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Influence of Sowing Dates and Plant Densities on Dry Matter Production and Nitrogen Uptake of Soybean under South Telangana Agro Climatic Zone of Telangana State, India

N. Mahesh[1*], G. Sreenivas[2], P. Leela Rani[3], Akhilesh Gupta[4], P.D. Sreekanth[5] and A. Madavi[6]

[1]Department of Agronomy, College of Agriculture, [2]Agro climate research center, ARI, [3]AICRP on Weed Management, College of Agriculture, [4]Department of Science and Technology, New Delhi, [5]NAARM, Rajendranagar, Hyderabad - 500 030; [6]Radio Tracer Laboratory, ARI, Professor Jayashankar Telangana State Agricultural University, India

**Corresponding author*

A B S T R A C T

Nutrient uptake by crop mainly depends on the dynamics of biomass accumulation during crop growing season. So a field investigation was carried out during *kharif* 2015-16 at Agricultural Research Institute, Professor Jayashanar telangana state Agricultural University Rajendranagar, Hyderabad with an object to find out the optimum sowing date and plant density. The experiment was carried out with three dates of sowing (26 June, 6 July and 16 July) as one factor and three plant densities 3,33,333 plants ha^{-1}, 1,66,666 plants ha^{-1} and 1,11,111 plants ha^{-1} as another factor in RBD (factorial) design replicated four times. The study revealed that 26 June sown crop recorded significantly more dry matter production, nitrogen uptake, seed yield and haulm yield over 6 July and 16 July sown crop. Among plant densities of 3,33,333 plants ha^{-1} recorded significantly higher dry matter production, nitrogen uptake, seed yield and haulm yield.

Keywords

Soybean, Plant densities, Sowing dates, TDM, Nitrogen uptake, Seed yield.

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Introduction

Soybean [*Glycine max* (L.) Merrill] is a miracle crop of the world being the most important oilseed and pulse crop. It is the second largest oilseed crop in India after groundnut and is being grown in varied agro-climatic conditions. It is unique two in one crop having both high quality proteins (40-42 %) and oil (18-20 %) content. In spite of its high yield potential (4.5 t/ha), soybean productivity is much less in India (1.07 t/ha) than the world average of 2.43 tonnes per ha (Vyas and Rupendra, 2014).

The productivity of soybean is low due to various constraints. The time of sowing has a considerable influence on growth and yield of soybean. Early sowing in the season may encourage higher vegetative growth which may invite various diseases and insects pests. However, delayed sowing may shrink the vegetative phase, which in turn reduces dry matter accumulation leading to poor partitioning to reproductive parts and ultimately poor realization of the potential yield.

Plant population is another important factor for higher yield realization through light penetration in crop canopy. If plant density is above the optimum, the plant growth may be poor due to competition for nutrients, light and space. On the other hand, if it is below optimum then the nutrients, space and light will not be utilized to their full extent, thus resulting into poor TDM and yield. For exploiting the potential of high yielding varieties, the optimum plant stand is very important non-monetary input. Nutrient uptake by crop mainly depends on the dynamics of biomass accumulation. Decreased uptake of nutrients by the crop was noticed with delayed sowing due less dry matter production. Therefore, it is imperative to find out the optimum planting density to obtain higher TDM and nutrient uptake to improve yield potential of soybean.

Materials and Methods

The field experiment was conducted at Agricultural Research Institute,, Rajendranagar, Hyderabad having $17^{0}19'$ N Latitude, $78^{0}23'$ E Longitude and 542.3 m above mean sea level during 2015 and 2016. The experiment was laid out in randomized block design (factorial) with three sowing dates (26 June, 6 July and 16 July) as one factor and three plant densities (3,33,333 plants ha^{-1}, 1,66,666 plants ha^{-1} and 1,11,111 plants ha^{-1}) as another factor, replicated thrice. The soil of the experimental site was sandy loam in texture, neutral in reaction, low in available nitrogen, phosphorus and high in available potassium. The other package of practices used recommended for raising the crop.

Plant samples of soybean were collected for dry matter estimation at flowering and physiological maturity stages from different treatments and the same were utilized for chemical analysis. At harvest, chemical analysis of seed and haulm was done separately. Nitrogen content in the plant sample was estimated by modified Microkjeldhal method (Piper, 1966). Nitrogen content analyzed from dried samples was multiplied by dry matter for calculating uptake and recorded in kg ha^{-1}. Data on different characters *viz.,* growth and yield components and yield, were subjected to analysis of variance procedures as outlined for randomized block design, factorial concept (Gomez and Gomez, 1984). Statistical significance was tested by F–value at 0.05 level of probability and critical difference was worked out where ever the effects were significant. Total N uptake was determined by using following formulae

$$\text{Nitrogen uptake by seed (kg ha}^{-1}\text{)} = \frac{\text{\% N in grain} \times \text{seed yield (kg ha}^{-1}\text{)}}{100}$$

$$\text{Nitrogen uptake by haulm (kg ha}^{-1}\text{)} = \frac{\text{\% N in haulm} \times \text{haulm yield (kg ha}^{-1}\text{)}}{100}$$

Results and Discussion

Dry matter production (g m^{-2})

Dry matter accumulation was affected by environment under different dates of sowing and plant densities, however neither of them interacted with each other. Intuitively, as yield increases, it directly contributes to total DM, and environmental differences in total DM accumulation can easily be explained by various factors affecting the crop growth rate like temperature and precipitation (Muchow, 1985). Per usual of data revealed that, higher dry matter accumulation was observed at all the growth stages in 26 June sown crop and was significantly superior to 6 July and 16 July sown crop (Table 1). Late sowing affected the plant stature resulting in pre-mature flowering before the plant could attain its full size. The crop sown under late planting conditions could not accumulate sufficient dry matter because of lesser vegetative growth and reproductive period due to shorter day length (Neenu *et al.*, 2017).

Among plant densities more dry matter accumulation was observed in 3,33,333 plants ha^{-1} at end of the juvenile phase, flowering, pod development and physiological maturity stages over other plant densities of 1,66,666 plants ha^{-1} and 1,11,111 plants ha^{-1}. The observed difference in DM accumulation during development may result from differences in climate, differential absorption of PAR due to variation in plant population and LAI, or differences in the efficiency of converting absorbed photosynthetic active radiation (APAR) into DM (Tollenaar and Aguilera, 1992). It may be due to better utilization of available resources viz., mineral nutrients, water, solar radiation, etc. (Jatinder and Badiyala, 2005). The increase in dry matter accumulation at higher plant densities could be attributed to more number of plants per unit area as well as more LAI (Bilal *et al.*, 2009).

Nitrogen uptake (kg ha^{-1})

Uptake of nutrients was significantly different under different dates of sowing and plant densities. The uptake increased due to higher biomass production under different treatments (Table 1). Maximum N uptake at flowering and physiological maturity (haulm and seed) was observed in 26 June sown crop and was and significantly superior to 6 July and 16 July sown crop (Table 2).

Table.1 Dry matter (g m^{-2}) production of soybean at different growth stages as influenced by dates of sowing and plant densities

Treatments	Crop Growth Stages							
	End of juvenile stage		Flowering stage		Pod development stage		Physiological maturity stage	
Date of sowing (D)	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
D_1 : 26 June	25	30	174	204	549	620	733	1061
D_2: 06 July	15	20	133	165	441	508	590	839
D_3 :16 July	10	13	108	119	251	343	272	686
S.Em±	1.6	1.3	4.3	7	34	23	47	38
CD (P=0.05)	4.8	3.9	13	21	101	67	138	111
Plant densities (S)								
S_1: 30x10 cm (3,33,333 plants ha^{-1})	24	29	191	209	560	645	738	1076
S_2: 30x20 cm (1,66,666 plants ha^{-1})	16	20	131	148	392	454	501	837
S_3: 30x30 cm (1,11,111 plants ha^{-1})	11	14	92	111	288	372	355	672
S.Em±	1.6	1.3	4.3	7	34	23	47	38
CD (P=0.05)	4.8	3.9	13	21	101	67	138	111
Interaction (D X S)								
S. Em±	2.8	2.3	7.4	12	59	40	89	65
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table.2 Nitrogen uptake (kg ha^{-1}) by soybean during different stages as influenced by dates of sowing and plant densities

Treatments	Crop growth stages							
			Physiological maturity					
	Flowering stage		Seed		Haulm		Total	
Date of sowing (D)	2015	2016	2015	2016	2015	2016	2015	2016
D_{1}: 26 June	57.2	65.7	53.6	92.8	20.4	37.3	73.9	130.1
D_{2}: 06 July	39.5	46.3	41.8	79.0	17.1	25.9	58.9	104.8
D_{3}:16 July	31.1	27.6	34.9	68.1	14.2	17.4	49.1	85.5
S.Em$\pm$	1	3.1	1.2	1.7	0.6	0.8	1.4	1.9
CD (P=0.05)	3	9.3	3.5	4.9	1.7	2.5	4.1	5.6
Plant densities (S)								
S_1: 30x10 cm (3,33,333 plants ha^{-1})	59.3	61.8	51.4	92.8	21.0	33.8	72.4	126.6
S_2: 30x20 cm (1,66,666 plants ha^{-1})	38.6	44.6	43.2	78.8	17.0	27.7	60.2	106.4
S_3: 30x30 cm (1,11,111 plants ha^{-1})	29.8	33.3	35.6	68.4	13.7	19.1	49.3	87.5
S.Em$\pm$	1	3.1	1.2	1.7	0.6	0.8	1.4	1.9
CD (P=0.05)	3	9.3	3.5	4.9	1.7	2.5	4.1	5.6
Interaction (D X S)								
S. Em$\pm$	1.8	5.5	2.1	2.8	1.0	1.5	2.4	3.3
CD (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS

Table.3 Seed yield and haulm yield (kg ha^{-1}) of soybean as influenced by dates of sowing and plant densities

Treatments	Seed yield (kg ha^{-1})		Haulm yield (kg ha^{-1})		Harvest index (%)	
	2015	2016	2015	2016	2015	2016
Dates of sowing (D)						
D_{1}: 26 June	1523	2409	1939	3182	43	43
D_{2}: 06 July	1277	2002	1650	2290	44	47
D_{3}:16 July	1027	1704	1338	1747	45	49
S.Em$\pm$	34	41	49	55		
CD (P=0.05)	100	121	144	161		
Plant densities (S)						
S_1: 30x10 cm (3,33,333 plants ha^{-1})	1460	2310	1924	2818	43	45
S_2: 30x20 cm (1,66,666 plants ha^{-1})	1277	2031	1631	2453	44	46
S_3: 30x30 cm (1,11,111 plants ha^{-1})	1089	1774	1372	1948	45	48
S.Em$\pm$	34	41	49	55		
CD (P=0.05)	100	121	144	161		
Interaction (D X S)						
S. Em$\pm$	59	71	84	95		
CD (P=0.05)	NS	NS	NS	NS		

This increase in nitrogen uptake might be due to more dry matter production at flowering and physiological maturity stages on 26 June sown crop as DMP positively correlated with yield (un published data). In case of early sowing there was more time for plant growth under optimum temperature and moisture, so seed yield was increased (Table 3). Under late sown condition nutrient uptake decreased due to loss of suitable time may resulted in loss of its potential ability because low light interception and severely affected partitioning of photo assimilate lead to yield decline. Similar results were also reported by Jha *et al.,* (2010).

Maximum nitrogen uptake at flowering and physiological maturity (haulm and seed) was observed in 3, 33,333 plants ha^{-1} and was significantly superior to 1, 66,666 plants ha^{-1} and 1,11,111 plants ha^{-1}. This increase was might be due to more dry matter production (Table 1) and seed and hulm yield (Table 3). The shorting of duration at various growth phases in the late sown crop might be the probable reason of the reduction in haulm yield (Kumar *et al.,* 2008). Lower seed yield per unit area of land at lower density was mainly associated with a decrease in the number of pods or seeds per unit area of land. Ball *et al.,* (2000) observed similar results and concluded that increasing plants population reduced yield of individual plants but increased yield per unit of area. Though the dry matter production plant^{-1} obtained was high at lower plant density, it could not augment the haulm yield ha^{-1}. On the other hand, higher haulm yield ha^{-1} at higher plant density was primarily due to more number of plants and greater dry matter production per unit area (Rahman *et al.,* 2013)

Harvest index

Harvest index shows the physiological efficiency of plants to convert the fraction of photo assimilates to seed yield. The appraisal of the data on harvest index as influenced by different dates of sowing and plant densities was presented in (Table 3). Higher harvest index was obtained on 16 July sown crop followed by 6 July, and 16 June sown crops.
Among the different plant densities the highest harvest index was obtained in 1,11,111 plants ha^{-1} and it was followed by 1,66,666 plants ha^{-1} and 3,33,333 plants ha^{-1}, The lowest harvest index was obtained in S_1.

Based on research results, it is concluded that, to obtain higher dry matter with increased nutrient uptake optimum sowing window for soybean would be 26 June and plant density of 3,33,333 plants ha^{-1} at 30x10 cm spacing to get more seed and haulm yield.

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