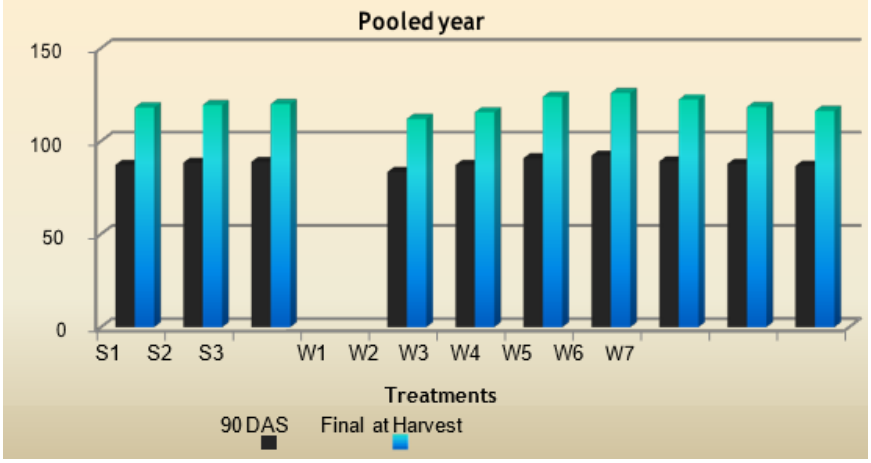
The data furnished in Table-1showed that various treatments of weed management influenced plant height during the entire

life span of crop growth. Treatment W_4 recorded the maximum plant height and remained statistically at par with treatments W_3 and W_5 in both the years and in pooled results. At 90 DAS and at harvest treatment W_4 (weed free), W_3 (Pendimethalin @ 1.0 kg/ha pre -emergence + hand weeding at 30 & 60 DAS), and W5 (pendimethalin @ 1.0 kg/ha + Quizalofop-p- ethyl@ 0.50 kg/ha at 30 DAS) were found equally effective in increasing the plant height but significantly superior to rest of the weed management practices. Significantly the lowest plant height was observed under W_1 (unweed control) treatment during all the stages of crop growth during entire period. An appraisal of the data in Table-2 stated that sympodial branches per plant were affected significantly observed at 30 DAS due to various weed management treatments. Treatment W_3 (Pendimethalin @ 1.0 kg/ha pre -emergence+ Hand weeding at 30 and 60 DAS) recorded maximum sympodial branches per plant and it was statistically at par with treatment W_5 and W_6 in first and second year and in pooled results Howear at 60 DA S and 90 DAS, treatment W_4 (weed free) recorded the heighest sympodial branches per plant but it was at par with treatment W_3 (Pendimethalin @ 1.0 kg/ha pre-emergence + Hand weeding at 30 and 60 DAS) during the both the years and in pooled results. Almost similar trend was found at harvest also. The data revealed that various treatments of spacing significantly influenced the boll weight per plant at harvest. So far boll weight per plant is concerned, all the treatments of spacing significantly differed where maximum boll weight per plant was recorded with wider spacing of S_3 (120 x 60 cm) but it was at par with spacing S_2 (120 x 45 cm) and minimum boll weight per plant in closer spacing S_1 (120 x 30 cm) during both the years and in pooled studies. A perusal of data presented in Table 3 indicated that different weed management practices significantly influenced boll weight per plant at harvest during the year 2010 -2011. All the treatments of weed management were found significantly superior in respect to boll weight per plant except Unweeded control (W_1). Almost similar trend was also found in pooled results. Similar teand also in the year 2011-12. The data pertaining to stalk yield per hectare as affected by spacing was found significant during both the years and also in pooled data. Treatment of wider spacing (S_3) recorded higher stalk yield per hectare at harvest (3712, 3749 and 3730 kg/ha) in 2010-11 and 2011-12 in pooled results, respectively. While, the lowest stalk yield per hectare was noticed under the lowest spacing (S_1) during both the year of experimentation. In pooled results all the treatments differed significantly in their effect on s talk yield per hectare and remained in following order of their significance $S_3 > S_2 > S_1$.

A perusal of data presented in Table-4 clearly indicated that different weed management practices significantly influenced the stalk yield per hectare at harvest during both the years and in pooled studies. Significantly the highest stalk yield per hectare (3883, 3939 and 3911 $kgha^{-1}$, in first and, second year and in pooled results, respectively) were recorded under W_4 (weed free) as compared to remaining all other weed management treatments but remained statistically at par with W_3, W_5, W_6, W_7 and W_2 during both the years. Significantly the lowest stalk yield per hectare was recorded in treatment W_1 (unweeded control) during both the years and in pooled results. Interaction effect of spacing and weed management was found non-significant with respect to stalk yield per hectare during both the years and in pooled results Data presented in Table 3 and 4 revealed that seed cotton yield and stalk yield of cotton were appreciably higher in all weed control treatments as compared to unweeded control (W_1). Significantly maximum seed cotton yield and stalk yield were recorded under weed free (W_4) followed by pendimethalin @ 1.0 kg/ha pre-emergence + hand weeding at 30 & 60 DAS (W_3) but remained at par with W_5 with respect to seed cotton yield kg ha^{-1} and stalk yield kg ha^{-1}. While the lowest seed cotton yield and stalk yield were recorded in unweeded control (W_1) in pooled results. Intraction effect of spacing and weed management was found non–significant with respect to plant height, bolls per plant, cotton yield and stalk yield during both the years and in pooled results.

Table 1: Plant height (cm) at 90 DAS and at harvest in cotton as influenced by various treatments of s and weed management

Treatments	90 DAS			Final at Harvest		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled
Spacing (S)						
S_1-120 cm x 30 cm	86.69	87.26	86.97	117.96	118.20	118.08
S_2-120 cm x 45 cm	87.79	88.50	88.14	118.33	119.48	118.90
S_3-120 cm x 60 cm	88.56	88.90	88.73	118.52	120.0	119.26
S.Em±	2.18	2.03	2.10	2.83	2.94	2.88
C.D at 5%	6.25	5.82	6.03	8.12	4.21	8.26
C.V.%	11.42	10.50	10.96	10.95	11.29	11.12
Weed management practices (W)						
W_1- Unweeded control	83.02	83.47	83.24	111	112	111.5
W_2 - Glyphosate@1.0kg/ha protected spraying at 30 and 60 DAS	87.21	87.21	87.21	115.25	115.56	115.38
W_3- Pendimethalin@1.0kg/hapre-emrgence + hand weeding at 30 and 60 DAS	90.27	90.82	90.54	123.7	123.89	123.83
W_4- Handweeding and inter culturing at 20, 40 and 60 DAS (weed free)	90.93	92.26	91.59	125	126	125.5
W_5 -Pendimethalin @ 1.0kg/ha + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	88.84	89.17	89	121.22	122.44	121.83
W_6- Pyrithiobac sodium @ 0.04 + hand weeding at 30 DAS	87.25	87.80	87.52	117.36	118.36	117.85
W_7- Pyrithiobac sodium @ 0.04 + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	86.25	86.81	86.52	114.33	116.33	115.33
S.Em±	1.25	1.34	1.29	2.25	2.26	2.25
C.D at 5%	3.59	3.85	3.72	6.45	6.48	6.46
C.V.%	4.28	4.56	4.42	10.21	10.23	10.22
Interaction	NS	NS	NS	NS	NS	NS



Plant height (cm) at 90 DAS and at harvest in cotton as influenced by

Fig 1: Plant height (cm) at 90 DAS and at harvest in cotton as influenced by various treatments of s and weed management

Table 2: Number sympodial branches at 90 DAS and at harvest in cotton as influenced by various treatments of spacing and weed management.

Treatments	90 DAS			Final at Harvest		
	1st year	2nd year	Pooled	1st year	2nd year	Pooled
Spacing (S)						
S_1-120 cm x 30 cm	18.58	18.50	18.85	38.94	39.46	39.20
S_2-120 cm x 45 cm	19.29	19.60	19.44	40.40	40.71	40.55
S_3-120 cm x 60 cm	20.41	19.91	19.95	41.42	41.94	41.68
S.Em±	0.49	0.48	0.48	0.92	0.92	0.92
C.D at 5%	1.40	1.38	1.39	2.64	2.64	2.64
C.V.%	11.60	11.44	11.52	10.48	11.56	11.04
Weed management practices (W)						
W_1- Unweeded control	11.54	12.10	11.82	20.67	21.28	20.97
W_2 - Glyphosate@1.0kg/ha protected spraying at 30 and 60 DAS	19.20	19.60	19.39	38.55	39.13	38.84
W_3- Pendimethalin@1.0kg/hapre- emrgence + hand weeding at 30 and 60DAS	23.56	23.54	23.55	50.76	51.39	49.78
W_4- Handweeding and inter culturing at 20, 40 and 60 DAS (weed free)	25.22	25.44	25.33	52.28	53.19	52.73
W_5 -Pendimethalin @ 1.0kg/ha + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	22.42	19.98	21.19	46.12	46.34	46.22
W_6- Pyrithiobac sodium @ 0.04 + hand weeding at 30 DAS	19.88	20.33	20.10	43.17	43.50	43.33
W_7- Pyrithiobac sodium @ 0.04 + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	14.15	14.38	14.26	31.11	31.80	31.45
S.Em±	0.61	1.16	0.88	0.53	0.65	0.59
C.D at 5%	1.76	3.32	2.32	1.52	1.88	1.70
C.V.%	9.46	17.98	14.34	3.94	4.82	4.41
Interaction	NS	NS	NS	NS	NS	NS

Table 3: Number of bolls per plant and boll weight per plant 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- Handweeding 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 30 DAS	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 4: Seed cotton yield in cotton as influenced by various treatments of spacing and weed management.

Treatments	Stalk 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	3654	3717	3685	2138	2155	2147
S_2-120 cm x 45 cm	3709	3737	3723	2239	2230	2235
S_3-120 cm x 60 cm	3712	3749	3730	2309	2314	2311
S.Em±	126	96	112	70.49	54	63
C.D at 5%	363	27	322	202	157	185
C.V.%	15	11	13	14	11	12
Weed management practices (W)						
W_1- Unweeded control	3220	3520	3370	1826	1821	1415
W_2 - Glyphosate@1.0kg/ha protected spraying at 30 and 60 DAS	3632	3679	3656	2003	1980	1991
W_3- Pendimethalin@1.0kg/ha pre- emrgence + hand weeding at 30 and 60 DAS	3773	3804	3788	2412	2431	2422
W_4- Handweeding and inter culturing at 20, 40 and 60 DAS (weed free)	3883	3939	3911	2575	2581	2578
W_5 -Pendimethalin @ 1.0kg/ha + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	3765	3774	3769	2361	2365	2363
W_6- Pyrithiobac sodium @ 0.04 + hand weeding at 30 DAS	3673	3728	3700	2253	2288	2270
W_7- Pyrithiobac sodium @ 0.04 + quizalofop-p ethyl @ 0.05kg/ha at 30 DAS	3623	3640	3631	2010	2012	2011
S.Em±	230	145	192	120	106	113
C.D at 5%	660	417	276	346	305	325
C.V.%	18	11	15	16	14	15
Interaction	NS	NS	NS	NS	NS	NS

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