International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 1000-1003

Received: 01-09-2018
Accepted: 05-10-2018

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Performance of groundnut crop influence on dates of sowing and nitrogen levels, growth and yield of irrigated condition under changing climate in southern agro-climatic zones of Tamil Nadu

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Abstract
A study was conducted at the Agricultural College and Research Institute, Madurai to find out the influence on dates of sowing and nitrogen levels on the growth and yield of groundnut cultivar VRI-2 during *Rabi* crop season 2016. Twelve treatment combinations comprising of four dates of sowing (D_1:9th February, D_2:19th February, D_3: 29th February, and 9th D_4: March) and three N levels (Normal dose, 25% more, 25% less) was executed in factorial randomized block design with three replications. The growth parameters like plant height, dry matter production and leaf area index and yield of parameters like pod yield and haulm yield were significantly influenced by the dates of sowing. The highest pod yield and haulm yield were obtained from the plants sown during February 9th, followed by February 19th sowing. The variety VRI-2 recorded the highest pod yield and haulm yield. Delay in sowing reduced the crop duration and subsequently reduced the crop yield. Results of N levels highest influenced were significantly higher growth and yield parameters were influenced by N_3: Higher than normal and followed by N_1: Normal and lower on nitrogen levels was observed in N_2: Lesser than normal.Interaction between dates of sowing and nitrogen levels influenced highest growth and yield parameters significantly were D_1: 9thFebruary+ N_3: Higher than normal followed by D_1:9thFebruary+ N_1:Normal and lowest interaction was observed by D_1:9thFebruary+N_2: Lesser than normal.

Keywords: groundnut, climate change, D_1: 9thFebruary + N: normal sowing date, nitrogen levels, VRI-2

Introduction
Groundnut (*Arachis hypogaea*) is a C_3 leguminous oilseed crop grown during *Rabi* and *rabi* seasons in areas with the annual rainfall of 600 to 800 mm. It can be successfully grin drought prone area, however, during summer it requires irrigation. Groundnut is widely adapted to altering agro climatic conditions and soils, which has made its cultivation feasible in most of the tropical and subtropical countries. In Tamil Nadu, groundnut is cultivated over 3.38 lakh hectares with a production of 7.83 lakh tonnes. Out of which 70 per cent of the area is covered under rainfed crop and the remaining 30per cent is under irrigated conditions. The present study was undertaken to identify optimum date of sowing and N level for two ruling cultivars of groundnut for maximizing the productivity under changing climatic conditions.

Materials and Methods
The experiment was conducted at the Agricultural College and Research Institute, Madurai, during *Rabi* crop season 2016. The soil of the experiment field was sandy clay loam with low in available nitrogen (247 kgha^{-1}), medium in phosphorus (18.1 kgha^{-1}) potassium (362 kgha^{-1}) and organic carbon (0.48). Twelve treatment combinations with four dates of sowing D_1: February 9th, D_2: February 19th, D_3: February 29th, and D_4: March 9th and three N levels were tried in factorial randomized block design with three replications in D_1: 9thFebruary+ N: Normal the variety of Co(Gn 4).
The crop was sown with a spacing of 30 x 10 cm, Recommended fertilizer dose of 25 kgha^{-1} N, 50 kgha^{-1}P_2O_5 and 75 kgha^{-1} k_2O was followed. Nitrogen alone was applied as per the treatment (N_1-54.25kg/ha^{-1}, N_2-40.76kgha^{-1} and N_3-67.93kgha^{-1}). Intercultural operations were to maintain the field under weed free condition during crop season. Suitable plant protection measures were followed to keep the crop free form major insect pests.

Five plants were selected randomly and tagged in each treatment plots for the measured observation. The treatments were evaluated on the basis of growth parameters and yield parameters and were converted to per hectare for presenting the results.

Results

Phenology of Groundnut

The data on the mean phenology of groundnut viz., days to 50 % flowering, days to pod initiation and days to maturity are presented in Table 1. Different dates of sowing and nitrogen levels exerted significant influence on all the three parameters.

Table 1: Effects of dates of sowing and nitrogen levels on phenology of Groundnut.

Treatments	Days to 50% flowering	Days to pod initiation	Days to maturity
Dates of Sowing (D)			
D_1: 9th February	37	69	106
D_2:19th February	35	66	104
D_3:29thFebruary	33	63	102
D_4:9th March	31	61	99
Nitrogen levels (N)			
N_1: Normal (100%)	34	65	103
N_2: Lesser than normal (-25%)	33	64	102
N_3: Higher than normal (+25%)	35	66	104
SEd (D)	0.33	0.75	1.59
CD (0.05) (D)	0.68	1.56	3.29
SEd (N)	0.28	0.65	NS
CD (0.05) (N)	0.59	1.35	
SEd (Dx N)	NS	NS	NS
CD (0.05) (D x N)			

Days to 50% flowering

The mean number days to 50 % flowering significantly differed by various sowing dates. The days to 50 % flowering was observed on 37th days, in D_1:9th February sown crop, while it got delayed by 2,4 and 6 days, when the sowing was delayed to D_2:19th February (35days), D_3:29th February (33days) and D_4:9th March (31 days) respectively. With respect to N levels, the recommended dose of N application (N_3: Higher than normal) recorded 50% flowering on 35th day after sowing. When the N level was reduced by 25% (N_1: Normal), it got reduced by 1 day and if the N level is 25% reduced by (N_2) the days to 50% flowering for reduced by 2 days from the recommended level of N application. The interaction between dates of sowing and N levels with respect to days to 50% flowering is not statistically significant.

Days to pod initiation

The mean number days to pod initiation significantly differed by various sowing dates. The days to pod initiation was observed on 69 days, in D_1:9th February sown crop, while it got delayed by 3, 6 and 8 days when the sowing was delayed to D_2:19th February (66days) and D_3:29th February (63days) and D_4:9th March (61days) respectively. With respect to N levels, the recommended dose of N application recorded pod initiation on 66th day after sowing and N level was enhanced by 25% (N_3), it got delayed by 1 day and if the N level is recommended dose by (N_1), the days to pod initiation for reduced by 25% on days to pod initiation from the recommended level of N_2 application. The interaction between dates of sowing and N levels with respect to days to pod initiation is not statistically significant.

Days to maturity

The mean number days to maturity significantly differed by various sowing dates. For The days to maturity was observed on 106 days, in D_1:9th February sown crop, while it got delayed by 2, 4 and 7days when the sowing was delayed to D_2:19th February (104days) and D_3:29th February (102days) and D_4:9th March (99days) respectively. With respect to N levels and interaction between dates of sowing and N levels with respect to days to maturity was not statistically significant.

Growth parameters

The observation on growth parameters like plant height, dry matter production and leaf area index as influenced by different dates of sowing were recorded when groundnut repute forwards crop duration. The datas were presented in Table.2.

Table 2: Effects of dates of sowing and nitrogen levels on growth parameters of Groundnut

Treatments	Plant height (cm) 60DAS	Dry matter production (Kg/ha) 60DAS	Leaf area index (cm) 60DAS
Dates of Sowing (D)			
D_1: 9th February	35.22	8113.79	3.73
D_2:19th February	27.31	7811.65	3.55
D_3:29thFebruary	24.27	7592.87	3.48
D_4:9th March	19.00	6938.59	3.35
Nitrogen levels (N)			
N_1: Normal (100%)	26.32	7617.87	3.61
N_2: Lesser than normal (-25%)	24.14	6333.65	3.10
N_3: Higher than normal (+25%)	28.89	8892.16	3.87
SEd (D)	0.67	148.04	0.06
CD (0.05) (D)	1.40	307.03	0.13
SEd (N)	0.58	128.21	0.05
CD (0.05) (N)	1.21	265.90	0.11

SEd (Dx N)	1.17	256.41	0.11
CD (0.05) (D x N)	2.42	531.80	0.22

Plant height

The mean number of plant height 60DAS significantly differed by various sowing dates. The highest plant height was observed on 35.2, when it sowing dates on D_1:9th February sown crop, while it delayed 10 days interval on 27.3 and 24.2, when it sowing dates on D_2:19th February and D_3:29th February D_2:19th February and D_3:29th February, and lowest plant height dates of sowing was observed by 19.0 when it sowing the dates on D_4:9th March. With respect to N levels, the N application recorded highest plant height was 28.8, enhanced by 25% (N_3) followed by recommended dose by (N_1), and lowest plant height was observed on reduced by 25% (N_2) on plant height from the recommended level N application. The interaction between dates of sowing and N levels with respect to plant height was statistically significant.

Dry matter production

The mean number of dry matter production 60DAS significantly differed by various sowing dates. The highest dry matter production was observed on 8113.7kg/ha^{-1} and on par with 7811.65 kg/ha^{-1} when it was sowing dates on D_2:19th February and D_3:29th February sown crop, while it followed by 10 days interval delayed on 7592.8kg/ha^{-1} and lowest date sowing was observed by 6938.5kg/ha^{-1} when the sowing the dates on D_4:9th March. With respect to the N application recorded highest dry matter production was 8892.1kg/ha^{-1} N levels enhanced by 25% (N_3) followed by the N level (N_1), and lowest dry matter production was observed on reduced by 25% (N_2) on dry matter production from the recommended level N application. The interaction between dates of sowing and N levels with respect to dry matter production was statistically significant.

Leaf area index

The mean number of leaf area index 60 DAS significantly differed by various sowing dates. The highest leaf area index was observed on 3.73 when it was sowing dates on D_1: 9th February and followed by 3.5 and 3.4 when it was sowing dates on D_2: 19th February and D_3:29th February. The lowest date sowing was observed by 3.3 the sowing dates on D_4:9th March. With respect to the N levels application of N_3 recorded highest leaf area index was observed on 3.87 followed by 3.61 when it was application of N_1.The lowest leaf area index was observed by 3.1 when it application of N_2. The interaction between dates of sowing and N levels with respect to leaf area index was statistically significant.

Yield and Yield attributes

Number of matured pods / plant^{-1}

The observation on number of matured pods/plant^{-1},Shelling percent (%),100 seed weight(g), Pod yield (kgha^{-1}), Haulms yield (kgha^{-1}) as influenced by different dates of sowing were recorded when groundnut repute forwards crop duration. The datas were presented in Table.3.

The mean number of matured pods/plant^{-1} significantly differed by various sowing dates. The highest number of matured pods/plant^{-1} was observed on 31.53 when it was sowing dates on D_1: 9th February on par with 30.10 when it was sowing dates on D_2: 19th February. The lowest number of matured pods/plant^{-1} was observed by 28.73 the sowing dates D_3:29th February on par with 28.68 the sowing dates on D_4:9th March. With respect to the N levels application of N_3 recorded highest number of matured parts was observed on 30.68 and on par with 30.68, when it was application of N_3 followed by N_1. The lowest N levels was observed by 28.41 when it application of N_2. The interaction between dates of sowing and N levels with respect to number of matured pods/plant^{-1} was not statistically significant.

Table 3: Effects of dates of sowing and nitrogen levels on yield attributing characters and yield

Treatments	Number of matured pods / plant^{-1}	Shelling percent (%)	100 seed weight (g)	Pod yield (kg ha^{-1})	Haulms yield (kg ha^{-1})
Dates of Sowing (D)					
D_1: 9th February	31.53	88.25	71.18	2711.54	6763.75
D_2:19th February	30.10	82.49	67.32	2550.48	6483.60
D_3:29thFebruary	28.73	77.13	64.77	2261.32	6337.91
D_4:9th March	28.68	76.80	58.44	2123.97	5924.53
Nitrogen levels (N)					
N_1: Normal (100%)	30.19	80.84	65.54	2257.91	6582.17
N_2: Lesser than normal (-25%)	28.41	79.92	61.62	1741.33	5353.24
N_3: Higher than normal (+25%)	30.68	82.75	69.13	3236.25	7196.93
SEd (D)	0.70	1.28	1.01	59.36	101.38
CD (0.05) (D)	1.46	2.66	2.09	123.12	210.27
SEd (N)	0.61	1.11	0.87	51.41	87.80
CD (0.05) (N)	1.27	2.30	1.81	106.62	182.10
SEd (Dx N)	NS	2.22	1.74	102.82	175.60
CD (0.05) (D x N)		4.60	3.62	213.24	364.20

Shelling percent (%)

The mean of shelling per cent significantly differed by various sowing dates. The highest shelling per cent was observed on 88.25 when it was sowing dates on D_1:9th February followed by 82.49 when it was sowing dates on D_2: 19th February. The lowest shelling per cent was observed by 77.14 and on par with 76.80 the sowing dates D_3:29th February and D_4:9th March. With respect to the N levels of application was highest observed in 82.75 followed by 80.84 when the N application on extended 25% of N_3 and recommended level N_1.The lowest shelling percent observed on reduced levels of 25% of N_2.The interaction between dates of sowing and N levels with respect to shelling percent was statistically significant.

100 seed weight (g)

The mean of 100 seed weight significantly differed by various sowing dates. The highest 100 seed weight was observed on 71.18 followed by 67.32 when the dates of sowing D_1:9th February and D_2: 19th February. The lowest 100 seed weight was observed by 58.44 sowing dates on D_4:9th March. With respect to the N levels application of extended 25% of N_3 was highest observed in 69.13 followed by 65.54 recommended level N_1. The lowest 100 seed weight was observed on 61.62 reduced levels of 25% of N_2.The interaction between dates of sowing and N levels with respect to 100 seed weight was statistically significant.

Pod yield (kgha^{-1})

The mean of pod yield significantly differed by various sowing dates. The highest pod yield was observed on 2711.5 followed by 2550.4 when it was sowing dates on D_1:9th February and D_2: 19th February. The lowest pod yield was observed by 2123.9 sowing dates on D_4:9th March. With respect to the N levels application of extended 25% of N_3 was highest observed in 3236.25 followed by 2257.91 recommended levels of N_1. The lowest pod yield was observed on 1741.3 on reduced 25% of N_2. The interaction between dates of sowing and N levels with respect to pod yield was statistically significant.

Haulm yield (kgha^{-1})

The mean haulm yield significantly differed by various sowing dates. The highest haulm yield was observed on 6763.7, when it was sowing dates on D_1:9th February and followed by 6483.6 and on par with 6337.91 the sowing dates on D_2: 19th February and D_3: 29th February. The lowest haulm yield was observed by 5924.5 the sowing dates on D_4:9th March. With respect to the N levels application of extended 25% of N_3 was highest haulm yield observed in 7196.9 followed by 6582.1 recommended level of N_1. The lowest haulm yield was observed on 5353.2 on 25% reduced levels of N_2. The interaction between dates of sowing and N levels with respect to haulm yield was statistically significant.

Discussion

Bell *et al.* (1991) [2] also indicated that, groundnut cultivars vary by number of flowers produced. Craufurd *et al*. (2000) [3] who associated variation in fruit number to both the timing and the initial rate of flower production. These results from phenology of groundnut during crop duration Also, the differences in flowering pattern and days to 50% flowering demonstrate variation in flowers and flowering among the groundnut varieties and subsequently maximum pod maturity. Shwetha *et al*., (2017) [6] reported that growth parameters *viz*., plant height, dry matter production and leaf area index increased in the changing climate associated with treatments as compared to the dates of sowing. These results observed that the growth has increased in the plant height and dry matter production and leaf area index which may be influenced by to the factors that the carbon dioxide has enhance the crop growth. Sahu *et al*., (2004) [5] reported that yield and yield attributes of groundnut during rainy season were significantly influenced by times of sowing. Varieties did not exert significant influence on yield and yield attributes of groundnut. Due to changing weather variables, different sowing times altered the yield and yield components significantly except shelling percentage**.** Many of earlier studies are in line with the present findings which reported that groundnut being a C_3 plant, respond positively to temperature showed increase in photosynthetic rate, biomass, increased plant height, root length, shoot length, stem length, leaf area and total biomass compared to the a CO_2 condition.

Conclusion

These results were concluded that solution to improve dates of sowing and different nitrogen levels to enhance the growth and yield to increase crop production and productivity while enhancing growth and yield and protecting environmental quality. The present study shows that dates of sowing and different nitrogen treatments were recorded highest growth and yield parameters D_1 sowing and N_3 nitrogen levels of our indicate the *Rabi* season in the irrigated condition at the southern districts. The days to maturity decreased gradually with the delay in sowings. This may be due to increase in temperature and photo thermal environment encountered by the crop during the growth period. However, reduction in duration under fourth date sowing may be mainly due to exposed to higher maximum temperature (45.2°C) at flowering stage in experimental field.

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