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EFFECT OF PLANTING GEOMETRY AND NITROGEN LEVELS ON GROWTH, YIELD AND QUALITY OF GOLDEN ROD (*SOLIDAGO CANADENSIS* L.)

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Abstract

A study was conducted to evaluate the effect of planting geometry and nitrogen levels on growth, yield and quality parameters of golden rod at Horticultural College and Research Institute, Venkataramannagudem (Andhra Pradesh), India; in 2014-15. The results revealed that an application of 300 kg ha^{-1} nitrogen and 45 cm × 30 cm spacing recorded maximum plant height, number of leaves, leaf area and number of suckers. Whereas, maximum number of days to opening of first floret, number of primary branches in inflorescence, length and breadth of inflorescence were recorded maximum with higher dose of nitrogen and wider spacing. The highest number of panicles per plot was registered by the highest dose of nitrogen (300 kg ha^{-1}) and closer spacing (30 cm × 15 cm). However, number of marketable panicles per plot was recorded maximum with 300 kg ha^{-1} of nitrogen and 30 cm × 30 cm spacing.

Key words : Golden rod, planting geometry, nitrogen, planting geometry, leaf area, plant height.

Introduction

Golden rod is a herbaceous perennial botanically known as *Solidago canadensis* L. It belongs to the family Asteraceae and is a perennial flower crop cultivated for attractive flower stalk. The generic name *Solidago* means “to make whole” in Latin. About 100 species of the genus *Solidago* are native to North America (Biswas and Parya, 2008). The bloom is a pyramid-shaped cluster of many tiny flowers, which are yellow in colour. The inflorescence of golden rod is very complex in nature. Each small head consist several disc florets. Heads are auxillary, solitary on main axis as well as on branches and on small branchlets forming a whole compound flower stalk with golden yellow inflorescence. The blooms are very attractive as cut flowers and are used in bouquets as filler material and for floral arrangements. Golden rod is also used as a dry flower and outdoor ornamental plant. Golden rod is one such crop that attracts an increasing attention, because of its extensive use as filler material and interior decorations. Considering the importance and increasing popularity of the golden rod, it is felt important to study the performance of the crop under different planting geometry levels and nitrogen doses in order to find out the optimum values.

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Materials and Methods

The present investigation was carried out at Horticultural College and Research Institute, Venkataramannagudem in 2014-15 to study the effect of nitrogen levels and planting geometry on growth and yield of golden rod. Sixteen treatment combinations with four levels of nitrogen (0, 100, 200 and 300 kg ha^{-1}) and four levels of planting geometry (45 cm × 30 cm, 30 cm × 30 cm, 45 cm × 15 cm and 30 cm × 15 cm) were tried in factorial randomized block design with three replications. Half dose of nitrogen was applied as per the treatment before planting and the remaining half dose of nitrogen was applied after 45 days of planting. However, potash and phosphorus were applied as a basal dose before planting. Various growth, yield and quality observations *viz*., height of plant (cm), leaf area (dm^2), number of suckers per plant at 30, 60 and 90 DAP, number of days to first floret opening, number of primary branches, length of inflorescence (cm), number of panicles per plot and number of marketable panicles per plot were recorded. The data recorded on each character were analyzed by

the ANOVA technique as described by Panse and Sukhatme (1967). The treatment means were compared using the critical difference values calculated at 5 per cent level of significance.

Results and Discussion

Growth parameters

Plant height (cm)

Significant differences existed in the plant height due to planting geometry and nitrogen levels as well as their interaction (table 1). At 90 DAP, application of nitrogen at the rate of 300 kg ha^{-1} (N_4) recorded the maximum plant height (65.89 cm) and was on par with N_3 *i.e.* 200 kg ha^{-1} (64.87 cm). The minimum plant height (60.12 cm) was recorded by N_1 (0 kg ha^{-1}). Among the planting geometry levels, 45 cm × 30 cm spacing (S_1) recorded maximum plant height (68.22 cm) on par with S_2 *i.e.* 30 cm × 30 cm (65.27 cm). Among interactions, N_4S_1 recorded maximum plant height (70.95 cm) and was on par with N_3S_1 (69.98 cm) and N_4S_2 (67.86 cm) whereas, minimum value for plant height (54.87 cm) was recorded by N_1S_4.

Number of leaves

The data presented in table 2 indicated that there were significant differences among the nitrogen levels and planting geometry levels with respect to number of leaves per plant. The number of leaves per plant at 90 DAP was found to be highest (89.70) in N_4 and was on par with N_3 (86.77) among nitrogen levels. The minimum number of leaves (80.75) was recorded by N_1. Among planting geometry S_1 recorded the maximum number of leaves (90.36) and was on par with S_2 (87.26). With respect to interaction, N_4S_1 registered maximum value (95.54) in terms of number of leaves and was found to be on par with N_4S_2 (91.97) and N_3S_1 (90.67 cm) whereas minimum value (74.22) was registered by N_1S_4 treatment combination.

Leaf area (dm^2)

There were significant differences in leaf area at 30, 90 and 60 DAP due to the different levels of nitrogen and planting geometry and their interaction at different stages of crop growth (table 3). At 90 DAP maximum leaf area was obtained by N_4 (7.09 dm^2) and was on par with N_3 (6.85 dm^2) among nitrogen levels. With respect to the planting geometry levels, S_1 recorded the maximum value for leaf area (7.14 dm^2) and was on par with S_2 (6.89 dm^2). With respect to the interactions, N_4S_1 registered the maximum leaf area (7.55 dm^2) and it wasat par with N_3S_1 (7.16 dm^2), N_3S_2 (7.00 dm^2) and N_4S_2 (7.27 dm^2). The corresponding minimum values were recorded by N_1 (6.38 dm^2) among nitrogen levels. S_4 recorded the minimum leaf area (6.34dm^2) among planting geometry levels. Among interaction, N_1S_4 recorded minimum leaf area (5.86 dm^2) and it was on par with N_1S_3 (6.32 dm^2) and N_2S_4 (6.29 dm^2).

Number of suckers per plant

Nitrogen doses and planting geometry levels influenced the number of suckers per plant significantly at 30, 60 and 90 DAP (table 4). The mean numbers of suckers per plant increased from 2.70 at 60 DAP to 5.83 at 90 DAP. At 90 DAP maximum number of suckers was recorded by N_4 (8.80) followed by N_3 (6.15) among nitrogen levels. On the other hand, a spacing of 45 cm × 30 cm (S_1) registered the maximum numbers of suckers (6.68) and was on par with S_2 (6.00) and S_3 (5.90). The interaction of N_4S_1 recorded maximum number of suckers per plant (9.37). The minimum number of suckers (3.67) was recorded with N_1 and was on par with N_2 (4.68) among nitrogen levels. Among spacings S_4 (4.72) recorded minimum number of suckers whereas, the interaction of N_1S_4 registered least value (2.24) in respect of number of suckers per plant.

The superiority of these parameters with higher levels of nitrogen might be due to higher availability of elemental nitrogen in the soil solution at higher doses of external supply. The more nitrogen that was available to plant roots might have enabled the plant to have a better vegetative growth at quicker rate. This might be because of the fact that nitrogen is an elementary constituent of amino acids, nucleic acid, proteins, nucleotides, chlorophyll and secondary substances such as alkaloids, an important constituent of the protoplasm and also responsible for cell division and cell elongation. Similar results were also obtained by Karetha *et al*. (2011) in gaillardia, Sodha and Dhaduk (2002), Biswas and Parya (2008), Lale *et al*. (2003) in golden rod.

It is interesting to note that both the plant height and number of suckers were more with wider spacings perhaps because of the upright growth habit of the plant. It is inferred from these results that golden rod recorded more plant height even at wider spacings mainly because it has ample availability of nitrogen as compared to closer spacings and has not diverted photosynthates greatly for lateral growth at the expense of vertical growth. These results are supported by the findings of Tingare *et al*. (2007) in golden rod and Mane *et al*. (2006) in tuberose.

Quality parameters

Number of days taken for opening of first floret

The data presented for the number of days taken for first floret opening was significantly influenced by

different levels of nitrogen and planting geometry (table 5). The minimum number of days taken for first floret opening (7.58 days) was recorded by N_1 level was on par with N_2 (7.96 days) whereas, N_4 recorded maximum number of days (8.62 days) for first floret opening. Among planting geometry levels S_4 recorded the minimum number of days for first floret opening (7.03 days) and was on par with S_3 (7.32 days) on the other hand, S_1 recorded maximum number of days (9.42 days). With respect to interactions, N_1S_4 recorded minimum number of days (6.42 days) and it was on par with N_2S_4 (6.76 days) and N_1S_3 (6.78 days). The delay in first floret opening was observed in N_4S_1 (9.86 days) and it was on par with N_4S_2 (9.18 days) and N_3S_1 (9.68 days).

Number of primary branches in an inflorescence

The data on number of primary branches per panicle as influenced by various levels of nitrogen, planting geometry and their interactions were presented in table 5. The mean number of primary branches per panicle were found to be maximum (35.68) with N_4 level of nitrogen, which was on par N_3 (33.86). Among planting geometry levels, S_1 registered maximum number of primary branches per panicle (35.82) followed by S_2 (33.53). The interaction of N_4S_1 recorded highest number of primary branches per panicle (38.23) and was on par with N_4S_2 (35.56) and N_3S_1 (36.98). The minimum number of primary branches (30.17) was recorded with N_1 level of nitrogen. Among planting geometry levels minimum value (30.56) was recorded with S_4. Regarding interactions, minimum value (27.11) was registered by N_1S_4 combination followed by N_1S_3 (28.47).

Length of inflorescence (cm)

The data regarding the length of inflorescence (cm) as influenced by nitrogen, planting geometry and their interaction is presented in table 6. Among nitrogen levels, maximum value for inflorescence length (40.18 cm) was registered with highest dose of nitrogen (300 kg ha^{-1}) and was on par with N_3 (38.22 cm). Among planting geometry levels, S_1 was superior (40.52 cm) to S_2 (38.27 cm) in terms of inflorescence length. The interaction of N_4S_1 registered maximum value of inflorescence length (42.22 cm), was on par with N_3S_1 (41.30 cm) and N_4S_2 (41.01 cm). Among nitrogen levels, N_1 registered minimum inflorescence length (34.92 cm) whereas, S_4 registered (34.42 cm) inflorescence length. Among the interactions, N_1S_4 registered least value (32.11 cm) and it was on par with N_2S_4 (32.98 cm) and N_1S_3 (34.02 cm).

Breadth of inflorescence (cm)

The influence of nitrogen, planting geometry as well as their interaction was found to be significant on breadth of inflorescence at all growth stages and the data are presented in table 6. The data noticed for breadth of inflorescence at 90 DAP were maximum (24.64 cm) with N_4 and it was on par with N_3 (23.79 cm)among nitrogen levels, on the other hand N_1 was minimum (22.55 cm). Among planting geometry levels, S_1 (27.09 cm)was superior to S_2 (25.00 cm) whereas, S_4 recorded least value (18.74 cm) in terms of breadth of inflorescence. The interaction of N_4S_1 registered best value (28.11 cm) for breadth of inflorescence and was on par with N_3S_1 (27.32 cm) and N_4S_2 (26.03 cm) but followed by N_3S_2 (25.27 cm) whereas, the least value (17.68 cm) was recorded by N_1S_4 and it was on par with N_2S_4 (18.18 cm). Most of these quality parameters are increasing with increase in nitrogen and decrease in density *i.e.* wider planting geometry. However, the combinations of N_4S_1, (nitrogen at 300 kg ha^{-1} coupled with 45 cm × 30 cm spacing) N_4S_2 (nitrogen at 300 kg ha^{-1} coupled with 30 cm × 30 cm spacing) and N_3S_1 (nitrogen at 200 kg ha^{-1} coupled with 45 cm × 30 cm spacing) were showing on par results with respect to a majority of quality parameters *viz*., size of inflorescence (length and spread) and number of primary branches. This might be due to more vegetative growth with higher nitrogen and wider planting geometry where an increased amount of assimilates were involved in expanding the inflorescence and spending more time in it might have substantially caused delay in opening of individual florets. These results are also supported by the findings of Sodha and Dhaduk (2002) in golden rod, Khalaj *et al*. (2012) and Patel *et al*. (2006) in tuberose, Jadhav *et al*. (2014) in calendula.

Yield parameters

Number of panicles per plot

The graded levels of nitrogen, planting geometry and their interactions showed significant influence on the number of panicles per plot (table 7). The nitrogen level N_4 recorded the highest number of panicles per plot (71.88). Among planting geometry levels, S_4 was the best with 109.32 panicles per plot followed by S_3 (74.56) and S_2 (56.66). Among the interactions, the treatment combination of N_4S_4 recorded the highest number of panicles per plot (111.08) was on par with N_3S_4 (109.23). The minimum number of panicles per plot (67.76) was recorded by N_1 among nitrogen levels. Among planting geometry levels, S_1 registered the minimum number of panicles per plot (38.00). With respect to the interactions, N_1S_1 registered the least number of panicles per plot (36.09).

Number of marketable panicles per plot

The data on number of marketable panicles per plot

Table 1 : Plant height (cm) as influenced by nitrogen levels, planting geometry and their interaction in golden rod.

Nitrogen levels / Planting geometry	30 DAP					60 DAP					90 DAP				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	3.42	3.98	4.28	4.87	**4.14**	35.64	38.08	42.08	48.33	**41.03**	64.06	67.87	69.98	70.95	**68.22**
S_2	3.35	3.39	3.97	4.31	**3.76**	30.78	32.77	36.10	42.57	**35.56**	61.67	64.64	66.89	67.86	**65.27**
S_3	3.32	3.77	3.76	3.74	**3.65**	29.69	31.34	34.83	40.80	**34.17**	59.87	61.93	63.76	64.76	**62.58**
S_4	2.41	3.09	3.44	3.61	**3.14**	27.56	30.67	32.86	34.02	**31.28**	54.87	57.66	58.84	59.98	**57.84**
Mean	**3.13**	**3.56**	**3.86**	**4.13**	**3.67**	**30.92**	**33.22**	**36.47**	**41.43**	**35.51**	**60.12**	**63.03**	**64.87**	**65.89**	**63.47**
	SEm			**CD at 5%**		**SEm**			**CD at 5%**		**SEm**			**CD at 5%**	
N	0.21			0.63		1.30			3.93		1.13			3.41	
S	0.16			0.47		1.17			3.52		1.07			3.23	
N × S	0.33			0.99		1.87			5.62		1.67			5.02	

N_1 = Nitrogen @ 0 kg ha^{-1}
N_2 = Nitrogen @ 100 kg ha^{-1}
N_3 = Nitrogen @ 200 kg ha^{-1}
N_4 = Nitrogen @ 300 kg ha^{-1}

S_1 = 45 cm × 30 cm
S_2 = 30 cm × 30 cm
S_3 = 45 cm × 15 cm
S_4 = 30 cm × 15 cm

Table 2 : Number of leaves as influenced by nitrogen levels, planting geometry and their interaction in golden rod.

Nitrogen levels / Planting geometry	30 DAP					60 DAP					90 DAP				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	11.56	12.65	14.90	17.67	**14.20**	56.45	59.41	62.07	65.03	**60.74**	86.33	88.89	90.67	95.54	**90.36**
S_2	10.70	11.55	14.50	16.55	**13.33**	52.78	55.51	58.93	61.37	**57.15**	82.47	85.97	88.63	91.97	**87.26**
S_3	10.50	11.45	13.45	15.78	**12.80**	48.18	51.03	53.73	56.18	**52.28**	79.98	82.97	85.05	86.91	**83.73**
S_4	9.90	11.02	13.12	15.33	**12.34**	46.68	50.23	53.59	55.54	**51.51**	74.22	79.67	82.71	84.36	**80.24**
Mean	**10.67**	**11.67**	**13.99**	**16.33**	**13.16**	**51.02**	**54.05**	**57.08**	**59.53**	**55.42**	**80.75**	**84.38**	**86.77**	**89.70**	**85.40**
	SEm			**CD at 5%**		**SEm**			**CD at 5%**		**SEm**			**CD at 5%**	
N	0.42			1.27		1.78			5.36		1.76			5.30	
S	0.23			0.69		2.02			6.10		2.15			6.48	
N × S	0.79			2.39		2.79			8.40		2.86			8.61	

N_1 = Nitrogen @ 0 kg ha^{-1}
N_2 = Nitrogen @ 100 kg ha^{-1}
N_3 = Nitrogen @ 200 kg ha^{-1}
N_4 = Nitrogen @ 300 kg ha^{-1}

S_1 = 45 cm × 30 cm
S_2 = 30 cm × 30 cm
S_3 = 45 cm × 15 cm
S_4 = 30 cm × 15 cm

Table 3 : Leaf area (dm^2) as influenced by nitrogen levels, planting geometry and their interaction in golden rod.

Nitrogen levels / Planting geometry	30 DAP					60 DAP					90 DAP				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	0.83	0.91	1.07	1.27	**1.02**	4.40	4.63	4.84	5.07	**4.74**	6.82	7.02	7.16	7.55	**7.14**
S_2	0.77	0.83	1.04	1.19	**0.96**	4.12	4.33	4.60	4.79	**4.46**	6.52	6.79	7.00	7.27	**6.89**
S_3	0.76	0.82	0.97	1.14	**0.92**	3.76	3.98	4.19	4.38	**4.08**	6.32	6.55	6.72	6.87	**6.61**
S_4	0.71	0.79	0.94	1.10	**0.89**	3.64	3.92	4.18	4.33	**4.02**	5.86	6.29	6.53	6.66	**6.34**
Mean	**0.77**	**0.84**	**1.01**	**1.18**	**0.95**	**3.98**	**4.22**	**4.45**	**4.64**	**4.32**	**6.38**	**6.67**	**6.85**	**7.09**	**6.75**
	SEm			**CD at 5%**		**SEm**			**CD at 5%**		**SEm**			**CD at 5%**	
N	0.03			0.09		0.14			0.42		0.14			0.42	
S	0.02			0.05		0.16			0.48		0.17			0.51	
N × S	0.06			0.17		0.22			0.66		0.23			0.68	

N_1 = Nitrogen @ 0 kg ha^{-1}
N_2 = Nitrogen @ 100 kg ha^{-1}
N_3 = Nitrogen @ 200 kg ha^{-1}
N_4 = Nitrogen @ 300 kg ha^{-1}

S_1 = 45 cm × 30 cm
S_2 = 30 cm × 30 cm
S_3 = 45 cm × 15 cm
S_4 = 30 cm × 15 cm

Table 4 : Number of suckers per plant as influenced nitrogen levels, planting geometry and their interaction in golden rod.

Nitrogen levels / Planting geometry	30 DAP					60 DAP				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	1.55	2.77	3.89	4.22	**3.11**	4.67	5.68	7.01	9.37	**6.68**
S_2	1.48	2.37	3.44	3.77	**2.77**	4.00	4.79	6.48	8.74	**6.00**
S_3	1.40	2.19	3.03	3.74	**2.59**	3.78	4.56	6.16	9.10	**5.90**
S_4	1.20	2.00	2.88	3.33	**2.35**	2.24	3.69	4.96	7.98	**4.72**
Mean	**1.41**	**2.33**	**3.31**	**3.77**	**2.70**	**3.67**	**4.68**	**6.15**	**8.80**	**5.83**
	SEm			**CD at 5%**		**SEm**			**CD at 5%**	
N	0.26			0.79		0.35			1.06	
S	0.16			0.48		0.40			1.20	
N × S	0.33			0.99		1.18			3.55	

N_1 = Nitrogen @ 0 kg ha^{-1} S_1 = 45 cm × 30 cm
N_2 = Nitrogen @ 100 kg ha^{-1} S_2 = 30 cm × 30 cm
N_3 = Nitrogen @ 200 kg ha^{-1} S_3 = 45 cm × 15 cm
N_4 = Nitrogen @ 300 kg ha^{-1} S_4 = 30 cm × 15 cm

Table 5 : Number of days taken for first floret opening and number of primary branches in an inflorescence as influenced by nitrogen levels, planting geometry and their interaction in golden rod.

Nitrogen levels / Planting geometry	Days to first floret opening					Number of primary branches				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	8.90	9.26	9.68	9.86	**9.42**	33.81	34.24	36.98	38.23	**35.82**
S_2	8.19	8.60	8.75	9.18	**8.68**	31.30	32.82	34.44	35.56	**33.53**
S_3	6.78	7.18	7.55	7.78	**7.32**	28.47	31.38	32.90	35.22	**31.99**
S_4	6.42	6.76	7.26	7.67	**7.03**	27.11	30.33	31.10	33.71	**30.56**
Mean	**7.58**	**7.96**	**8.31**	**8.62**	**8.12**	**30.17**	**32.19**	**33.86**	**35.68**	**32.97**
	SEm			**CD at 5%**		**SEm**			**CD at 5%**	
N	0.25			0.76		0.70			2.11	
S	0.26			0.78		0.72			2.17	
N × S	0.36			1.10		1.67			5.04	

N_1 = Nitrogen @ 0 kg ha^{-1} S_4 = 45 cm × 30 cm
N_2 = Nitrogen @ 100 kg ha^{-1} S_2 = 30 cm × 30 cm
N_3 = Nitrogen @ 200 kg ha^{-1} S_3 = 45 cm × 15 cm
N_4 = Nitrogen @ 300 kg ha^{-1} S_4 = 30 cm × 15 cm

as influenced by various levels of nitrogen, planting geometry and their interactions were presented in table 7. Among nitrogen levels the highest number of marketable panicles per plot (42.53) were recorded with N_4 and it was on par with N_3 (40.47). Among planting geometry levels, S_2 recorded highest number of marketable panicles per plot (38.80) was on with S_1 (31.00) and S_3 (29.35). The interaction of N_4S_2 was best with highest number of marketable panicles (55.99) and it was on par with N_3S_2 (54.35), N_4S_1 (40.32), N_3S_1 (38.12). Among nitrogen levels, minimum number of marketable panicles were recorded with N_1 (19.07) whereas, the least value (27.21) was recorded with S_4 in terms of marketable panicles per plot. The interaction of N_1S_4 registered minimum number of marketable panicles (18.00) and it was on par with N_1S_3 (18.34), N_2S_4 (23.26) and N_2S_3 (23.42). It is interesting to note that the number of marketable panicles per plot did not follow the trend as exhibited by the number of total panicles per plot or per m^2 particularly when the planting geometry levels were taken into account. The widest geometry of planting at 45 cm × 30 cm and next immediate level *i.e.* 30 cm × 30 cm were on par with respect to number of marketable panicles per plot and both were significantly higher compared to other closer geometry levels that recorded a higher number of total panicles per plot. This clearly indicated that even though the total number of golden rods produced per unit area was higher with the closest

Table 6 : Length and breadth of inflorescence (cm) as influenced by nitrogen levels, planting geometry and their interaction in golden rod.

Nitrogen levels / Planting geometry	Length of inflorescence (cm)					Breadth of inflorescence (cm)				
	N_1	N_2	N_3	N_4	Mean	N_1	N_2	N_3	N_4	Mean
S_1	38.35	40.22	41.30	42.22	**40.52**	26.24	26.68	27.32	28.11	**27.09**
S_2	35.21	37.42	39.44	41.01	**38.27**	24.09	24.63	25.27	26.03	**25.00**
S_3	34.02	35.87	37.43	39.60	**36.73**	22.19	22.82	23.53	24.36	**23.23**
S_4	32.11	32.98	34.71	37.88	**34.42**	17.68	18.18	19.04	20.05	**18.74**
Mean	**34.92**	**36.62**	**38.22**	**40.18**	**37.49**	**22.55**	**23.08**	**23.79**	**24.64**	**23.51**
	SE m±			**CD at 5%**		**SE m±**			**CD at 5%**	
N	0.65			1.97		0.30			0.91	
S	0.67			2.02		0.51			1.53	
N × S	1.17			3.54		0.94			2.82	

N_1 = Nitrogen @ 0 kg ha^{-1} S_1 = 45 cm × 30 cm
N_2 = Nitrogen @ 100 kg ha^{-1} S_2 = 30 cm × 30 cm
N_3 = Nitrogen @ 200 kg ha^{-1} S_3 = 45 cm × 15 cm
N_4 = Nitrogen @ 300 kg ha^{-1} S_4 = 30 cm × 15 cm

Table 7 : Number of panicles and marketable panicles per plot as influenced by nitrogen levels, planting geometry and their interaction in golden rod.

Nitrogen levels / Planting geometry	Number of panicles per plot					Number of marketable panicles per plot				
	N_1	N_2	N_3	N_4	mean	N_1	N_2	N_3	N_4	mean
S_1	36.09	37.45	38.12	40.32	**38.00**	20.18	25.38	38.12	40.32	**31.00**
S_2	54.66	55.93	57.06	58.99	**56.66**	19.76	25.11	54.35	55.99	**38.80**
S_3	72.19	73.56	75.34	77.14	**74.56**	18.34	23.42	37.24	38.38	**29.35**
S_4	108.10	108.88	109.23	111.08	**109.32**	18.00	23.26	32.16	35.43	**27.21**
Mean	**67.76**	**68.96**	**69.94**	**71.88**	**69.63**	**19.07**	**24.29**	**40.47**	**42.53**	**31.59**
	SEm			**CD at 5%**		**SEm**			**CD at 5%**	
N	0.35			1.05		2.92			8.79	
S	2.53			7.63		3.37			10.15	
N × S	4.54			13.67		6.02			18.14	

N_1 = Nitrogen @ 0 kg ha^{-1} S_1 = 45 cm × 30 cm
N_2 = Nitrogen @ 100 kg ha^{-1} S_2 = 30 cm × 30 cm
N_3 = Nitrogen @ 200 kg ha^{-1} S_3 = 45 cm × 15 cm
N_4 = Nitrogen @ 300 kg ha^{-1} S_4 = 30 cm × 15 cm

orientation of plants or closest planting geometry level, such panicles were of least quality and hence were inferior in marketability. Therefore, the wider spacings only could yield significantly higher number of marketable panicles per plot even though the total number of panicles produced by them was less. On the contrary, the nitrogen levels exerted the similar influence as observed in case of total panicles per plot. The highest number of marketable panicles per plot was registered by the application of nitrogen at 300 kg ha^{-1} which was on par with that at 200 kg ha^{-1}. Similar opinions were expressed by Sodha and Dhaduk (2002) in golden rod and Kishore *et al*. (2010) in marigold.

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