Int.J.Curr.Microbiol.App.Sci (2017) *6*(7): 4193-4200

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 6 Number 7 (2017) pp. 4193-4200**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2017.607.434

Effect of Sowing Density on the Growth, Yield and Nutrient Uptake of Hybrid Sunflower (*Helianthus annuus* L.) in Rabi Season

S. Ravichandran* and N. Srinivasan

Department of Agronomy, Agriculture College and Research institute,
Tamil Nadu Agricultural University, Coimbatore
**Corresponding author*

Keywords

Dry matter production, Head diameter, Number of seeds per head, Seed volume weight.

Article Info

Accepted:
29 June 2017
Available Online:
10 July 2017

A B S T R A C T

The field experiments were conducted at Eastern Block farm of Tamil Nadu Agricultural University during rabi season of 2015 and 2016, to study the effect of different sowing density and nutrient management on growth, yield and nutrient uptake of sunflower (Helianthus annuus L.). The experiment was laid out in a randomized block design with eleven treatment combinations and replicated thrice. The soil of the experimental field was silty clay loam in texture, low in available nitrogen, medium in available phosphorus and high in available potassium content. The sowing density of 30 x 30 cm with single seedling and 200% had accumulated the highest amount of DMP (10987 and 12070 kg ha-1 during rabi season of 2015 and 2016 respectively) which was 15% higher than the lower sowing density of 60 x 30 cm. The yield parameters like head diameter (cm), number of seeds per head, head weight, seed weight and seed volume weight were higher under the sowing density of 60x30 cm with single seedling and 100% RDF. The seed yield significantly higher by adoption of 30x30 cm with single seedling and application of 200% RDF.

Introduction

Sunflower (*Helianthus annuus* L.) is photo insensitive and not a season bound crop. It is the third most important oilseed crop after soybean and groundnut in the world. The area under sunflower in India is not sufficient to workout with the needs of growing population and to buildup the economy of the country.

Therefore, it should be our prior effort to find ways that can increase the yield by overcoming some constraints in the path of increasing productivity. Among various factors responsible for low yield in sunflower, management of fertilizers and planting population may be of much importance. In case of sunflower proper spacing provides sufficient interception of light and satisfactory absorption of nutrients and water from the soil due to the proper development of root system and results in higher crop yield. Seed yield was increased upto a plant population of 85000 plants ha^{-1} while beyond this had a depressing outcome on production. Higher plant density produce taller plants, lighter seeds and more yield than low plant population (Beg *et al*., 2007; Ishfaq *et al*., 2009). Nitrogen is a structural component of amino acids, protein and chlorophyll. Phosphorus is a constituent of ATP, ADP, Nucleic acids and Phospholipids. Potassium is

involved in providing appropriate ionic environment for metabolic process, growth regulation, stomatal control, activation of enzymes and photosynthesis. But maximum inherent potential of a variety can only be achieved when nutrients are applied in balanced form with recommended dose of fertilizers (RDF) (Murali *et al.*, 2009). Judicious application of N, P and K nutrient enhances the crop growth and development which helps in increasing seed yield and oil content.

Therefore, this study was conducted to find out the optimum sowing density and nutrient on its growth, yield and nutrient uptake.

Materials and Methods

A field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore during *rabi* season of 2015 and 2016 to investigate the effect of planting density and nutrient management on growth, yield and quality of sunflower. The experimental site is geographically situated in the western agro-climatic zone of Tamil Nadu at 11° N latitude and 77° E longitude and at an altitude of 426.7 meters above mean sea level (MSL). The study was conducted in randomized block design and replicated thrice. The treatment comprised of 60x30 with single seedling and 100% RDF (T_1), 60x30 cm with two seedling per hill and 150% RDF (T_2), 60x30 cm with two seedling per hill and 200% RDF (T_3), 60 x 45 cm with two seedlings per hill and 125% RDF(T_4), 60 x 45 with two seedlings per hill and 150% RDF (T_5), 45 x 45 cm with two seedling and 150% RDF (T_6), 45 x 45 cm with two seedling with 200% RDF (T_7), 45 x 30 cm with single seedling and 125% RDF (T_8), 45 x 30 cm single seedling and 150% RDF (T_9), 30 x 30 cm with single seedling and 150% RDF (T_{10}), 30 x 30 cm with single seedling and 200% RDF (T_{11}). The soil of the experimental field was sandy clay loam in texture belonging to *Typic Ustropept.* The nutrient status of the soil during start of the experiment was low in available nitrogen, medium in available phosphorus and high in available potassium. The field experiments were conducted during *rabi* season of 2015 and 2016. The sunflower hybrid, TNAU Sunflower Hybrid CO2 was used as test crop. The recommended fertilizer dose followed for sunflower was 90:60:60 kg NPK ha^{-1}. Half dose of N and K and full dose of P were applied basally to all the treatments. The remaining N and K were top dressed at 30 DAS. The crop was harvested at maturity stage, seed yield per net plot of each treatment was recorded. Five plants were selected in each net plot area for measuring nutrients uptake. The various biometric observations, analytical data of plant sample and the computed data were subjected to statistical scrutiny as per the procedures given by (Gomez and Gomez, 1984). The treatment differences were worked out at five per cent probability level.

Results and Discussion

The results of the investigation with cause and effect of relationship and supported with relevant references based on experimental evidences were mentioned below.

Effect on growth (Table 1)

Data in table 1 revealed that, the sowing density and nutrient management exerted significant influence on growth characters of sunflower. Higher TDM (10987 and 12070 kg ha^{-1}during *rabi* season of 2015 and 2016 respectively) was accumulated by adopting 30x30 cm with single seedling and 200% RDF as compared to 60x30 cm with single seedling and 100% RDF (5602 and 6157kg ha^{-1} in *rabi* season of 2015 and 2016 respectively). Sowing density and nutrient management had significant influence on number of leaves per hill was observed during

rabi season of 2015 and 2016. The treatment 60 x 30 cm with two seedlings per hill and application of 200% RDF significantly recorded 45.7 and 46.5 leaves per hill during *Rabi*2015and*Rabi*2016 respectively at 90 DAS. This may be due to the two plants accommodated in a hill in the treatment resulted in higher number of leaves.

On 90 DAS, T_1 (60 x 30 cm with single seedling and 100% RDF) significantly recorded higher stem girth of 7.15 cm and 7.19 cm during *Rabi* 2015 and 2016 respectively. This was due to less competition between the plants which leads to the better utilization of available resources *viz.*, light, moisture and nutrients at optimum plant population. The lower stem girth was recorded at closer spacing due to the high competition between the plants for nutrient, moisture and light. These results are in concurrence with those of Vijayakumar and Ramesh (2005). The root volume (75.1 and 75.0 cc during *rabi* 2015 and 2016 respectively) and root dry weight (58.7 and 59.3 gin *rabi* 2015 and 2016 respectively) was higher under the 60x30 cm with single seedling and 100% RDF.

Growth analysis (Table 2)

The plant population favourably influenced the LAI and the high plant population (T_3) registered the higher LAI at all the stages. LAI of 17.46 and 14.87 during *rabi* 2015 and 2016 was recorded under T_3. Significant influence on CGR and RGR was observed during the course of investigation. The highest CGR and RGR value was recorded in T_{11}. This may be due to the higher number of leaves per hill and higher leaf area per hill which reflected on the higher value of LAI. Moreover, wider space availability between the rows and optimum intra row spacing might have increased the root spread which eventually utilized the applied nutrients and water effectively, which reflected on higher leaf area and more number of leaves per hill. This might be attributed to the minimal competition among the plants under this treatment, which might have provided sufficient space to the crop to harness the solar energy and utilization of applied nutrients and moisture effectively, which reflected on leaf area and dry matter production per plant. Moreover, the lesser value of spacing (900 cm^2) in numerator might have increased the CGR and RGR of the treatment (Kumar *et al.*, 2011).

Yield parameters and seed yield (Tables 3 and 4)

During *rabi* season of 2015 and 2016, the T_1 (60x30 cm with single seedling and application of 100% RDF) recorded higher head diameter (34.5 cm and 32.2 cm respectively) as against the lower head diameter recorded in 45 x45 cm with two seedling per hill and application of 150% RDF (T_6). The same trend followed in other characters *viz.*, seeds per head, 100 seed weight and seed volume weight. This may be due to the sufficient of environmental conditions in wide spacing and less competition between plants as well as increase light penetration within plant canopy which increased assimilation rate and oil formation. These results are in a good line with those obtained by Yakout *et al*., (1992), Sharief (1998), Allam *et al*., (2003), Ruffo *et al*., (2003), Ali and Osman (2004), And Tenebe *et al*., (2008). The sowing density and different nutrient levels had exerted a significant positive influence on seed yield of sunflower. Sunflower grown at 30x30 cm with single seedling and 200% RDF produced higher seed yield (2992 and 3232 kg ha^{-1}) over 60x30 cm with single seedling and 100% RDF. These results are in a good line with those obtained by Sloan *et al*., (2003) and El-Mohandes *et al*., (2005) on sunflower.

Table.1 Effect of planting density and nutrient management on number of leaves per hill and dry matter production (kg ha^{-1}) at 90 DAS of sunflower during rabi season

		No. of leaves per hill		DMP (kg ha^{-1})	
	Treatment	**2015**	**2016**	**2015**	**2016**
T1	**60 x 30 Single seedling with 100% RDF**	28.1	28.3	5602	6157
T2	**60 x 30 Two seedling with 150% RDF**	42.8	41.6	8312	9365
T3	**60 x 30 Two seedling with 200% RDF**	45.7	46.5	9175	10258
T4	**60 x 45 Two seedling with 125% RDF**	37.0	37.1	6512	7412
T5	**60 x 45 Two seedling with 150% RDF**	39.9	38.2	6608	7679
T6	**45 x 45 Two seedling with 150% RDF**	34.1	32.2	7185	8856
T7	**45 x 45 Two seedling with 200% RDF**	36.2	35.0	7451	9355
T8	**45 x 30 Single seedling with 125% RDF**	27.0	26.5	6671	7976
T9	**45 x 30 Single seedling with 150% RDF**	27.9	27.6	6713	8537
T10	**30 x 30 Single Seedling with 150% RDF**	24.0	22.5	10049	11166
T11	**30 x 30 Single Seedling with 200% RDF**	25.3	26.2	10987	12070
	SEd	1.3	1.4	411	426
	CD (0.05)	2.8	2.9	859	890

Table.2 Effect of planting density and nutrient management on stem girth (cm), root volume (cc) and root dry weight (g) of sunflower at 90 DAS during rabi season

		Stem girth (cm)		Root volume (cc)		Root dry mass (g)	
	Treatment	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
T1	**60 x 30 Single seedling with 100% RDF**	7.15	7.19	75.1	75.0	58.3	65.8
T2	**60 x 30 Two seedling with 150% RDF**	4.85	4.85	43.5	43.5	27.0	29.4
T3	**60 x 30 Two seedling with 200% RDF**	5.01	5.01	45.2	45.2	27.7	30.1
T4	**60 x 45 Two seedling with 125% RDF**	5.08	5.08	46.9	46.8	29.5	32.0
T5	**60 x 45 Two seedling with 150% RDF**	5.12	5.12	49.6	49.6	29.6	32.1
T6	**45 x 45 Two seedling with 150% RDF**	4.51	4.51	33.7	33.7	21.8	23.7
T7	**45 x 45 Two seedling with 200% RDF**	4.61	4.61	35.9	35.9	24.9	27.1
T8	**45 x 30 Single seedling with 125% RDF**	6.07	6.09	63.5	63.5	49.5	56.5
T9	**45 x 30 Single seedling with 150% RDF**	6.61	6.64	69.2	69.1	54.2	61.3
T10	**30 x 30 Single Seedling with 150% RDF**	5.15	5.15	53.0	53.0	41.2	45.4
T11	**30 x 30 Single Seedling with 200% RDF**	5.57	5.57	58.1	58.1	44.9	51.1
	SEd	0.25	0.25	2.4	2.4	1.8	1.9
	CD (0.05)	0.52	0.53	5.1	5.1	3.7	4.1

Table.3 Effect of planting density and nutrient management on growth analytical parameters of sunflower during rabi season

		LAI		CGR ($g\ m^{-2}\ day^{-1}$)		RGR ($mg\ g^{-1}\ day^{-1}$)	
	Treatment	2015	2016	2015	2016	2015	2016
T1	60 x 30 Single seedling with 100% RDF	6.80	6.92	2.15	2.24	2.03	2.12
T2	60 x 30 Two seedling with 150% RDF	15.27	12.82	2.56	2.62	3.84	4.05
T3	60 x 30 Two seedling with 200% RDF	17.46	14.87	2.85	2.95	4.21	4.54
T4	60 x 45 Two seedling with 125% RDF	8.00	7.00	1.59	1.60	2.05	2.18
T5	60 x 45 Two seedling with 150% RDF	9.10	7.26	1.69	1.80	2.09	2.19
T6	45 x 45 Two seedling with 150% RDF	8.67	7.39	2.00	1.98	2.15	2.24
T7	45 x 45 Two seedling with 200% RDF	10.00	8.18	2.16	2.27	2.27	2.29
T8	45 x 30 Single seedling with 125% RDF	7.24	7.80	2.24	2.57	2.53	2.79
T9	45 x 30 Single seedling with 150% RDF	7.53	8.94	2.28	2.85	3.35	2.93
T10	30 x 30 Single Seedling with 150% RDF	10.51	9.13	3.21	3.31	4.75	5.25
T11	30 x 30 Single Seedling with 200% RDF	12.19	10.69	3.49	3.65	5.21	5.73
	SEd	0.47	0.46	0.11	0.12	0.16	0.17
	CD (0.05)	0.99	0.97	0.24	0.25	0.33	0.37

Table.4 Effect of planting density and nutrient management on yield parameters of sunflower during rabi season

		Head diameter (cm)		No. of seeds $head^{-1}$		Head weight (g)		Seed volume weight (g)	
	Treatment	2015	2016	2015	2016	2015	2016	2015	2016
T1	60 x 30 Single seedling with 100% RDF	34.5	32.2	1485	1499	24.7	24.6	38.3	42.1
T2	60 x 30 Two seedling with 150% RDF	21.4	21.3	986	963	15.5	16.0	28.4	39.1
T3	60 x 30 Two seedling with 200% RDF	22.4	21.8	996	975	16.0	16.2	28.5	36.1
T4	60 x 45 Two seedling with 125% RDF	23.7	22.0	1010	983	16.2	16.3	28.5	32.7
T5	60 x 45 Two seedling with 150% RDF	24.3	22.5	1028	995	16.7	16.5	28.8	29.7
T6	45 x 45 Two seedling with 150% RDF	18.6	19.5	957	945	14.0	15.2	28.0	29.2
T7	45 x 45 Two seedling with 200% RDF	21.0	20.1	974	957	15.2	15.4	28.1	28.7
T8	45 x 30 Single seedling with 125% RDF	28.6	26.0	1249	1205	21.4	20.5	32.3	28.5
T9	45 x 30 Single seedling with 150% RDF	31.2	28.7	1365	1308	23.1	22.7	35.2	28.5
T10	30 x 30 Single Seedling with 150% RDF	26.1	23.1	1081	999	18.0	18.1	29.1	24.7
T11	30 x 30 Single Seedling with 200% RDF	27.6	25.2	1143	1101	19.7	18.6	29.3	24.2
	SEd	1.2	1.1	48	49	0.8	0.8	1.4	1.3
	CD (0.05)	2.4	2.3	101	102	1.6	1.6	2.8	2.8

Table.5 Effect of planting density and nutrient management on seed yield (kg ha^{-1}) and nutrient uptake (kg ha^{-1}) of sunflower during rabi season

		Seed yield (Kg ha^{-1})		N Uptake (Kg ha^{-1})		P Uptake (Kg ha^{-1})		K Uptake (Kg ha^{-1})	
	Treatment	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**
T1	**60 x 30 Single seedling with 100% RDF**	2021	2041	34.5	38.2	11.0	12.3	76.9	86.2
T2	**60 x 30 Two seedling with 150% RDF**	2381	2404	50.1	53.7	18.7	18.2	130.6	130.6
T3	**60 x 30 Two seedling with 200% RDF**	2604	2655	56.1	59.1	20.0	20.0	141.3	143.1
T4	**60 x 45 Two seedling with 125% RDF**	2084	2104	38.5	42.6	13.2	14.8	91.5	103.8
T5	**60 x 45 Two seedling with 150% RDF**	2240	2262	39.6	44.5	13.3	15.4	93.0	107.5
T6	**45 x 45 Two seedling with 150% RDF**	2327	2349	40.0	44.7	14.5	16.2	101.6	111.7
T7	**45 x 45 Two seedling with 200% RDF**	2348	2371	40.3	47.3	15.1	17.1	105.7	119.5
T8	**45 x 30 Single seedling with 125% RDF**	2350	2373	44.5	51.5	13.2	17.2	92.5	124.0
T9	**45 x 30 Single seedling with 150% RDF**	2364	2387	45.9	53.5	14.1	17.9	94.2	131.0
T10	**30 x 30 Single Seedling with 150% RDF**	2854	2915	61.3	64.3	19.0	22.3	139.9	156.3
T11	**30 x 30 Single Seedling with 200% RDF**	3124	3182	66.7	71.5	21.3	24.5	145.3	169.2
	SEd	115	118	2.2	2.5	0.8	0.9	5.8	5.9
	CD (0.05)	245	247	4.7	5.3	1.7	1.8	12.1	12.5

Nutrient uptake (Table 5)

Among the different treatments, significantly higher uptake of nitrogen, phosphorus and potassium (66.7 and 71.5 $kgha^{-1}$, 21.3 and 24.5 $kgha^{-1}$, 145.3 and 169.2 $kgha^{-1}$respectively during *rabi* 2015 and 2016) was noticed with 30x30 cm with single seedling and 200% RDF as compared to 60x30 cm with single seedling and 100% RDF (34.5 and 38.2 $kgha^{-1}$, 11 and 12.3 $kgha^{-1}$, 76.9 and 86.2 $kgha^{-1}$ respectively during *rabi* 2015 and 2016). Higher nutrient uptake in higher plant population level is attributed to more below and aboveground competition for nutrients and all the applied resources are effectively utilized, which in turn resulted in higher seed yield. This result is in conformity with the findings of Devand Sarawgi (2004).

It is concluded that, sowing density of 30 cm apart row to row and 30 cm plant to plant distances with single seedling and application of 200% RDF proved to give higher productivity in sunflower hybrid SFH CO_2. Therefore SFH CO_2 should be planted with a 30x30 cm with single seedling and 200% RDF in order to exploit its maximum yield potential.

References

Ali, E.A. and. Osman, E.B.A. 2004. Effect of hill spacing fertigation using drip irrigation system in sandy calcareous soil on the productivity of some safflower genotypes. The 2nd *Syrian Egyptian Conf.*

Allam, A.Y., El-Nagar, G. R and Galal, A.H. 2003. Response of two sunflower hybrids to planting dates and densities. *ActaAgronomica Hungarica*, 51(1): 25-35

Beg, A., Pourdad, S.S and Alipour, S. 2007. Row and plant spacing effects on agronomic performance of sunflower in warm and semi-cold area of Iran. *Hella*, 30(47): 99-104.

Dev, C.M. and Sarawgi, S.K. 2004. Balance sheet of nitrogen,phosphorus and potassium as influenced by spacing and nutrient management in sunflower, *Helianthus annuus* L. *J. Oilseeds Res.*, 21(1): 187-188

El-Mohandes, Salwa, Ali, E.A. and Osman, E. B.A. 2005. Response of two sunflower hybrids to the number of NPK fertilizers splittings and plant densities in newly reclaimed soil. *Assiut J. Agric. Sci*., Vol 36(5): 27-38.

Gomez, K.A. and Gomez, A.A. 1984. Statistical procedures for agricultural research, 2nd edn., *John Wiley and Sons*. New York. p.680.

Ishfaq, M., Ali, A., Khaliq, A., and Yaseen, M. 2009. Allometry, agronomic traits and yield of autumn planted sunflower hybrids under varying row spacing. *Pak. J. Agric. Sci*., 46: 248- 257.

Kumar, S., Tewari, S.K. and Singh, S.S. 2011. Effect of sources and levels of sulphur and spacing on the growth, yield and quality of spring sunflower (*Helianthus annuus*). *Indian J. Agron.*, 56(3): 242-246.

Murali, A.P., Balasubramanian, T.N. and Amanullah, M.M. 2009. Impact of climate and nutrient management on yield components and yield of sunflower (*Helianthus annuus* L.). *Am.-Eurasian J. Sustain. Agric*., 3: 13-16

Ruffo, M.L., Garcia, F.O., Bollero, G.A., Fabrizzi, K., and Ruiz, R.A. 2003. Nitrogen balance approach to sunflower fertilization. C*ommunications in Soil Sci. and Plt. Analysis*., 34(17- 18): 2645-2657

Sharief, A.E. 1998. Productivity of some introduced sunflower cultivars as affected by planting date and plant population density. *Zagazig J. Agric. Res*., 25(6): 895 - 909.

Sloan, R.C., Harkness, S.S. and Reel, K.L. 2003. Effect of spacing on sunflower production. Annual Report of the North Mississippi Research and Extension Center, Mississippi *Agriculture and Forestry Experiment Station Information Bull.*, 398: 475-478.

Tenebe, V.A., Pal, U.R., Okonkwo, C.A.C. and Auwalu, B.M. 2008. Response of rainfed sunflower (*Helianthus annuus* L.) to nitrogen rates and plant population in the semi-arid savanna region of Nigeria. *J. Agron. and Crop Sci*., 177(3): 207-2015.

Vijayakumar, M. and Ramesh, S. 2005. Effect of crop geometry and nitrogen management on growth analysisand yield of rain-fed sunflower (*Helianthus annuus*). *J. Ecotoxicol. Environ. Monitoring*, 15(4): 371-376.

Yakout, G.M., Awad, A., Abdel-Wahab, A.M. and. Griesh, M.H.M. 1992. Effect of some agronomic practices on sunflower production. 2-planting date and planting distances on yield and its components of some sunflower cultivars. *Ann. Agric. Sci. Moshtohor*, 30: 109-126.

How to cite this article:

Ravichandran, S. and Srinivasan, N. 2017. Effect of Sowing Density on the Growth, Yield and Nutrient Uptake of Hybrid Sunflower (*Helianthus annuus* L.) in Rabi Season. *Int.J.Curr.Microbiol.App.Sci.* 6(7): 4193-4200. doi: https://doi.org/10.20546/ijcmas.2017.607.434