Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Plant Sciences 2 (8): 593-596, 2003
ISSN 1682-3974

Monitoring the Growth and Development of Cotton Plants Using Main Stem Node Counts

Umer Q. Khan
Department of Plant Breeding and Genetics, Faculty of Agriculture, Gomal University, D.I.Khan, Pakistan

Abstract: A research experiment was conducted to study the physiological growth pattern of six cotton varieties namely CIM 443, CIM 435, CIM1100, FH634, Vihari-53 and MNH-93. The design was RCB with four replications. Main stem nodes were counted above the highest first position white flower on weekly basis. Five nodes above the first position white flower were considered to be the stage at which the crop changes the growth pattern from vegetative to reproductive phase. Significant differences were noted in varieties regarding number of days to NAWF-5 (five nodes above the first position highest white flower). CIM 443 took least number of days (64.05) to NAWF-5 and was the earliest in maturity while CIM1100 took the highest number of days (86.14) to NAWF-5 and was the latest in maturity. Significant differences were noted for sympodial number at first flowering, days to first flowering, nodes to first sympodia and days from NAWF-5 to boll opening. Phenotypic correlations of NAWF-5 with seed cotton yield and fibre micronaire were negative (-0.55, -0.93) and positive with boll number^{-1} plant and boll weight (0.31, 0.45), respectively.

Key words: Monitoring cotton, NAWF counts

Introduction

Cotton is the most important fibre crop of the world and is cultivated on 33.923 million hectares in some 80 countries of the world. For Pakistan, cotton is the most important cash crop and is grown on 2929 thousand hectares of land producing 10800 thousand bales of cotton, with about 627 kgs hec^{-1} yield of seed cotton (CCRI, 2001). Cotton plant is very systematic in its growth. It follows a well defined, consistent, orderly calendar and physiological pattern. Growth and development of the plant is influenced by an array of transient, genetic and environmental interactions, many of which may cause relatively minor changes in plant phenology but have major effects on maturity and yield. The concept presented here is proposed as a method for monitoring growth and developmental changes of cotton and thus assists in the formulation of timely management decisions, Bourland *et al.* (1992). In this regard Karner *et al.* (1998) reported that scouting for insects pests in cotton can be terminated when the irrigated crop reaches 5-NAWF plus 350 heat units and the rainfed crop reaches 6-NAWF plus 350 heat units.

Main stem nodes on cotton plants are discernible soon after emergence and continue to appear until terminal development ceases (Mauney, 1986a). the number of main stem nodes in relation to plant height has been recognized as a means to monitor and possibly to adjust early season growth of the plant (Hake *et al.*, 1991). The nodal position of the highest first position white flower on the main axis relative to the plant apex should be a reliable description of the relationship between fruit set and rate of terminal growth. Since first position squares are detectable in the plant terminal and then develop to white flowers at a

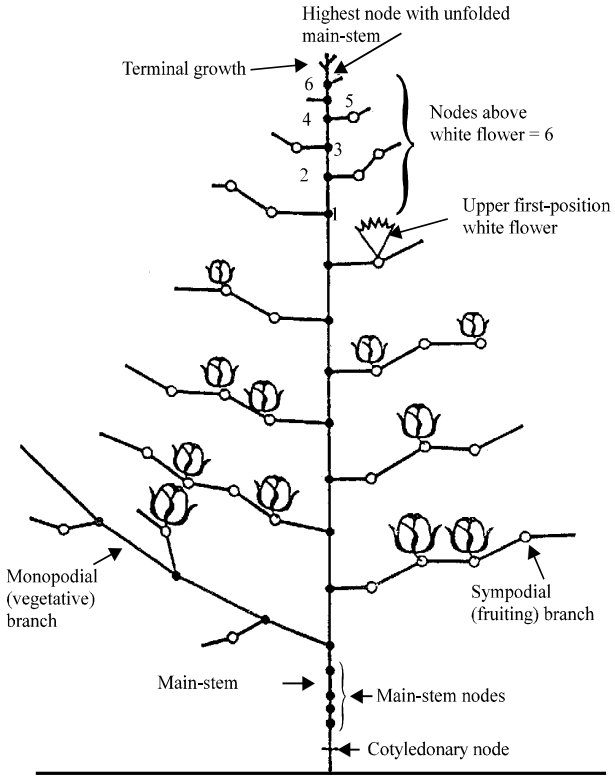

Fig. 1: Typica cotton plant structure showing six nodes above the uppermost white flower (NAWF=6 Source: Oosterhuis *et al.*, 1993)

predictable rate, the plant structure above any first position white flower reflects the growth and development of the plant during the relatively constant square to white flower interval, (Bourland, 1992). When cotton crop flowers in last week of July or first week of August, the node number above first position white flower is 10 or more than 10, if it is 8 or less, then it is a clear evidence that the crop is in stress and something has limited early season growth (irrigations, soil salinity, disease, weeds etc) if it is 10 or more than 10, the crop is in good condition (Guinn, 1985). Upto 2 weeks, the node number increases, then it starts decreasing and a stage comes when the node no above highest first position white flower is 5 or less than 5 (Fig. 1). At this stage, the vegetative growth starts declining and resources are devoted for boll formation. NAWF-5 is the stage at which the vegetative growth phase turns into reproductive growth phase and is the physiological maturity stage or cutout (Bourland, 1992).

The present research study was based on observing NAWF (Nodes Above White Flower) counts of six cotton varieties of cotton namely CIM 443, CIM 435, CIM 1100, FH 634, MNH-93 and Vehari-53 in four replications with Randomised Complete Block design.

Materials and Methods

During the year 1997-98, six cotton varieties namely CIM 443, CIM 1100, CIM 435, FH 634, Vihari-53 and MNH-93 were planted at the experimental area of PBG Department, Faculty of Agriculture, Gomal University, D.I.Khan.

The design was RCB with four replication. Row to row distance was kept as 100cm and plant to plant was 30 cm. All the standard cultural practices such as irrigations, hoeing, weeding and fertilizer application were adapted to keep the crop in good health. Spray of various insecticides was done to control various insect pests of the crop. The research study was based on observing the physiological development of the cotton varieties by watching the movement of the first position white flower on the main stem.

Data were recorded for the following characters

- Days to first NAWF (Nodes Above White Flower): Number of days were counted from planting to the appearance of first flower
- Number of sympodia at first NAWF: number of fruiting branches were counted at first flowering.
- Days from planting to NAWF-5: number of days were recorded from planting to 5 nodes above the first position white flower. After recording data, their means were subjected to linear regression equation and days from planting to NAWF-5 were recorded for each cultivar.

$$Y = a + bx$$

Where; Y = NAWF counts
a = Y intercept
b = slope
x = days from planting

Days from NAWF-5 to boll opening: number of days were recorded from NAWF-5 to boll opening.

Yield components such as boll weight, boll number per plant, total yield and fibre quality.

Moreover, correlation of NAWF-5 (physiological maturity) with seed cotton yield, boll number per plant, boll weight and fibre fineness was calculated to know the relationship of NAWF-5 with these traits.

Results and Discussion

The data means for various physiological, morphological and yield characteristics are given in the Table 1. Mean values regarding days to NAWF-5 shows that CIM-443 took (64.05) least number of days to NAWF-5 and was the earliest maturing variety, CIM1100 stood late maturing by taking (86.14) days to NAWF-5, VH-53, FH-634, CIM-435 and MNH-93 were medium maturing varieties by taking 77.42, 81.10, 81.04 and 76.16 days to NAWF-5. These findings are consistent with Oosterhuis *et al.* (1993), studying the physiological basis of NAWF technique and reported that the vegetative growth during the early season consists mainly of root development, leaf growth and nodal development and these tissues represent the dominant sinks for the sugars and nutrients. As fruit develop more sugars are diverted to the developing bolls and less is available for continued vegetative growth. Root growth decreases during the later part of the season as sugars are diverted to the developing fruit load and the plant becomes unable to provide sufficient nutrients to

Table1: Mean values of some physiological parameters of cotton cultivars

Variety	Days to NAWF-5	Nodes to Ist Sympodia	Days to Ist NAWF	Sympodia at first NAWF	Days from NAWF-5 to boll opening
CIM-443	64.05	6.2	45	7.45	4-6
VH-53	77.42	9.0	50	7.50	0-2
FH-634	81-10	9.55	58	6.30	7-8
CIM-435	81.04	6.87	52	6.10	10-11
MNH-93	76.16	10.6	57	7.70	5-6
CIM-1100	86.14	7.8	64	7.20	7
F Value	13.5**	9.17*	21.83**	6.52**	6.55**

* = Significant at 5% level of significance
** =Significant at 1% level of significance

Table 2: Correlation of NAWF-5 (physiological maturity) with some agronomic traits of cotton

	Seed cotton yield	Boll number plant^{-1}	Boll weight	Fibre micronaire
NAWF-5	-0.55 NS	0.31 NS	0.45 NS	-0.93**

NS=Not significant, **= significant at 1% level

Table 3: Mean performance of some Agronomic & fibre quality traits of cotton cultivars

Variety	Average boll weight	Boll No/plant	Total yield/plant	Fibre length in inches	Fibre strength gms/tex	Fibre micronaire
CIM-443	2.7	26.10	55.50	1.08	18.1	5.1
VH-53	3.60	23.60	60.80	1.07	22.8	4.4
FH-634	3.73	25.40	43.30	1.08	17.5	4.3
CIM-435	4.59	20.00	44.60	1.23	19.9	4.5
MNH-93	3.90	35.70	48.50	1.07	18.5	4.8
CIM-1100	3.20	42.00	47.00	1.18	18.3	4.2
F value	0.8	5.12**	0.33 NS	1.87 NS	5.1*	1.61 NS

Table 4: Degree days (D.D.60s) required for different growth stages in cotton cultivars

	CIM-443	VH-53	FH-634	CIM-435	MNH-93	CIM-1100	F Value
From planting to emergence	76.38	63.93	63.93	76.63	91.67	91.67	66.03**
From emergence to square	416.8	602.32	624.18	502.39	574.58	464.98	21.38**
From square to first White bloom	186.95	134.14	152.62	261.73	194.24	239.39	46.58**
From planting to first bloom	725.58	800.39	840.75	840.75	860.69	796.04	83.57**
From white bloom to open bolls.	211.54	256.84	236.42	404.73	329.58	477.93	36.52**
Total Heat Units	994.70	1114.81	1261.73	1303.06	1247.87	1331.55	38.25**

** = Significant at 1% level of significance

meet the requirements of both developing bolls and vegetative growth and it favors the developing bolls in preference to vegetative growth. This resuction in vegetative growth is reflected in a decrease in main stem nodes. This decrease in NAWF provide an indication of the vegetative-reproductive balance of the crop. These results are also confirmed by Rehana *et al.* (2001), who reported that characters attaining date of 5-NAWF were more reliable indicators of maturity. Number of nodes to first sympodia is a good indicator of crop's growth and maturity. In cooler temperatures, the node number to first sympodia is increased while in warmer than normal temperature it is decreased. With a lower node number than average (4.4), the crop tends to allocate (CHO) to fruit at a lower growth stage and the crop matures very early resulting in low yield. If it si higher than average, it results in excessive vegetative growth and retards early boll set; Guthrie *et al.* (1993). In this regard CIM-443 developed the least no of nodes (6.2) to first sympodia and therefore reached to cutout stage (NAWF-5) earlier than other varieties, while MNH-93 developed the highest number of nodes (10.6) and was late to reach physiological maturity (NAWF-5). Aden, (1997) while working on some cotton cultivars reported that the varieties bearing first sympodial branch considerably at lower main stem nodes were rated as early maturing. The mean values regarding number of days to first flowering (Ist NAWF) show that CIM 443 took the least number of days to flower (45) and was the earliest among the varieties followed by vihari-53 (50), CIM435 (52), MNH-93 (57) and FH634 (58). While CIM 1100 took the highest number of days to flower (64) and was late maturing. In this regard Bano *et al.* (2002) considered main stem node number to first sympodia and days taken to open first flower as reliable indictors of earliness in cotton. MNH-93 produced the highest number of fruiting branches (sympodia) at first NAWF while CIM435 produced the lowest sympodial branches at first flowering (Ist NAWF). The data regarding days from NAWF-5 to boll opening shows that Vihari-53 was very speedy in growth and took least number of days from cutout to boll opening while CIM435 took almost 11 days to open bolls beyond cutout. The correlation of NAWF-5 with the traits such as yield of seed cotton, boll number/plant, boll weight and fibre micronaire is very helpful in monitoring and management of the crop. Increased days to NAWF-5 has a considerable negative impact on seed cotton yield indicating that if physiological maturity is delayed, it translates into increased vegetative growth delaying the reproductive phase of the crop causing decreased yield (Table 2). These results are confirmed by Benson and Bourland (1993) who reported that cotton cultivars showing late maturity had increased days to NAWF-5 related to increased early season growth, large plant structures (number of nodes and branches and plant height) and low boll retention in early set positions. Similarly delayed physiological maturity produce low quality fibre showing a negative correlation between days to NAWF-5 and Micronaire values of cotton crop which is being confirmed by Cook and El-Zik (1991), who also found a negative correlation of NAWF-5 with fibre length and fibre Micronaire. Boll weight and boll number have a considerable positive correlation with NAWF-5 indicating that more days to NAWF-5 translates into more vegetative growth resulting into increased boll number and boll weight. Oosterhuis *et al.* (1993) also confirmed this relationship.

The understanding of events such as appearance of first square (flowering bud), first flower and first boll split described in terms of degree days 60s (heat units) helps to design and implement crop management practices which are efficient and profitable. Table 4 shows number of degree days (Heat Units) consumed by the varieties in case of various developmental stages. The table indicates

that VH-53 and FH-634 availed the least number of degrees days, while CIM 443 and CIM 435 were medium and MNH-93 and CIM 1100 took the highest thermal units for germination. CIM 443 and CIM 1100 squared nearly at the same number of DD 60s while FH 634 squared latest except CIM 1100. Flowering buds took least number of DD 60s to bloom in case of VH-53 while CIM 435 took the highest number of DD 60s to produce flowers. Finally CIM 443 consumed least number of DD 60s to open bolls followed by VH 53, MNH-93, FH-634, CIM 435 and CIM 1100, respectively.

Charles (1994) while working on cotton varieties, DPL50, DPL-90 and Acala Mexxa in Tennessee, USA, reported that these varieties consumed 56-60 DD60s to germination, 425-475 DD60s from germination to square formation and 775 to 850 DD60s from planting to first bloom.

Table 3 shows the performance of cultivars regarding yield components and fibre quality traits. CIM 435 is the highest in boll weight as compared to the rest of the varieties, but boll number/ plant is the least in CIM 435. whereas the boll number/plant in CIM 1100 is the highest as compared to other varieties. VH-53 produced highest yield per plant among all the varieties. The data regarding fibre length showed that CIM 435, CIM 1100 and FH 634 have long fibre while rest of the varieties produced medium long fibre. The data regarding fibre strength indicated that VH-53 has medium fibre strength while FH-634 gave very low strength fibre. CIM 435 gave low strength fibre while, MNH-93, CIM 1100 and CIM 443 were categorized into very low strength fibre. The data regarding fibre micronaire indicated that CIM 443 has coarse fibre while, the rest of the varieties produced medium fine fibre.

References

Aden, S.A., 1997. Impact of nodal development, fruiting pattern and boll retention ability on earliness and yield in upland cotton. M.Sc. Thesis. Sindh Agric. Univ., Tandojam, Sind, Pakistan.

Anonymous, 2001. Area, production and yield of cotton from 1947 to 2001.

Bano, S.B., A.R. Soomro, A. Rehana, A.M. Memon and A.W. Soomro, 2002. Two preliminary reliable indicators of earliness in cotton-11. Asian Journal of Plant Sci., pp: 121-122.

Benson, N.R. and F. M. Bourland, 1993. Variation in plant structure and fruiting behaviour of cotton grown in Arkansas. Proc. Beltwide cotton. Res. Conf. National Cotton Council, Memphis, TN., 2: 616.

Bernhardt J.L., R.R. Phillips and N.P. Tugwell, 1986. Position of the upper most white flower defined by node counts as an indicator for termination of insecticide treatments in cotton. J. Econ. Ent., 79: 1430-1438.

Charles, P., 1994. Heat Units studied in various cotton varieties. Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council. Memphis, TN., 1: 79.

Coleman, P.A., 1993. Using plant monitoring to measure yield potential. Proc. Beltwide Cotton Prod. Res. Conf. National Cotton Council. Memphis, TN., 1:79.

Cook, C.G. and K.M. El-Zik, 1991. Influence of water stress, plant growth and fruiting characteristics of cotton on fibre quality. Proc. Beltwide Cotton. Prod. Res. Conf. National Cotton Council, Memphis, TN., 2: 259.

Guinn, G., 1985. Fruiting of cotton. 111. Nutritional stress and cutout. Crop Sci., 25: 981-985.

Karner, M.A., J.R. Goodson, P. Dugger and D. Richter., 1998. Nodes above white flower: indicator to use to terminate cotton insect scouting and insect control. Proc. Beltwide. Cotton. Conf., pp: 1326-1328.

Kerby T. and K. Hake, 1987. Monitoring cotton's growth. Cotton production, ANR Publication, University of California, Oakland, pp: 19-21.

Kerby T.A., R.D. Horrocks, and R.E. Plant, 1993. Plant monitoring to quantify vegetative vigor. Proc. Beltwide Cotton. Prod. Res. Conf. National Cotton Council, Memphis, TN., 2: 1177-1179.

Oosterhuis D.M., F.M. Bourland and N.P. Tugwell, 1993. Physiological basis for the nodes-above-white-flower cotton monitoring system. Beltwide Cotton Conf., 2: 1181-1183.

Rehana, A., A.R. Soomro and M.A. Chang, 2001. Measurement of earliness in upland cotton. Pak.. J. Biol. Sci., 4: 462-463.