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Interactive Effect of Spacing and Nitrogen Fertilization on Yield Parameters and Economics of Cotton (*Gossypium hirsutum* L.) Variety H-1098(i)

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ABSTRACT

A field trial was conducted at cotton research station, Sirsa, Haryana, India during the kharif season to study the performance of H-1098 (i) cotton variety under different spacing and nitrogen levels. The experiment was carried out in split plot design consisting of four spacing levels placed in main plots while sub plot contained four different doses of nitrogen with three replications.H-1098(i) variety of cotton was tested under different spacing viz; 67.5 cm × 10 cm, 67.5 cm × 15 cm, 67.5 cm × 22.5 cm and 67.5 cm × 30 cm and nitrogen levels viz; 75%, 100%, 125%, and 150% application of the recommended dose of nitrogen. Recommended dose of nitrogen of cotton crop was 87.5 kg/ha. Results demonstrated that spacing of 67.5 cm × 30 cm recorded significantly maximum seed cotton yield per plant whereas, higher seed cotton yield per hectare was produced in 67.5 cm × 15 cm spacingand while, 67.5 cm × 10 cm spacing had significantly higher stick and biological yield as compared to rest of treatments. Higher gross returns (115905 Rs/ha), net returns (58122 Rs/ha) and benefit cost ratio (2.0) was achieved with 67.5 cm × 15 cm spacing than rest of three spacing. In the term of fertilization, increased level of nitrogen significantly increased the yield parameters such as yield/plant, yield/hectare, stick yield, biological yield and economical parameters of net returns and benefit cost ratio (B:C) up to 125% Recommended dose (RD) of nitrogen which remained statisticall yat par with 150% RD of nitrogen. In conclusion, different levels of crop geometry and nitrogen doses had significant effect on performance, yield, productivity and economics of cotton cultivar H-1098 (i).

Keywords: *Gossypium hirsutum L., Nitrogen levels, Spacing, Economics, Yield, Productivity.*

INTRODUCTION

Cotton (*Gossypium spp.*) is a major fibre crop or cash crop cultivated in 80 countries with India ranking first in both area and production in the world.

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The top 5 cotton grown countries are India, China, USA, Pakistan and Brazil. Cotton is a money-making crop contributing nearly 75 % of total raw material needs of textile industry in India (Anonymous, 2015). It belongs to *Malvaceae* family, genus *Gossypium* (Singh et al., 2009) exist in tropical and subtropical regions of India. It is grown mainly for fiber purposes which utilized in the manufacturing of clothes for mankind. In spite of severe competition from synthetic fiber, it continues to enjoy a place of prime importance in the textile industry. In recent years, cotton clothing is being preferred than synthetic ones due to the increasing health consciousness among the people. Therefore, To address the accelerating fiber needs of the textile commerce and global trade, cotton production wants to be faster not only through the inclusion of more land areas of cotton but also through a more focused on agricultural practices including plant density and fertilizer management of genotypes for enhancing livelihood and improving financial status of farmers (Malik et al., 2019). The productivity of cotton in India is low as compared to world's productivity therefore to reduce this yield gap, there is requirement to modify and developed different combination of suitable agronomical practices under a known edaphic and environment conditions. Also due to increasing population pressure and limited land availability, it has become necessary to increase our production target which can be accomplished through high density planting (Ali et al., 2011). *Hirsutum* cotton varieties demand more appropriate spacing and nutrient to maximum yield under various conditions. There is a positive relationship between plant population and seed cotton yield. The most appropriate spacing enable plant to take best advantage of growing state as it is ultimately linked with root development as well as shoots growth. Growing of cotton cropunder narrow plant density had higher yield, net returns and benefit cost ratio (B: C)than wider plant density (Kumar et al., 2017).The performance of cotton is influence with different rate of fertilizer application under different spacing therefore, it is essential to recognize the best amalgamation of spacing and fertilizer. Satisfying the nutrient requirement of cotton is vital to gain higher yield and economic benefits. Nitrogen (N) is the essential macro-nutrient which should apply at right time and precise quantities (Giri et al., 2014). Thus, an acceptable spacing and nitrogen quantity for cotton crop can enhance the production through efficient utilization of inputs and affecting plant stand per hectare. The productivity and profitability of *Gossypium hirsutum* can enrich through appropriate spacing and fertilizer doses (Kumar et al., 2011). The variety under investigation is a sympodial type which select for growing under narrow spacing. Therefore, keeping in view of above aspects, a present study is undertaken to know the effect of different spacing and nitrogen levels on yield parameters and economics of cotton.

MATERIALS AND METHODS

The Experiment was conducted at cotton research station (CRS), Sirsa, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India during *Kharif season* of year 2015. Sirsa district is situated in the semi-arid, sub-tropical region in the state of Haryanaat an altitude of 202 meters above mean sea level (msl) having 29°25′ N latitude, 74°40′ E longitude. Sirsa has a typical semi-arid climate with hot and dry winds during summer season and severe cold during winter season. The mean monthly maximum and minimum temperature indicate a wide assortment of variations having 48°C during summer months of May and June and around freezing point accompanied by frost in winter months of December and January, respectively. Hot dry desiccating winds followed by frequent dust storms of high velocity and few showers of cyclonic rains during summer and cold winds during winter are widespread at this place.

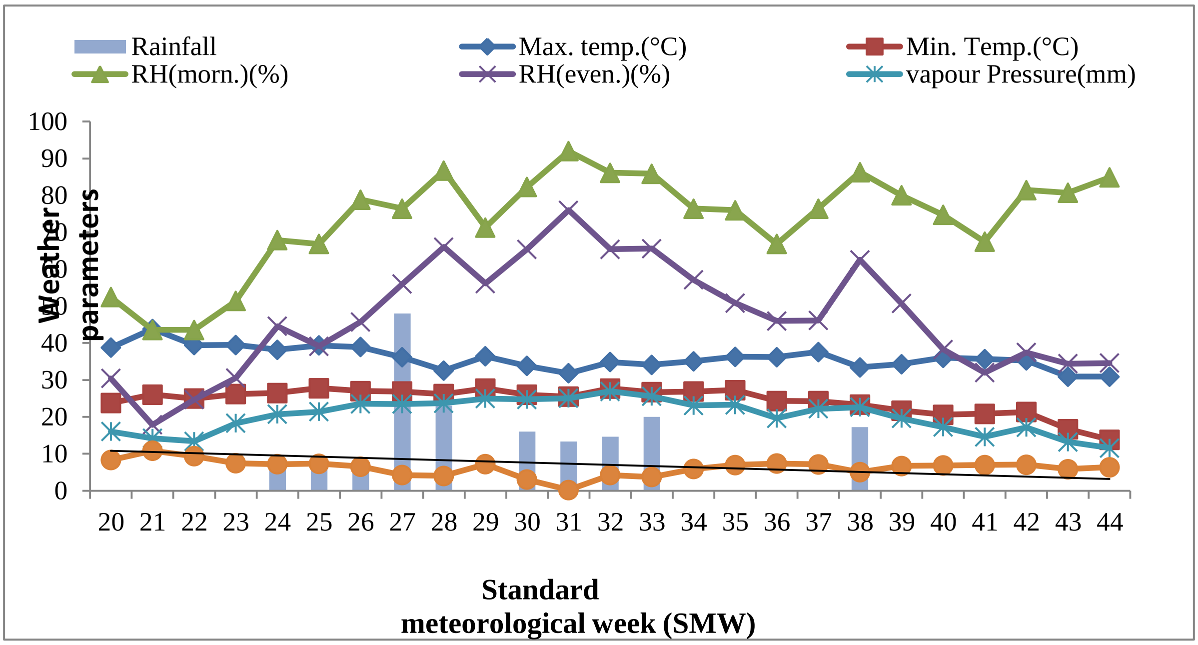

Fig. 1: Mean weekly meteorological data during crop growth period

Mean weekly values of important weather elements during the crop season 3rd week of May to 1st week of November recorded at the Meteorological Observatory at Central Institute of Cotton Research, Sirsa are depicted in fig.1. Rainfall OF 205.07 mm was received during the crop season and the maximum and minimum temperature during the crop season varied from 30°C to 43°C and 13°C to 27°C, respectively. The mean monthly weather data prevailed during crop growing season is also given in table-1.

Table 1: Mean monthly meteorological data during the crop growing season (May–Nov 2015)

Month	Temperature (°C)		Vapor Pressure (mm)		Relative Humidity (%)		Bright sunshine (h)	Rainfall (mm)
	Max.	Min.	Morn.	Even.	Morn.	Even.		
MAY	41.0	24.5	14.8	12.2	47.2	22.0	8.9	0.1
JUN	38.7	26.6	20.8	20.1	64.5	39.4	7.1	0.8
JUL	33.7	25.8	23.3	23.5	76.7	58.6	4.5	2.9
AUG	34.6	27.0	25.1	25.2	83.6	63.5	4.3	1.4
SEP	35.4	23.6	20.7	21.3	77.2	51.2	6.6	0.6
OCT	33.9	19.2	16.1	14.2	77.1	35.7	6.7	0.0
NOV	27.1	12.2	12.2	10.7	77.7	40.7	6.1	0.1

The texture of the experimental field is loamy sand and the soil was normal with respect to electrical conductivity (0.56dS m^{-1}), slightly high in pH (8.5), low in organic carbon(0.35 %), available nitrogen (137.0kg ha^{-1}) and medium in available phosphorus (13.4 kg ha^{-1}) and high in available potash(413 kg ha^{-1}). The research on cotton was accompanied in split plot design (SPD) having four spacing (S1= 67.5 cm × 10 cm, S2 = 67.5 cm × 15 cm, S3= 67.5 cm × 22.5 cm and S4 = 67.5 cm × 30 cm) in main plots and four nitrogen rates (75%, 100%, 125%, and 150% of the recommended dose of nitrogen) in sub plots replicated thrice in plot size of 5.4 m × 6.3 m. There commended dose of nitrogen was 87.5 kg per hectare. H-1098 cultivar of cotton was sympo dial early maturing variety grown for late planting situation. According to spacing treatments, seeds were sown deep at 5 cm depth by hand dibbling on 19thMay, 2015. Different doses of nitrogen (N) were applied half at squaring stage and remaining half at flowering stage through urea, however, basal application of full dose of phosphorus was applied through DAP as per nitrogen treatment show ever, the others cultural practices were performed as per the university guidelines.

The reading of seed cotton yield per plantat each picking was taken through separately picked the seed cotton of 5 tagged plants from each plot whereas, seed cotton yield per hectare was measured by taking the total yield for net plot by adding the quantities of seed cotton picked in all the pickings to get total seed cotton yield from each plot which was subsequently converted to seed cotton yield per hectare. After collected seed cotton, plants from the net plot were cut at ground level and kept separately in each plot, Biological yield was worked out by summing the Seed cotton weight and Stick dry weight. Harvest index of crop is represented in terms of percentage. The harvest index was calculated plot wise by dividing the seed cotton yield by the total dry matter (seed cotton yield + stick yield) of the same plot and multiplied by 100 as given below:

$$HI = \frac{\text{Seed cotton yield (kg ha}^{-1}\text{)}}{\text{Biological yield (kg ha}^{-1}\text{)}} \times 100$$

The data of cost of cultivation was calculated treatment wise by addition of fixed cost and variable cost while net returns (Rs. ha^{-1}) was worked out by subtracting the cost of cultivation of each treatment from the gross returns of respective treatment. The cost of cultivation (Rs. ha^{-1}) and gross returns (Rs. ha^{-1}) of the crop were calculated on the basis of the approved market rates for input. Benefit cost ratio is the ratio of gross monetary returns to the cost of cultivation, which can also be expressed as returns per rupee invested. The study data collected during the study were statistically analyzed by using the technique of analysis of variance (ANOVA) described by Cochran and Cox (1963).

RESULTS AND DISCUSSION

Yield Parameters

Seed cotton yield/plant

The seed cotton yield per plant was significantly influenced by different crop spacing depicted in fig. 2A. The highest seed cotton yield/plant (49.8g) was recorded under 67.5 cm × 30 cm spacing which was significantly higher than rest of spacing. However, seed cotton yield/plant (22.3g) was found lowest with spacing of 67.5 cm ×10 cm. Under wider spacing, individual plant received optimum microclimate which had beneficial influence on plant development. These results were also confirmed by Giri et al. (2008) and Basavanneppa et al. (2012).

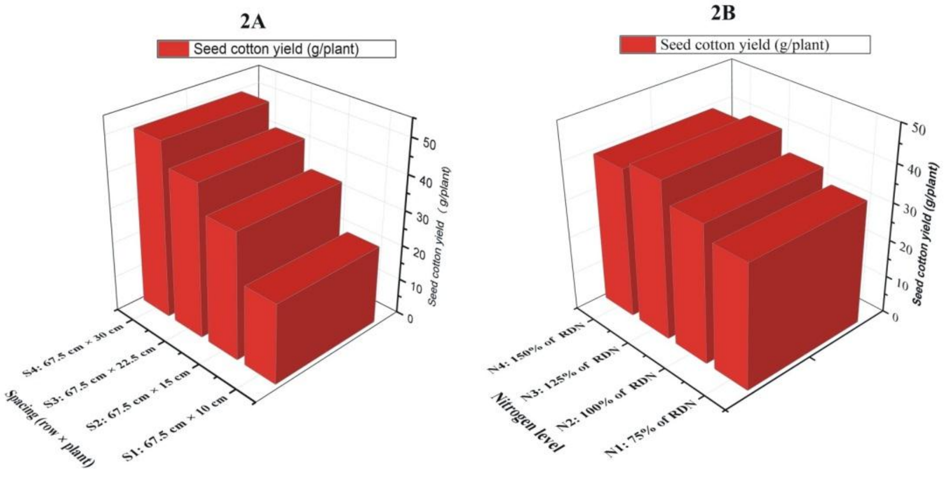

Fig. 2: Effect of spacing and nitrogen fertilization on seed cotton yield per plant

Likewise, Nitrogen levels had notably effect on seed cotton yield/plant presented in fig. 2B and yield/plant was increased significantly with increase in nitrogen levels up to 125% RD of nitrogen. The maximum seed cotton yield/plant was recorded with 125% RD of nitrogen, which was statistically at par with 150% RD but significantly higher than 75% and 100% RD of nitrogen. Seed cotton yield/plant obtained with 125% RD followed by 150% RD 100% RD and 75% RD of nitrogen were 41.8g, 39.6g, 36.6g and 33.1g respectively. The increased yield was resulted due to improvement in yield attributes i.e. number of picked bolls plant^{-1} and boll weight. Similar outcomes were also reported earlier by Seilsepour and Rashidi (2011) and Basavanneppa et al. (2012).

Seed cotton yield per hectare

Treatment differences with respect of seed cotton yield hectare^{-1} due to different spacing and nitrogen levels were observed significant (Table 2). Maximum seed cotton yield hectare^{-1} (2438 kg ha^{-1}) was obtained with plant spacing of 67.5 cm × 15 cm, which was significantly higher as compared to recommended spacing of 67.5 cm × 30cm (1971 kg ha^{-1}) due to more number of plants per unit area. These results are in accordance with those obtained by Devraj et al. (2011). However, Application of 125% RD of nitrogen recorded maximum yield (2354 kg ha^{-1}) which was significantly higher than 75% RD (1888 kg ha^{-1}) and 100% RD of nitrogen (2127 kg ha^{-1}) but statistically at par with 150% RD of nitrogen (2318 kg ha^{-1}). This was due to cumulative effect of application of higher dose of N which increased number of picked bolls/plant, seed cotton yield/plant and boll weight resulted into increased seed cotton yield hectare^{-1}. Similar results were reported by Kumar et al. (2011) and Asewar et al. (2013).

Table 2: Effect of spacing and nitrogen doses on seed cotton yield, stick yield, biological yield and harvest index

TREATMENTS	Seed cotton yield (kg ha^{-1})	Stick yield (kg ha^{-1})	Biological yield (kg ha^{-1})	Harvest Index (%)
Main plot: Spacing (row × plant)				
S1: 67.5 cm × 10 cm	2205	10314	12519	17.5
S2: 67.5 cm × 15 cm	2438	9023	11461	21.2
S3: 67.5 cm × 22.5 cm	2073	8346	10419	19.8
S4: 67.5 cm × 30 cm	1971	7816	9788	20.1
SE(m)±	65	148	176	0.5
CD (P=0.05)	222	521	611	1.7
Sub plot (Nitrogen level)				
N1: 75% of RDN	1888	8034	9922	19.1
N2: 100% of RDN	2127	8793	10921	19.5
N3: 125% of RDN	2354	9253	11608	20.4
N4: 150% of RDN	2318	9419	11737	19.8
SE(m)±	57	166	165	0.5
CD (P=0.05)	167	487	485	NS

RDN = Recommended Dose of Nitrogen (RD of N: 87.5 kg ha^{-1})

Stick yield, biological yield and harvest index

Significant difference was observed with respect to stick yield, biological yield and harvest index of crop due to different plant spacing and nitrogen doses (Table 1). Plant spacing of 67.5 cm × 10 cm recorded significantly higher stick yield (10314 kg ha^{-1})

and biological yield (12519 kg ha^{-1}) as compared to 67.5 cm ×15cm, 67.5 cm × 22.5 cm and 67.5 cm × 30 cm spacing. This was because of higher plant population per hectare. These results were also obtained by Bhalerao et al. (2010) and Ghule et al. (2013) recorded maximum stick and biological yield with closer spacing. However, there was an increasing trend in stick yield $hectare^{-1}$ with the increasing levels of nitrogen. The highest stick yield (9419 kg ha^{-1}) was recorded with 150% RD of nitrogen which was at par with yield (9253 kg ha^{-1}) at 125% RD of nitrogen but was significantly higher than 75% RD and 100% RD of nitrogen. Whereas, Application of 125% RD of nitrogen resulted into significant increase in biological yield $hectare^{-1}$ (11608 kg ha^{-1}) over 75% RD and 100 % RD of nitrogen, which remained statistically at par with further increase in nitrogen dose. This may be attributed to more number of sympodial branches coupled with increase in plant height. These findings are in conformity with the findings of Kalaichelvi (2009), Modhvadia et al. (2012) and Shukla et al. (2014). The 67.5 cm × 15 cm spacing recorded significantly higher harvest index of 21.1 % as compared to 67.5 cm ×10 cm but at par with 67.5 cm × 30 cm and 67.5 cm × 22.5 cm spacing whereas, application of different doses of nitrogen had no significant effect on harvest index but there was numerical increase in harvest index at higher levels of nitrogen upto 125% RD of nitrogen thereafter harvest index decreased at 150% RD of nitrogen.

Economics

The economics in the term of cost of cultivation, gross and net returns and benefit cost ratios of different treatment under investigation were showed in table 3. The total cost of cultivation (Rs. 58724 ha^{-1}) was recorded maximum with 67.5 cm × 10 cm spacing followed by 67.5 cm × 15 cm, 67.5 cm × 22.5cm and 67.5 cm × 10 cm spacing. Whereas, the maximum gross returns (Rs. 115905 ha^{-1}), net returns (Rs. 58122 ha^{-1}) and benefit cost ratio (2) were obtained with cotton growing at 67.5 cm × 15 cm spacing than rest of spacing. This was associated primarily due to higher seed cotton yield and stalk yield. The results were also observed by Shekar et al. (2012). Among different nitrogen levels, production cost (Rs. 57922 ha^{-1}) was observed maximum in 150% RD of nitrogen followed by 125% RD, 100% RD and 75% RD of nitrogen while The gross returns (Rs. 112783 ha^{-1}), net returns (Rs. 55118 ha^{-1}) and B: C (1.93) were highest in 125% RD of nitrogen followed by 150% RD, 100% RD and 75% RD of nitrogen. Similarly, Bharathi et al. (2012) and Gadade et al. (2015) also recorded higher gross returns, net returns and benefit cost ratio (B:C) with application of higher dose of nitrogen.

Table 3: Effect of different spacing and nitrogen levels on economics of cotton

TREATMENTS	Total cost of Cultivation (Rs ha^{-1})	Gross Returns (Rs ha^{-1})	Net Returns (Rs ha^{-1})	B:C
Main plot: Spacing (row × plant)				
S1: 67.5 cm × 10 cm	58724	108120	49396	1.83
S2: 67.5 cm × 15 cm	57783	115905	58122	2
S3: 67.5 cm × 22.5 cm	55414	99587	44172	1.79
S4: 67.5 cm × 30 cm	54755	94535	39782	1.7
Sub plot (Nitrogen level)				
N1: 75% of RDN	54749	91350	36600	1.66
N2: 100% of RDN	56338	102548	46209	1.81
N3: 125% of RDN	57665	112783	55118	1.93
N4: 150% of RDN	57922	111465	53543	1.92

RDN = Recommended Dose of Nitrogen (RD of N: 87.5 kg ha^{-1})

CONCLUSION

The Present study resulted that the yield potential and economical advantage of cotton variety H-1098(i) can be enhanced through planted it at narrow spacing (67.5 cm × 15 cm) along with application of 125% recommended dose of nitrogen (109.37 kg N/ha) . Broadcast the urea fertilizer in split dose with half quantity should apply at squaring stage and remaining half dose can give at flowering stage of crop for achieving higher seed cotton yield, stick yield, biological yield, harvest index, net returns and benefit cost ratio under the soil with low nitrogen status.

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