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Influence of different levels of nitrogen and dates of sowing on chlorophyll content, dry matter production and yield of cotton cv. SVPR 4

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Abstract
A field investigation was carried out at Agricultural College and Research Institute, Madurai during 2016 under irrigated condition with cotton cv. SVPR – 4 to study the effect of different levels of N and dates of sowing on chlorophyll content, dry matter production (DMP), no. of bolls plant^{-1} and seed cotton yield. The experiment was designed in Factorial randomized block design with four replications. The experiment details on factor I was assigned with two dates of sowing (D_1-21st September, D_2 -6th October). Factor II comprised with three N levels (N_1-80 kg N ha^{-1}, N_2-60 kg N ha^{-1}, N_3 -100 kg N ha^{-1}). Among the dates of sowing, D_1 recorded higher chlorophyll content, DMP, no. of bolls plant^{-1} and seed cotton yield. Nitrogen level significantly increased the chlorophyll content and higher values of DMP recorded at N_3 and the no of bolls plant^{-}1, seed cotton yield was higher in N_1. Among the treatment combinations, D_1N_3 and D_1N_1 were found significantly higher chlorophyll content, DMP and no. of bolls plant^{-1} and seed cotton yield.

Keywords: Chlorophyll content, DMP, dates of sowing, nitrogen levels and seed cotton yield

Introduction
Cotton is the most important commercial crop grown in all over the world, so popularly known as the "White Gold". It is a perennial with indeterminate growth habit belonging to the genus *Gossypium* under tribe *Gossypieae* of *Malvaceae* family. It is an important fibre crop that plays a significant role in reduction of unemployment, financial stability improvement, national and international industrial development and is a big source of raw material for textile industries, spindles and oil expelling units all over the world (Ahmed *et al*., 2009) [1]. Cotton accounts for more than 70 % of the raw fibre used by the world textile industry and handlooms. Hence it is also called "King of fibre" (James, 2006) [7]. It contributes not only fibre to the textile industry but also edible oil which plays an important role to meet out the ever increasing demand of edible oil in the country. In India, cultivated cotton species *viz*., *Gossypium arboreum, G. herbaceum, G. hirsutum and G. barbadense* are grown on commercial scale (Singh and Kairon, 2008) [12].
Nitrogen (N) is the key limiting nutrient for cotton production on irrigated condition. Nitrogen management practices under cotton cultivation in India is highly inefficient but can be substantially improved through better fertilizer management (Kienzler, 2010) [8]. Chaudhry (2007) [4] reported that N fertilization has contributed greatly to cotton production, because it plays a pivotal role to cotton growth and yield. The cotton production in the country is highly variable due to its wide adaptability in different climate regions. In the present scenario of climate change led global warming, there is great challenge of sustainable cotton production. Different weather parameters (*i.e.* temperature, rainfall, humidity *etc*.) affects phenology, development and yield of cotton crop. These morphological adaptations in terms of canopy development, light interception, source sink relationship and assimilates partitioning are the major determinant of lint yield and quality. So the optimum time of sowing plays a vital role in realizing potential crop yields (Yang *et al*., 2014) [13]. Hence an attempt has been made to study the effect of different levels of N and sowing dates on the crop growth and yield of cotton.

Materials and methods
The experiment was conducted in field no. C.46 of the Central Farm, Agricultural College and Research Institute TNAU Madurai, under irrigated condition during 2016-17.

The experimental site is geographically situated at 9º 54'N latitude and 78º 54'E longitude at an altitude of 147 m above mean sea level. The farm is situated in the Southern agro-climatic zone of Tamil Nadu. The location falls under the climate of semi-arid with the mean annual rainfall of 893 mm and the mean maximum and minimum temperature of 33.66 ˚C and 20.81 ˚C, respectively. The mean daily pan evaporation and relative humidity recorded during the crop season were 4.90 mm and 62.91 per cent, respectively. An amount of 539 mm was received during the experimental period. The soil of the experimental fields was well drained and sandy clay loam in texture. The soil was neutral in reaction and low in available nitrogen (234.4 kg ha^{-1}), medium in available phosphorus (14.88 kg ha^{-1}) and available potassium (198.50 kg ha^{-1}). Cotton cv. SVPR 4 with duration of 150-160 days belonging to the species of *G. hirsutum* was chosen for this study.

The experiment was laid out in Factorial randomized block design with four replications. The Treatment details are as follows *viz*, factor I includes dates of sowing: D_1-21th September – 2016, D_2-6th October – 2016.Three levels of nitrogen N_1- Normal 80 Kg N ha^{-1} (100 %), N_2-Lesser than normal 60 Kg N ha^{-1} (-25 %), N_3 - Higher than normal 100 Kg N ha^{-1} (+25 %) were allotted in factor II. Nitrogen, phosphorus and potassium were applied in the form of urea (46 per cent N), single super phosphate (16 per cent P_2O_5) and muriate of potash (60 per cent K_2O), with a recommended level of 80:40:40 kg NPK ha^{-1}. Entire dose of phosphorous, 50 per cent of N and K were applied as basal. The balance dose of N was applied in two splits according to the treatments, at the time of square initiation (45 DAS) and peak flowering (75 DAS).

The observations on *viz.*, Chlorophyll content of leaves was estimated as described by Peng *et al*. (1993) [9] using the chlorophyll meter (SPAD – 502, Soil Plant analysis Development Section, Minolta Camera Co. Ltd., Japan). The readings were recorded on the upper most fully expanded leaves in five randomly chosen plants at different growth stages. The average values were worked out and expressed as SPAD readings. DMP was measured at 30, 60, 90 and 120 days after sowing. The no. of bolls $plant^{-1}$and seed cotton yield were recorded at harvest stage. The data were subjected to statistically analyse.

Results and Discussion

Chlorophyll content (Table.1)

Nitrogen levels significantly influenced the chlorophyll content at all the stages of observation. Among the three different nitrogen levels, maximum chlorophyll values of 46.61, 44.81, and 41.45 were recorded at 60, 90 and 120 DAS, respectively with application of N_3 -100 kg N ha^{-1}, followed by N_1- 80 kg N ha^{-1} (39.67, 37.41, and 35.39). Plants grown under N_2-60 kgNha^{-1} recorded significantly low chlorophyll content (32.75, 32.31, and 30.19) compared to other nitrogen levels.

Among the different dates of sowing, significantly higher chlorophyll content of 41.57, 40.42, 37.46 were observed with sowing of 21st September (D_1), which was followed by sowing of 6th October (D_2). The interaction effect was found to be significant. Among the different combinations September 21st (D_1) sown crop with higher than recommended dose of N 100 kg N ha^{-1} (N_3) (D_1N_3) recorded significantly higher chlorophyll values of 50.01, 48.65, 44.65 at 60, 90, 120 DAS respectively, than the other treatment combinations. This might be due to increase the application of nitrogen levels, increase the synthesis of chlorophyll and thus results in higher chlorophyll content. These findings are in close vicinity with those reported by (Brar *et al*., 2000) [3].

Table 1: Effect of different levels of Nitrogen and dates of sowing on Chlorophyll SPAD values of cotton

Treatment	60 DAS				90 DAS				120 DAS			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
D_1	40.98	33.73	50.01	41.57	38.95	33.67	48.65	40.42	36.66	31.09	44.65	37.46
D_2	38.36	31.78	43.21	37.78	35.87	30.96	40.98	35.93	34.12	29.3	38.26	33.89
Mean	39.67	32.75	46.61		37.41	32.31	44.81		35.39	30.19	41.45	
	D	N	D XN		D	N	D X N		D	N	D X N	
SEd	0.71	0.87	1.24		0.72	0.89	1.26		0.68	0.83	1.18	
CD(P=0.05)	1.53	1.87	2.65		1.56	1.91	2.70		1.46	1.79	2.53	

Dry matter production (Table 2)

Significantly higher dry matter production (DMP) was recorded under September 21st (D_1) (711,2244,3551,5468 kg ha^{-1}),which was closely followed with October 6th (657,2125,3323,5210 kg ha^{-1})at 30,60,90,120 DAS. Among the various nitrogen levels, 100 kg N ha^{-1} (+25%) (N_3) recorded higher DMP (748, 2268, 3831, 5808 kg ha^{-1}) followed by recommended dose of N 80 kg N ha^{-1}(N_1) (674, 2225, 3412, 5432 kg ha^{-1}).The lower DMP was registered under 60 kg N ha^{-1}(-25%) (N_2) (630, 2061, 3068, 4777 kg ha^{-1}). Among the interactions significantly higher DMP was observed under 100 kg N ha^{-1}(+25%)(N_3) with September 21st (D_1)(D_1N_3) (795,2342,3987,5903 kg ha^{-1}).This might be due to the fact that over nitrogen encourages vegetative growth because of higher uptake of N. Elevated nitrogen supply can boost dry matter content through production of photo-assimilates through leaves which is the center of plant growth during vegetative stage and later distribution of assimilates to the reproductive organs. Synchronization of crop N demands with its supply is crucial for improving crop nitrogen use efficiency (NUE). Nitrogen demand for a crop is strongly related to yield potential which in turn is associated with N supply and crop management. This findings matched with the earlier findings of Yousaf *et al*. (2016) [14]

The planting time strongly influenced N status in cotton leaves, between the dates of sowing September 21st recorded higher chlorophyll content, growth and yield. Ansari and Mahey (2003) [2] reported that normal sowing of cotton (1st May) produced more plant height, LAI and total dry matter accumulation and finally producing higher seed cotton yield ha^{-1} as compared to late sown crop (29th May).

Table 2: Effect of different levels of Nitrogen and dates of sowing on total dry matter production in cotton

Treatment	30 DAS (kgha^{-1})				60 DAS (kgha^{-1})				90 DAS (kgha^{-1})				120 DAS (kgha^{-1})			
	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean	N_1	N_2	N_3	Mean
D_1	688	650	795	711	2311	2078	2342	2244	3542	3123	3987	3551	5514	4987	5903	5468
D_2	661	610	700	657	2139	2044	2193	2125	3281	3012	3675	3323	5349	4567	5713	5210
Mean	674	630	748		2225	2061	2268		3412	3068	3831		5432	4777	5808	
	D	N	D XN		D	N	D X N		D	N	D X N		D	N	D X N	
SEd	10.80	13.23	18.72		21.86	26.77	37.87		30.33	37.15	52.55		40.127	49.145	69.50	
CD (p=0.05)	23.13	28.32	40.06		46.78	57.30	81.03		46.78	57.30	81.03		46.78	57.30	81.03	

No of bolls plant^{-1} and Seed cotton yield (Table.3)

The nitrogen levels had significant influence on no. of bolls plant^{-1} and seed cotton yield. The recommended dose of N 80 kg ha^{-1} (100%) (N_1) recorded significantly higher no. of bolls plant^{-1} and seed cotton yield (kgha^{-1}) of (56.75, 2649), which was closely followed by higher than the recommended dose of N 100 kg ha^{-1} (+25%) (N_3) (51.38, 2373).The lesser no. of bolls plant^{-1} and yield was recorded under 60 kg N ha^{-1} (-25%) (N_2) (44.50, 1787). The nutrient provide adequate amounts rather than low or high amounts to the crop as it is needed by the crop and the yield decreases some times as a result of N application above an optimum level (Howard *et al*., 2001) [6]

Between the dates of sowing, September 21st (D_1) recorded significantly higher no. of bolls plant^{-1} and seed cotton yield kg ha^{-1} of (54.0, 2469) which was followed with October 6th (D_2) (47.75, 2070). Number of bolls per plant and seed cotton yield ha $^{-1}$.This might be due to favorable climatic condition prevailed during the early sown crop. Similarly, Dhoble *et al.* (1988) [5] also reported that early sowing of cotton on 20th June recorded the highest seed cotton yield over sowing on 30th July. This may be because of full utilization of rain water right from its sowing period of favorable climatic condition resulting in increased no. of bolls per plant and boll weight.

Interaction between nitrogen levels and dates of sowing was found to be significant. Among the interaction effect recommended dose of N 80 kg ha^{-1} (100%) (N_1) with September 21st (D_1) (D_1N_1) recorded highest no. of bolls plant^{-1} and seed cotton yield kg ha^{-1}(62.0, 2794) followed by application of N 100 kg ha^{-1}(+25%) (N_3) with September 21st (53.75, 2548) and was on par with recommended dose of N 80 kgha^{-1}(100%) with October 6th dates of sowing (51.50, 2503). The lowest no. of bolls plant^{-1} and yield of (42.75, 1510) were observed in the treatment with N 60 kg N ha^{-1}(-25%) with October 6th (D_2N_2). This might be due to suitable amounts of photosynthates provided at boll formation stage which result into proliferation of bolls. These results are in agreement with Ram Parkash and Mangal Prasad (2000) [10]. Ravankar *et al.* (2001) [11] also observed that lower doses of nutrients decreased the yields as well as less uptake of nutrient by the crops.

Table 3: Effect of different Nitrogen levels and dates of sowing on no. of bolls plant^{-1} and seed cotton yield

Treatment	No. of bolls plant^{-1}				Seed cotton yield (kg ha^{-1})			
	N_1	**N_2**	**N_3**	**Mean**	**N_1**	**N_2**	**N_3**	**Mean**
D_1	62.00	46.25	53.75	54.00	2794	2064	2548	2469
D_2	51.50	42.75	49.00	47.75	2503	1510	2198	2070
Mean	56.75	44.50	51.38		2649	1787	2373	
	D	N	D X N		D	N	D X N	
SEd	1.05	1.28	1.82		41.10	50.34	71.20	
CD(p=0.05)	2.25	2.76	3.90		87.97	107.74	152.37	

Conclusion

From this study, it is concluded that between dates of sowing September 21st recorded higher chlorophyll content, DMP, no. of bolls plant^{-1} and seed cotton yield. Among the varying nitrogen levels 100 kg N ha^{-1} significantly increased the chlorophyll content and higher values of DMP were recorded and the no of bolls plant^{-1} and seed cotton yield was higher in 80 kg N ha^{-1}.

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