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SHORT COMMUNICATION

COMPARATIVE PERFORMANCE OF A RAINFED COTTON VARIETY AND HYBRID UNDER LATE SOWN CONDITION

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The growth and physiological performance of a normal and late sown cotton variety (LRA 5166) and a hybrid (NHH44) was tested during 2003-04 and 2004-05 cropping seasons under rain-fed condition. Normal planting (D1) was done with the commencement of rain while, late sowing (D2) was done 15 days after D1. Phenological development of the variety and the hybrid was similar up to flowering however, the hybrid had an extended reproductive period compared to variety both in D1 and D2. Hybrids also accumulated more biomass and had higher LAI at reproductive phase and showed a strong correlation with photosynthesis rate (P_N). This higher P_N in addition to longer duration of reproductive stage enabled hybrids to produce far more number of squares and bolls compared to the variety in D2.

Key words: **Cotton, growth, hybrid, late sown, photosynthesis, variety, yield**

In India more than 60 % of the cotton is grown under rainfed conditions. Sowing is generally done with the commencement of rains, which generally occurs in 2nd or 3rd week of June. Varieties belonging to *G. hirsutum*, *G. arboreum*, and *G. herbaceum* and a number of inter-specific and intra-specific hybrids have been recommended for different soil types and agro-climatic conditions (Basu and Iyer 2004). Hybrids are exploited not only for their higher productivity under high input and optimum growing conditions, but also for their stability under adverse pedo-climatic conditions (Bhale 1999). Under sub-optimal, low yielding environments hybrids perform exceedingly well (Davis 1978). Bulk of the hybrid cotton area in India is rain-fed where cotton is sown with the onset of monsoon rains. Often, a delay in the onset of monsoon, inordinately delays sowing which in turn substantially reduces yield (Hebbar *et al*. 2002). Late sown crop is subjected to low temperature and terminal drought in the month of October and November. Although it is a known fact that hybrids out-yield varieties, yet, detailed information on the phenology, growth and physiological processes associated with this yield improvement is lacking in both normal and late sown conditions. This is essential for the calibration of models to simulate the growth and yield of hybrids.

Field experiments were conducted under rain fed conditions of Central Institute for Cotton Research Farm, Nagpur (21 ^{o}N and 79 ^{o}E) in Central India, during 2003-04 and 2004-05 seasons. A popular *Gossypium hirsutum* variety LRA5166 along with a popularly cultivated intra-hirsutum hybrid NHH44 were used in these experiments to study the phenology and growth at two dates of planting. Normal (D1) and late (D2) plantings were done on 25 June and 11 July in 2003-04 and 11 July and 26 July in 2004-05, respectively. Each genotype was grown in plots of size 20 m × 20 m and replicated six times. Fertilizer N (90 kg ha^{-1}) was applied in three splits at 20, 45, and 70 DAS. Phosphorus and potassium at the rate of 20 kg P and 37 kg K ha^{-1} were

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applied at sowing. Need based plant protection measures were taken up.

The duration required for 50% flowering (at least 50% of plants have one flower on the plant), and boll bursting was recorded. The heat unit required for various growth stages was calculated using 12.8 °C as base temperature (Young *et al*. 1980). At every 15 days interval, plants from 1 m^2 were cut at the cotyledonary node and used for assessing total above ground dry matter. Plant parts were separated into stem, leaf and fruiting parts (squares+flowers+bolls). They were weighed after drying to a constant weight. These weights were used in the calculation of biomass partitioning in various plant parts. The post squaring weights of fruiting parts and total biomass were used to calculate the reproductive growth rate and plant growth rate, respectively. At the end of boll opening, the seed cotton from the central 4 rows was manually harvested and weighed to determine the seed cotton yield. Photosynthesis (P_N) of the youngest fully expanded leaf (3rd leaf from top) was measured with a Portable Photosynthesis System (model *CIRAS-1*, *PP Systems*, UK) at 90 and 120 DAS. Measurements were taken in each plot at least twice under conditions of full sunlight, between 1200 and 1500 μmol m^{-2} s^{-1}.

The heat unit requirement for flowering (Table 1) was not influenced either by cultivar or date of sowing because the commercially cultivated varieties are known to be photo insensitive (Bhatt 1996, Reddy *et al*. 1997). However, normal sown crop accumulated more heat units compared to late sown crop. It is a known fact that in cotton the moisture deficit stress leads to early cut out (Guinn 1985) and thus the late sown crop had early maturity. NHH44 had an extended period of reproductive phase in both the experiments and thus matured later compared to LRA5166. Hence, the total heat units required for crop maturity was more in NHH44 compared to LRA5166.

Table 1. Heat units required for flowering and maturity, photosynthesis, yield and yield attributing characters of a cotton variety LRA 5166 and hybrid NHH 44 under normal (D1) and late sown (D2) condition of 2003-04 and 2004-05.

Treatments	**Heat units (°C)**		**Photosynthesis rate (μmol m^{-2} s^{-1})**		**Yield attributing characters**		
	Flowering	**Maturity**	**90 DAS**	**120 DAS**	**Yield kg ha^{-1}**	**Bolls $plant^{-1}$**	**Boll wt (g)**
2003-04							
LRA 5166 D1	1014	2383	-	-	935	19	2.288
LRA 5166 D2	1075	2232	-	-	433	26	2.256
NHH 44 D1	991	2567	-	-	1516	16	2.526
NHH 44 D2	1082	2313	-	-	907	22	2.374
2004-05							
LRA 5166 D1	1129	2270	22.40	20.23	857	21	2.336
LRA 5166 D2	1030	2010	17.90	18.83	649	29	2.306
NHH 44 D1	1129	2381	26.60	26.03	1206	11	2.592
NHH 44 D2	1062	2127	24.53	21.00	922	22	2.436
Mean							
LRA 5166	1062	2224	20.15	19.53	719	18	2.296
NHH 44	1066	2347	24.06	24.51	1138	24	2.482
Normal sown (D1)	1066	2400	24.50	23.13	1128	25	2.435
Late sown (D2)	1062	2170	21.71	19.40	728	17	2.343
CD at 5%							
Cultivar	NS	26	1.14	1.49	124	0.97	0.08
Date of sowing	NS	22	0.98	0.79	112	0.84	0.06

Leaf area index showed an initial lag phase for 45 days followed by an exponential increase up to 120 DAS (Fig. 1). The canopy build up was faster in NHH44 compared to LRA5166 in both the sowings. NHH44 had highest LAI of 2.8 as against 1.2 in LRA5166. LAI of D2 reduced by 39 and 20 % in NHH44 and LRA5166, respectively. Similar to LAI, biomass accumulation too showed an initial lag phase and thereafter, it increased sharply (Fig.1). Unlike the LAI, biomass accumulation continued to increase throughout the observation period (150 DAS). In D2, the difference between the hybrid and variety for LAI and biomass accumulation narrowed down suggesting that hybrids had lost their vigor under late sown condition (Blum *et al*. 1990, Meyer *et al*. 2004).

Seed cotton yield of D1 was significantly higher than D2 (Table 1). In a multi-location trial earlier, we had seen similar response of cotton to delayed sowing (Hebbar *et al*. 2008). Hybrid NHH44 significantly out yielded the variety LRA5166 in both the years. D2 of hybrid yielded more than D1 of variety. Unlike boll weight, the number of bolls/plant showed significant variation with date of sowing (Table 1). Normal sown crop had 39 % and 24 % more bolls than late sown crop in 2003-04 and 2004-05, respectively. Boll weight of NHH44 was significantly higher than LRA5166.

At early seedling growth nearly 70 to 75 % of the biomass is partitioned to the leaf and rest to the stem (Fig. 2). This proportion was marginally higher in

Fig. 1. Leaf area index (LAI) and dry matter accumulation in relation to days after sowing of a cotton variety LRA5166 (V1) and hybrid NHH44 (V2) under normal (D1) and late sown (D2) condition

Fig. 2. Biomass partitioning into leaf, stem and fruiting parts of a cotton variety LRA5166 and hybrid NHH44 under normal (D1) and late sown (D2) condition

LRA5166 than NHH44. At 65 DAS almost equal amount of biomass was apportioned to the leaf and stem. Biomass partitioning to the leaf and the stem was in the proportion of 0.70:0.30, 0.52:0.42 and 0.34:0.50 in NHH44 and 0.72:0.28, 0.53:0.42 and 0.38:0.42 in LRA5166 at early seedling, squaring and flowering, respectively. Expansion of leaves and stems was limited during the fruit-growing period. Between flowering and start of boll fill 0.25 of biomass and between the start of the boll fill and the end of the maturity nearly 0.6 of the biomass was partitioned to fruiting parts. The fraction was higher in NHH44 compared to LRA5166 especially under D2.

Photosynthesis rate of D2 was significantly lower than D1 (Table 1). LRA5166 had lower P_N than NHH44 both in D1 and D2. P_N reached its peak at 90 DAS in D1 while, in D2 it was high at 120 DAS. P_N has positive association with developing bolls (Hebbar *et al*. 2007). From the Fig. 2 it is evident that the biomass accumulation in bolls (fruiting parts) peaked around 90 DAS in D1 while, at 120 DAS in D2 as the boll development is slow under low temperature. As with the boll load, P_N of NHH44 was significantly higher compared to LRA 5166 in D2. Thus both longer reproductive period and higher P_N contributed to higher yield of hybrid NHH44 under late sown condition.

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