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Effect of weed management and fertilizer levels on growth and yield of rainfed cotton (*Gossypium hirsutum* L.) under south Gujarat condition

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Abstract
A field experiment conducted during 2020-21 and 2021-22 at College farm, College of Agriculture, Navsari Agricultural University, Bharuch, Gujarat to study the effect of weed management and fertilizer levels on growth and yield of rainfed cotton (*Gossypium hirsutum* L.) under south Gujarat condition. Almost all the growth and yield attributes, yields, nutrient content and their uptake as well as available nutrients (N, P_2O_5 and K_2O) in soil after harvest of cotton significantly improved due to different treatments. The results revealed that application of two hand weeding and interculturing at 30 and 60 DAS or Pendimethalin 1.00 kg/ha PE *fb* Hand weeding and Interculturing at 60 DAS and application of 100% RDF (120-40-0 kg NPK/ha) found better for effective weed control and remunerative seed cotton yield. Significantly higher seed cotton weight per plant (124.57, 122.77 and 123.67 g/plant), stalk yield (2629, 2683 and 2656 kg/ha) and higher seed cotton yield (1923, 1982 and 1961 kg/ha) were recorded under W_1 (Two hand weeding and interculturing at 30 and 60 DAS). It was statistically at par with the treatment having application of Pendimethalin 1.00 kg/ha PE *fb* hand weeding and interculturing at 60 DAS (W_2) during both the years and in pooled data.

Keywords: Cotton, seed yield, stalk yield and fertilizer levels

Introduction
Cotton is one of the most important fiber and cash crop of India and plays a dominant role in the industrial and agricultural economy of the country. It provides the basic raw material (cotton fibre) to cotton textile industry. Cotton in India provides direct livelihood to 6 million farmers and about 40-50 million people be employed in cotton trade and its processing. Cotton known as a "White Gold" and the "King of Fiber Crops". It is cultivated in tropical and subtropical regions of more than 111 countries. It provides the main raw material for textile industry. Cotton is the most important global cash crop and controls economy of many nations. India is the second largest producer of cotton next to china with 34% of world production. In India, it is grown in an area of 130.61 lakh hectare with a production of 343.47 lakh bales of cotton (lint) and productivity of 447 kg/ha (Anon, 2023) [1]. In Gujarat, it is grown in an area of 25.54 lakh hectare with production of 894.97 lakh bales of cotton (lint) and productivity of 632 kg/ha (Anon, 2023) [1]. In the recent decades, scope for naturally available material is vast than the synthetic ones. For instance, demand for cotton based fabrics given much emphasis in global markets level especially in developed countries like USA and U.K. On the other hand, supply of cotton raw material to the textile industry seems to be in adequate due to various reasons. It could not be possible to increase the production of cotton with the available cotton growing areas. On the other hand, extension of area in cotton is questionable as most of the agricultural lands are being converted into other purposes like urbanization, industrialization *etc.* Hence, only alternative to tide over the above situations is to increase cotton yield from the existing cotton areas. Though there is lot of factors which led to cause decline in productivity of cotton, the fore most important factor that reduces the yield of cotton is weed and soil fertility. Therefore, it is necessary to study the "Effect of weed management and fertilizer levels on

growth and yield of rainfed cotton (G*ossypium hirsutum* L.) under south Gujarat condition''.

Materials and Methods

A field experiment conducted during summer season of year 2020-21 and 2021-22 at College Farm, College of Agriculture, Navsari Agricultural University, Bharuch, Gujarat. The soil of the experimental field was low in nitrogen medium in available phosphorus, rich in available potash with clayey texture, and slightly alkaline in reaction, which found suitable for raising cotton crop. The experiment was laid out with ten treatment combinations consisting of five treatments of weed management *i.e*., Two hand weeding and interculturing at 30 and 60 DAS (W_1), Pendimethalin 1.00 kg/ha PE fb hand weeding and interculturing at 60 DAS (W_2), Pendimethalin 1.00 kg/ha as PE+ Dhaincha as smother crop harvested and mulched at 50 DAS (W_3), Soil solarization with transparent plastic sheet (LDPE 50 µm) for 6 weeks in the month of April and May + one hand weeding at 60 DAS (W_4), Unweeded control (W_5) and two treatment of fertilizer levels *i.e*., F_1: 75% RDF (90-30-0 kg N, P_2O_5, K_2O kg/ha) and F_2:100% RDF(120-40-0 kg N, P_2O_5, K_2O kg/ha) evaluated in factorial randomized block design with three replications. The plant height of the five tagged plants in net plot were measured from the base of the plant (ground level) to the growing tip of the main stem at 30, 60, 90 DAS and at harvest. Sympodial branches on the main stem counted before first picking from previously tagged five plants and average numbers of sympodial branches/plant recorded for each treatment. The number of burst bolls of previously tagged five plants from each plot counted and the average numbers of bolls/plant recorded separately for each plot in each replication. Seed cotton picked from each net plot and its weight recorded picking wise. After last picking, plants of net plot uprooted, sun dried for ten days then weighed, and dry stalk yield recorded for each net plot and converted into kilogram per hectare.

Results and Discussion

Effect of weed management on growth and yield parameter

Plant height at 30, 60, 90 DAS and at harvest was affected higher due to weed management during both years and in pooled analysis. Two hand weeding and interculturing at 30 and 60 DAS (W_1) recorded significantly higher plant height at all growth stages which was statistically at par with W_2 (Pendimethalin 1.00 kg/ha PE fb hand weeding and interculturing at 60 DAS) during both the years as well as in pooled analysis except at 90 DAS and at harvest in pooled data. This might be due to better weed control in the above treatments, which resulted in efficient utilization of light, water and nutrients than other treatments. Significantly higher number of sympodial branches per plant (22.10, 25.82 and 23.96) and number of bolls per plant (35.80, 34.97 and 36.38) observed under the treatment having two hand weeding and interculturing at 30 and 60 DAS (W_1) but it was remained at par with treatment W_2 (Pendimethalin 1.00 kg/ha PE fb hand weeding and interculturing at 60 DAS) during both the years and in pooled data. The superior performance attributed to reduce crop-weed competition in crop growth, which helped in synchronization of number of sympodial branches and number of bolls per plant. Two hand weeding and interculturing at 30 and 60 DAS (W_1) produced significantly higher seed cotton weight per plant (124.57, 122.77 and 123.67 g/plant) and higher seed cotton yield (1923, 1982 and 1961 kg/ha) which was statistically at par with the treatment having application of Pendimethalin 1.00 kg/ha PE fb hand weeding and interculturing at 60 DAS (W_2) during both the years and in pooled data, respectively. Effective control of weeds by manual weeding/herbicides/smother cropping/soil solarization under the above superior treatments might have reduce crop-weed competition for moisture, nutrients, sunlight and ultimately enhanced photosynthetic and metabolic activities in the crop, which reflected in improved growth and development of the crop and finally increased seed cotton and stalk yields. This might due to the season long weed control which favorable for better growth and enhanced leaf area contributing for the activated photosynthesis and translocation of more photosynthates to sink which increased the plant height, number of sympodial branches per plant, number of bolls per plant and seed cotton yield per plant ultimately increased the seed cotton yield per hectare. The highest stalk yield (2629, 2683 and 2656 kg/ha) were recorded under W_1 (Two hand weeding and interculturing at 30 and 60 DAS) but it was statistically at par with W_2 during both the years and pooled results, respectively. This might due to higher accumulation of photosynthetic in leaves, stem and reproduction parts. Minimization of losses caused by weed growth that leads to improve growth characters of cotton and thus increased biomass in cotton. Different weed management treatments did not exert their significant effect on the harvest index during the 2020-21. However, significantly higher harvest index (52.74 and 47.51) was recorded under W_1 (Two hand weeding and interculturing at 30 and 60 DAS) during second year and in pooled results, respectively Similar results reported by Deshmukh *et al.* (2013) [3], Kamble *et al.* (2017) [6], Madavi *et al*. (2017) [8], Mathukia *et al.* (2018) [11] and Patel *et al*. (2022) [12].

Effect of fertilizer levels on growth and yield parameter

Significantly, higher plant height at all periodical stages during both the years and in pooled data obtained in F_2 (100% RDF). While, the lowest plant height was observed with F_1 (75% RDF) at all stages during both the years and in pooled analysis. Role of nitrogen in cell division and cell elongation might have resulted in increased plant height with increase in fertilizer levels. Nitrogen plays an important role in multiplication of cells and formation of plant parts, which resulted in higher growth of cotton. The result was in the conformity with the finding of Significantly, highest number of sympodial branches per plant (21.08, 23.55 and 22.31) was recorded under the treatment F_2 (100% RDF) and lowest (17.41, 20.14 and 18.78) under F_1 (75% RDF) during both the years and in pooled results, respectively. The increased sympodial branches/plant in higher dose of fertilizer through fertilizer levels might be due to enhanced availability and uptake of plant nutrients to enhance photosynthesis, expansion of leaves and translocation of nutrients from source to sink. The highest number of bolls per plant (34.14, 35.39 and 34.76) recorded under the treatment F_2 (100% RDF). However, less number of bolls per plant (31.26, 32.33 and 31.80) was observed under the treatment F_1 (75% RDF) during both the years and in pooled results, respectively. Number of bolls/plant observed more in higher level of fertilizer due to cumulative effect of various growth attributes viz., number of sympodial/plant and dry matter accumulation/plant and its subsequent translocation of photosynthesis to reproductive part *i.e*., number of bolls per plant. Different fertilizer levels did not exert their significant effect on boll weight, but significantly higher number of bolls per plant was

recorded under the treatment F_2 (34.14, 35.39 and 34.76) during both year and pooled analysis, respectively. These results are in conformity with 100% RDF (F_2) recorded significantly higher seed cotton yield (118.61, 115.68 and 117.14 g/plant), highest seed cotton yield (1762, 1830 and 1796 kg/ha) and stalk yield (2409, 2454 and 2432 kg/ha). The improvement in growth and yield component in these treatments was due to fulfill the nutrient requirement of plant. This was due to cumulative effect of application of optimum dose of nutrients, which increased number of picked bolls/plant, seed cotton yield/plant, and boll weight resulted into increased seed cotton yield. These results are in accordance with those reported by Treatment F_2 (100% RDF) recorded significantly higher harvest index (49.76 and 45.77) and lower harvest index (45.73 and 42.46) during the year 2021-22 and in pooled results, respectively. It shows at physiological efficiency of plant to convert the total dry matter into economically usable products. Increased harvest index in 100% RDF fertilizer level treatments are the evidences of more efficient production of economic yield from a given biological yield in fertilizer level treatments compared to 75% RDF applied. These results are in accordance with those reported by Deekshita *et al.* (2016) [2], Kalaisudarson *et al.* (2019) [4, 5], Kamble *et al.* (2022) [6], Malik *et al.* (2021) [10], Rawal *et al.* (2015) [13] and Solanki *et al.* (2020) [15].

Economic

Highest gross realization (₹ 146566/ha), net-realization (₹ 105152/ha) and B: C ratio (2.54) obtained with the treatment W_1 (Two hand weeding and interculturing at 30 and 60 DAS) followed by treatment W_2. While, the lowest gross realization (₹ 73759/ha), net realization (₹ 39805/ha) and B: C ratio (1.17) was obtained under W_5 (unweeded control) treatment. Due to its season long effective control of weeds appropriated with better growth parameters, yield attributes resulting in highest seed cotton yield compared with rest of the weed control treatments Fertilizer level treatment of 100% RDF (F_2) registered maximum gross realization (₹ 134232ha) and net realization (₹ 93198/ha) with B:C ratio of (2.27). However, treatment F_1 (75% RDF) recorded lowest gross realization of ₹ 107016/ha, net realization of ₹ 67741/ha and B:C ratio of (1.72). Due to higher seed cotton yield at that particular level of fertilizer application. These results were in conformity with the findings of Hosamani *et al.* (2013), Leelarani *et al.* (2016) [7], Malarkodi *et al.* (2017) [9], Malik *et al.* (2021) [10] and Solanki *et al.* (2020) [15].

Table 1: Plant height at 30, 60, 90 DAS and harvest of *Bt.* cotton as influenced by different treatments of weed management and fertilizer levels

Treatments	Plant height at 30 DAS (cm)			Plant height at 60 DAS (cm)			Plant height at 90 DAS (cm)			Plant height at harvest (cm)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Weed management (W)												
W_1	23.44	21.33	22.39	64.18	61.91	63.04	114.38	111.99	113.19	129.69	127.41	128.55
W_2	21.75	20.08	20.92	60.08	57.92	59.00	106.43	102.53	104.48	121.50	118.53	120.02
W_3	19.58	18.08	18.83	55.83	53.67	54.75	99.43	95.20	97.32	114.67	111.97	113.32
W_4	20.75	18.83	19.79	57.58	56.08	56.83	102.42	98.80	100.63	117.80	115.33	116.57
W_5	17.00	15.33	16.17	51.25	48.67	49.96	91.50	87.30	89.40	106.83	103.73	105.28
S.Em±	0.89	0.82	0.61	2.17	1.94	1.49	4.01	4.39	3.01	3.96	3.98	2.85
C.D. at 5%	2.66	2.44	1.75	6.46	5.76	4.28	11.92	13.04	8.63	11.75	11.82	8.18
Fertilizer levels (F)												
F_1	18.88	17.03	17.96	54.65	52.31	53.48	97.59	93.79	95.69	112.82	110.02	111.42
F_2	22.13	20.43	21.28	60.92	58.99	59.95	108.10	104.54	106.32	123.37	120.77	122.07
S.Em±	0.57	0.52	0.38	1.37	1.23	0.94	2.54	2.78	1.90	2.50	2.52	1.80
C.D. at 5%	1.68	1.54	1.10	4.08	3.65	2.71	7.54	8.25	5.46	7.43	7.48	5.18
Interaction (W X F)												
S.Em±	1.26	1.16	0.86	3.07	2.74	2.11	5.68	6.21	4.25	5.59	5.63	4.03
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	10.68	10.74	10.73	9.21	8.54	9.11	9.56	10.84	10.31	8.20	8.45	8.46

Table 2: Yield parameters of *Bt.* cotton as influenced by different treatments of weed management and fertilizer levels

Treatments	Number of sympodial branches per plant			Number of bolls per plant			Seed cotton yield (g/plant)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Weed management (W)									
W_1	22.10	25.82	23.96	35.80	36.97	36.38	124.57	122.77	123.67
W_2	20.63	23.10	21.87	33.66	34.92	34.29	116.94	113.37	115.15
W_3	18.33	21.03	19.68	31.74	32.95	32.34	109.43	101.24	105.33
W_4	19.53	20.67	20.10	32.69	33.84	33.27	112.99	107.48	110.23
W_5	15.63	18.60	17.12	29.61	30.63	30.12	101.02	87.63	94.32
S.Em±	0.75	1.23	0.78	1.02	1.02	0.74	3.75	4.47	2.97
C.D. at 5%	2.24	3.65	2.23	3.04	3.02	2.12	11.15	13.28	8.53
Fertilizer levels (F)									
F_1	17.41	20.14	18.78	31.26	32.33	31.80	107.37	97.31	102.34
F_2	21.08	23.55	22.31	34.14	35.39	34.76	118.61	115.68	117.14
S.Em±	0.48	0.78	0.49	0.65	0.64	0.47	2.37	2.83	1.88
C.D. at 5%	1.42	2.31	1.41	1.92	1.91	1.34	7.05	8.40	5.40
Interaction (W X F)									
S.Em±	1.07	1.74	1.10	1.45	1.44	1.04	5.31	6.32	4.20

C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	9.59	13.76	13.10	7.66	7.36	7.68	8.13	10.28	9.38

Table 3: Yield parameters of *Bt.* cotton as influenced by different treatments of weed management and fertilizer levels

Treatments	Seed cotton yield (kg/ha)			Stalk yield (kg/ha)			Harvest index (%)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
Weed management (W)									
W_1	1923	1982	1961	2629	2683	2656	42.27	52.74	47.51
W_2	1837	1876	1857	2439	2493	2466	42.90	48.91	45.91
W_3	1526	1603	1565	2274	2325	2299	40.09	46.19	43.14
W_4	1645	1738	1691	2343	2403	2373	41.07	47.67	44.37
W_5	941	994	968	1693	1755	1724	36.08	43.22	39.65
S.Em±	59.44	72.24	46.82	86.7	93.2	63.7	1.63	1.68	1.22
C.D. at 5%	176.63	214.65	134.40	257.6	277.0	182.9	NS	4.99	3.49
Fertilizer levels (F)									
F_1	1387	1447	1420	2142	2210	2176	39.18	45.73	42.46
F_2	1762	1830	1796	2409	2454	2432	41.78	49.76	45.77
S.Em±	37.60	45.69	29.61	55	59	40.30	1.03	1.06	0.77
C.D. at 5%	111.71	135.76	85.00	163	175	115.69	NS	3.15	2.21
Interaction (W X F)									
S.Em±	84.07	102.17	66.22	123	132	90.12	2.31	2.37	1.72
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
CV (%)	9.23	10.80	10.09	9.33	9.79	9.58	9.89	8.61	9.55

Table 4: Economics of *Bt.* cotton as influenced by different treatments of weed management and fertilizer levels

Treatments	Seed cotton Yield (kg/ha)	Stalk cotton Yield (kg/ha)	Gross realization (₹/ha)	Cost of Cultivation (₹/ha)	Net-realization (₹/ha)	B:C ratio
Weed management (W)						
W_1	1961	2656	146566	36822	105152	2.54
W_2	1857	2466	138605	36080	97932	2.41
W_3	1565	2299	117567	33500	79474	2.09
W_4	1691	2373	126699	40292	81815	1.82
W_5	968	1724	73759	29362	39805	1.17
Fertilizer levels (F)						
F_1	1420	2176	107016	34683	67741	1.72
F_2	1796	2432	134232	36442	93198	2.27

Conclusion

Based on the results of two years investigation, it can be concluded that two hand weeding and interculturing at 30 and 60 DAS or Pendimethalin 1.00 kg/ha PE *fb* Hand weeding and interculturing at 60 DAS and application of 100% RDF (120:40:0 kg NPK/ha) found better for effective weed control and remunerative seed cotton yield under south Gujarat condition.

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