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Effect of Nitrogen on Maturity of Cotton by Using Node above White Flower

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Abstract: Due to indeterminate growth habit of cotton plant (*G. hirsutum* L.) maturation is affected by many environmental and cultural factors. An easy and reliable measure of progression towards maturity that can be attained during crop development is needed for both production and research programme. The node above white flower (NAWF) technique was used to monitor the growth, development and maturity of three varieties viz; MNH552, MNH554 and AC-134 under five nitrogen level (N_1=0, N_2=75, N_3=125, N_4=175 and N_5=250 kg ha^{-1}). The objective of this study was to evaluate physiological cut out date (NAWF-5) as a measure of maturity by comparing it with percent first pick, days taken to first flower and days taken to open first boll and to evaluate the effect of nitrogen on maturity related traits and seed cotton yields. Within each test, sequential node above white flower counts were used to determine physiological cutout date (days taken to NAWF-5), percent first pick was determined by sequential harvest. The days taken to first flowers and days taken to open first boll were recorded from planting date to open first white flower and boll open. Significant variation was found within each nitrogen level for all of the maturity measurements and seed cotton yield except between N_4 and N_5. The days taken to NAWF-5 was closely related to percent first pick, days taken to first flower, days taken to open first boll and seed cotton yield. It was also concluded that excess of nitrogen application increase the potential for rank growth, risk of nitrogen losses through soil run-off or leaching. From the result of present study it was also indicated that application of nitrogen fertilizer above 175 kg ha^{-1} did not extend the flowering period and also did not increase seed cotton yield significantly. Days to NAWF-5 could be used for monitoring cotton plant after flowering, earliness determination, detecting fruiting problems during growth season and for all management decisions (Nitrogen fertilizer application etc)

Key words: Nitrogen, cotton, white flower, node

INTRODUCTION

Enhancing earliness without sacrificing yield has been goal in cotton research programme since the early 1950. Typically, crop maturity has been evaluated by sequentially harvesting seed cotton and comparing yields at each harvest with final yield. The most commonly used of these maturity measurements are % first pick (percentage of crop harvested in the first of two harvests) days taken to first flower and days taken to open first boll. These measurements can not be used for in season management and are easily skewed by factors that either cause shedding of buds or flowers (e.g. insect damage, shortage of water), premature boll opening or prevent boll opening (eg. cool temperatures).

Early crop maturation and harvest cotton can enhance production efficiency by alleviating late season risks associated with insect problems and adverse weather (Anderson *et al*., 1976). Various measurements have been used to evaluate earliness of cotton. Richmond and Radwan (1962) found that phenological (first square, flower and open boll) and product quality measurements (ratios of fractions relative to total yield) of earliness were significantly correlated. Richmond and Ray (1966) found that mean maturity date provided a more exact measurement of earliness than did percentage of total harvest in multiple harvests but it can not be calculated until after harvests are completed. The percent first pick is also masked by delay harvests and use of boll openers (e.g. ethephon).

As boll load increases, maturation of cotton plants is signaled by slowed development of new main stem nodes, which causes first position white flowers to appear progressively closer to the plant apex (Oosterhuis *et al*., 1992). Waddle (1974) was the first to report the use of node number of first position of white flower relative to the plant apex as an indictor of maturity in cotton. Comparing varieties that differed in maturation time, be observed that earlier maturing varieties had fewer nodes above the last white flower during the third and fourth weeks of flowering than did later maturing varieties.

Furthermore, he indicated that it is reasonable to expect that the number of nodes above the last white bloom will be on excellent herald for cutout and a general growth indictor for any one variety. Sequential measurements of this plant parameters, now referred to as

NAWF, can be used to monitor the development and maturation of cotton (Bourland *et al.*, 1992; Iqbal *et al.*, 2003). The physiological cutout has been defined as the flowering date of the last effective flower population, as determined by an average NAWF-5 (Oosterhuis *et al.*, 1996). Like mean maturity date, physiological cutout date may provide a temporal measurement of maturity that can be compared among diverse environments, but does not require multiple harvests.

The objective of this research was to evaluate physiological cut out date as a measure of maturity by comparing it with harvest based maturity measurement (% first pick), days taken to first flower and days taken to open first boll, under different nitrogen fertilizer rate using three varieties of upland cotton. The second objective of this study was to determine whether physiological cutout date provides an accurate in season measure of maturity and crop management.

MATERIALS AND METHODS

The present investigations to determine the maturity of cotton varieties were carried out in the experimental area of Cotton Research station, Multan during the years 2001-2002. The genetic material comprised three varieties of upland cotton (*G hirsutum* L.) viz., MNH-552, MNH-554, AC-134 with five nitrogen fertilizer level (kg ha^{-1}) i.e N_1=0, N_2=75, N_3=125, N_4=175, N_5=250.

The experiment was sown on 15 May 2001 in a well-prepared soil low in nitrogen and phosphorus using split plot design with three replications. The sowing was done by dibbling, three seeds per hill to ensure uniform stand, later thinned to one plant per hill. Each experimental plot was comprised of ten rows of 15 m long keeping 30 cm plant to plant distance. The row to row distance was kept 75 cm and nitrogen fertilizer was applied three split doses, at 40, 65 ans 85 days after planting. All the other cultural practices were applied according to the requirement of crop. The data was collected from 10 guarded plants of central row of each replication for following traits.

- Days taken to first flower
- Days taken to open first boll
- Weekly nodes above white flower (NAWF) count (start after one week of flower initiation and continued until one week after average NAWF-5)
- Percent first pick (% first pick on plot weight basis). First pick was harvested after 130 days from planting and second pick was harvested, when all mature bolls were opened.
- Seed cotton yield (kg ha^{-1}) on plot weight basis

Means for sequential dates of NAWF counts in each test were evaluated by analysis of variance using a split plot design with three replications. Mean for the sequential dates were regressed on days from planting. Using these regression equations, numbers of days required to attain NAWF of 5.0 (NAWF-5) were calculated. Simple correlation coefficients among days to NAWF-5, days taken to first flower, days taken to open first boll, percent first pick and seed cotton yield was then determined by using the method given by Gomez and Gomez (1983).

RESULTS AND DISCUSSION

The data recorded for NAWF for all the nitrogen levels in three varieties under study revealed that the value of NAWF was near seven or above during early flowering season and this value existed for four to five weeks, then declined as flowering period continued (Table 1). This decrease in NAWF value indicated that more assimilate was diverted to developing bolls, less was available for further vegetative growth, which confirms the earlier findings of Cappy (1979) and Oosterhuis *et al.* (1989) and Bourland *et al.* (1991) who reported that as fruit developed more photosynthate was diverted to the developing bolls and less was available for continued vegetative growth. When plant enter reproductive phase, it needs more nutrients elements (water, nitrogen, phosphorus and other micro nutrients and carbon dioxide) to enhance the photosynthesis process to meet the need of developing bolls and to continue the vegetative growth. The decrease in NAWF value may thus provided an indication of source-sink growth activity of the crop with reference to development of bolls and vegetative growth of the main stem. This study also suggested that the decline in NAWF provides an indication that the sink associated with developing bolls has become sufficiently strong, relative to vegetative growth, to slow down further main stem growth and abort or impede the production and development of additional bolls.

NAWF value of seven or more indicated that a maximum amount of photosynthate available for developing bolls and this value should exist for four to five weeks under favourable cotton growing conditions. Crop monitoring, especially in the first four to five weeks of flowering, becomes a critical adjunct to the use of NAWF. It can further be safely concluded that any production practice that extends the effective flowering period would increase cotton yield, if external factors such as insects and diseases remain under control and favourable weather conditions prevail during the season.

As the nitrogen application to soil is made to meet expected yield goal. The values of NAWF, days to NAWF-5, seed cotton yield and % first pick for N_4 (175 kg ha^{-1}) and N_5 (250 kg ha^{-1}) were nearly equal through out the season (Table 1, 3). It indicated that the

Table 1: Number of nodes above white flower (NAWF) for cotton variety response to nitrogen rate

Variety	N rate kg ha^{-1}	NAWF by date 11/8	18/8	25/8	1/9	8/9	15/9	22/9	29/9	Days to NAWF-5	R^2
MNH-552	0	6.7	6.9	6.9	6.4	5.4	4.1	3.2	2.5	108.2	0.89
	75	7.6	7.9	8.0	7.8	7.1	6.5	5.3	4.4	131.7	0.79
	125	7.8	8.0	7.9	7.5	7.2	6.7	5.5	4.6	133.4	0.83
	175	7.7	7.8	8.0	7.7	7.4	6.9	5.7	4.8	140.5	0.78
	250	7.9	8.1	8.2	7.9	7.7	7.1	6.0	4.9	142.4	0.77
MNH-554	0	9.7	9.1	9.2	8.8	8.3	7.6	6.1	5.1	134.6	0.88
	75	9.7	9.2	9.4	8.9	8.4	7.8	6.2	5.2	145.9	0.86
	125	9.8	9.2	9.5	8.7	8.5	7.7	6.3	5.3	150.4	0.87
	175	9.7	9.3	9.6	8.9	8.7	7.8	6.5	5.5	160.4	0.81
	250	9.8	9.4	9.7	9.0	8.8	7.9	6.7	5.8	162.3	0.80
AC-134	0	7.2	6.5	6.7	6.6	6.3	6.0	5.5	4.4	140.7	0.89
	75	7.1	6.6	6.9	7.1	6.8	6.3	5.8	4.5	153.8	0.89
	125	7.2	6.8	6.9	7.3	6.9	6.5	5.9	4.7	157.1	0.85
	175	7.4	7.0	7.2	7.5	7.2	6.9	6.2	4.9	169.4	0.89
	250	7.9	7.7	7.3	7.2	7.1	6.9	6.4	5.1	171.4	0.83

Table 2: Mean squares for cotton variety response to nitrogen rate

S.O.V	d.f	Days to NAWF-5	Yield kg ha^{-1}	% first pick	Days taken to first flower	Days taken to open first boll
Rep	2	32.96$^{n.s}$	684.62$^{n.s}$	26.07$^{n.s}$	37.86$^{n.s}$	44.42$^{n.s}$
Variety	2	3096.14**	544737.16**	4458.77**	1174.86**	4336.09**
Error a	4	18.98	4080.97	39.98	17.34	21.31
Nitrogen	4	1539.04**	473666.89**	311.91**	615.75**	250.80**
V x N	8	35.19**	12526.52**	33.18**	28.17**	65.86**
Error b	24	5.57	211.04	4.90	1.48	8.33

Table 3: Yield and maturity measurements in a cotton variety response to nitrogen rate

Variety	N rate kg ha^{-1}	Days to NAWF-5	Yield kg ha^{-1}	% first pick	Days taken to first flower	Days taken to open first boll
MNH-552	0	108.2	2545	58.86	50.18	92.33
	75	131.7	2598	53.56	52.35	95.0
	125	133.4	2798	60.86	57.66	93.66
	175	140.5	2918	48.93	64.67	101.33
	250	142.4	2911	46.16	68.33	101.66
MNH-554	0	134.6	2054	24.5	62.67	119.0
	75	145.9	2258	21.43	67.33	122.0
	125	150.4	2390	19.73	75.67	132.67
	175	160.4	2581	16.86	84.67	137.33
	250	162.3	2596	14.6	90.00	143.00
AC-134	0	140.7	2266	36.86	58.00	110.00
	75	153.8	2449	29.9	61.33	112.67
	125	157.1	2768	27.53	66.00	115.33
	175	169.4	2881	22.43	69.33	113.00
	250	171.4	2894	20.5	71.37	115.67
LSD 0.05, variety x N- rate		2.88	17.26	2.62	1.45	2.43
MNH-552		131.16	2754	52.48	58.53	96.80
MNH-554		152.56	2385	19.42	76.06	130.62
AC-134		158.45	2651	27.44	65.20	113.33
LSD 0.05, variety		3.12	45.48	4.53	2.99	3.31
	0	127.84	2288	40.07	56.89	107.11
	75	143.83	2435	34.96	60.22	109.88
	125	146.98	2652	36.04	66.44	113.91
	175	156.74	2793	29.41	72.89	117.22
	250	157.59	2815	25.08	73.56	120.11
LSD 0.05, N-rate		1.62	9.97	1.52	1.25	1.98

nitrogen fertilizer application above 175 kg ha^{-1} did not show any response toward seed cotton yield, % first pick and days to NAWF-5. It was also conclude that application of nitrogen fertilizer above 175 kg ha^{-1} could not extend the flowering period as the NAWF values remained nearly same which indicated that excessive nitrogen application increases the potential for rank plant growth. It was also concluded that liberal nitrogen input increase the risk of nitrogen losses through soil run-off, or leaching, From present study it was further concluded that excessive rate of nitrogen promote later maturity and delayed boll opening.

The NAWF-5 values (Table 1, 2) indicated that early maturing varieties/ treatment required less number of days

Table 4: Correlation coefficient among Yield and maturity measurements in a cotton variety response to nitrogen rate

Variables	Correlation coefficient
Days to NAWF-5 vs Seed cotton yield	-0.852**
Days to NAWF-5 vs % first pick	-0.928**
Days to NAWF-5 vs days taken to first flower	0.783**
Days to NAWF-5 vs days taken to open first boll	0.745**
Seed cotton yield vs % first pick	-0.986**
Seed cotton yield vs days taken to first flower	-0.806**
Seed cotton yield vs days taken to open first boll	-0.94**
% first pick vs days taken to first flower	-0.775**
% first pick vs days taken to open first boll	-0.874**
days taken to first flower vs days taken to open first boll	0.856**

*, **Correlation coefficients vary significantly from zero at p= 0.01 and 0.001, respectively

to reach the NAWF-5 stage and late maturing required higher number of days to achieve NAWF-5 stage. The rate of decreasing NAWF over time is shown by regression equation for varieties/ N level (Table 1). It is evident from Table 1 that the R^2 values ranged between 0.77 to 0.89 suggesting that 77 to 89 percent variation in the NAWF is mainly due to number of days from planting.

Correlation coefficient among seed cotton yield, percent first pick and days from planting to 5-node above white flower (days to NAWF-5) for varieties were computed (Table 4). Days to NAWF-5 was significantly and negatively correlated with percent first pick and seed cotton yield while significantly and positively correlated with days taken to first flower and days taken to open first boll. The Percent first pick was also significantly and positively correlated with seed cotton yield (Table 4). These results clearly suggested that early maturing variety/genotype contributed relatively higher percentage of yield early in the season and also produced over all more yield probably due to possible escape from boll worm attack.

From the above study it was further concluded that technique of monitoring plant growth and boll development through counting NAWF can be efficiently used for the measurement of earliness in segregating populations and precise management of crop throughout the season for proper utilization and saving of irrigation water, fertilizer and pesticide for achieving optimum seed cotton yield. This technique can easily transfer to growers and adaptable in field to achieve maximum benefit from nitrogen fertilizer and variety potential.

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