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Influence of planting geometry and nutrition on plant growth and seed yield attributes of okra cv. Arka Anamika

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Abstract

The field experiment was conducted to study the effect of planting geometry and nutrition on plant growth and seed yield of okra at NSP, UAS, Bangalore. The experiment was laid out in FRCBD design with 12 treatment combinations replicated thrice which includes three different planting geometry S_0 (60×45 cm), S_1 (60×30 cm) and S_2 (60×60 cm), four levels of nutrients N_0 (100% RDF), N_1 (125% RDF), N_2 (150% RDF) and N_3 (200% RDF) (RDF: 156.25: 93.75: 78.75 kg NPK ha^{-1}). Results revealed that S_2 and N_1 are superior in plant growth and seed yield attributes viz., plant height at 30, 60, 90 and at harvest (19.66, 53.47, 164.97, 171.79 cm), number of branches at 60, 90 and at harvest (3.17, 3.90, 3.90), internodal length (10.80 cm) and chlorophyll content (60.83 SPAD unit), Days to 50% flowering (46.0), Days to maturity (110.67), maximum seed yield $plant^{-1}$ (69.06 g), seed yield $plot^{-1}$ (1115.45 g) and seed yield ha^{-1} (19.36 q).

Keywords: Okra, planting geometry, plant nutrition, growth, yield

1. Introduction

Okra (*Abelmoschus esculentus* (L.) Moench) known in many English-speaking countries as ladies finger, bhindi, bamila, ochro or gumbo, is a flowering plant in the Malvaceae family and it is valued for its edible green pods. It is widely cultivated in tropics, sub-tropics and warm temperate regions around the world. Okra originated near the equator in Africa. It is an important pan-tropical vegetable, particularly in West Africa, India, Brazil and Southern USA. It is widely cultivated in Uttar Pradesh, Assam, Bihar, Orissa, Maharashtra, West Bengal and Karnataka states of India. India is second largest producer of okra after China. In India, okra is grown during pre-kharif (March to June) and kharif season (July to October). In India okra is cultivated in an area of 511 thousand ha with an annual production of 5849 thousand tonnes and productivity of 11.5 t ha^{-1} . In Karnataka, okra occupies an area of 9.66 thousand hectares with an annual production of 79.61 thousand tonnes and productivity of 8.24 t ha^{-1} . (Horti.Statistics at glance, 2015) [7].

Okra plays a significant role in human nutrition by providing carbohydrates, protein, fat, minerals and vitamins that are generally deficient in basic foods. Okra is a vegetable valued for many of its properties. The fruits are used in making soup, salad and for flavoring when dried and powdered. Sometime, the seeds are roasted and used as a substitute for coffee. Its ripe fruit and stems contain crude fiber, which is used in the paper industry. The tender fruits contain minerals especially calcium, magnesium, iron, phosphorus, protein, vitamin A and C including riboflavin as well as high mucilage (Ndaeyo *et al.*, 2005) [14]. Its every 100 g green pod contains among others, protein 1.8 g, carbohydrate 6.4g, fiber 1.2 g, vitamin C 18 mg and Ca 90 mg. Mature okra seeds are good source of protein and oil and it has been known to be very important in nutritional quality. Okra accounts for 60 per cent of export of fresh vegetables excluding potato, onion and garlic (Rashid, 1999) [15].

Due to this high prominence, okra has been a beneficiary of worldwide research over many years resulting in many varieties currently been planted in different parts of the world. Seed is very important input on which the ultimate yield of the crop depends. To obtain maximum seed yield with superior quality, the proper growth of the plant and its fruits are desired. Most of the studies are concerned with the development of varieties adopted to specific other needs while seed quality has been neglected.

Hence, there is need to give utmost attention to both monetary (fertilizers) and non-monetary (spacing and fruit position) inputs for improvement of seed yield and quality. Optimum plant population provides conditions for maximum light interception right from early period of crop growth and it ensures the plants to grow uniformly and properly through efficient utilization of moisture, nutrients and lack of it thus eases to produce maximum yield in okra. The yield and quality of commercial vegetables are directly related to plant population (Samling and Sam Ruban, 2007)^[16]. By changing planting geometry, it is possible to achieve better plant growth which in turn contributes to a higher yield. Further, it has been reported that optimum plant population is the key element for better yields of okra, as plant growth and yield are affected by intra and inter row spacing (Amjad *et al.*, 2002)^[2]. Nutrient is one of the most important inputs contributing to production of crop because it increases productivity and improves seed yield and quality (Shiyab *et al.*, 2014)^[17]. Among the nutrient, nitrogen (N) exhibits a high positive response in okra. It plays an important role in chlorophyll, protein, nucleic acid, hormone and vitamin synthesis and also helps in cell division, cell elongation. Phosphorus (P) involved in photosynthesis and respiration and it helps in enhancing root growth, formation of root nodules, and crop maturity. Potassium (K) plays a unique role in osmotic regulation, opening and closing of stomata and also improves the color, flavors and size of fruits. (Bhende *et al.*, 2015)^[4].

Present nutritional rates are insufficient to sustain higher yields and to replenish nutrient removal by the crop due to continuous cropping and use of high yielding varieties, there is depletion of nutrients from soil. Hence, to meet the crop demand in long run, there is a need to apply NPK nutrients based on soil fertility status. So, present investigation will help to standardize the nutrition level which influence on seed yield and quality in okra. Various factors influence the seed quality in okra among which position of fruit is of great significance. Ability of seeds to produce a greater number of normal and vigorous seedlings depends on fruit position which affects proper seed filling and maturation due to the competition for assimilates between fruits and within fruit distresses seed set and development (Bertin, 1998)^[5]. Fruits produced at the base; middle and apex positions of the stem would have a variation in seed quality due to the varied flow of nutrients (source-sink relationship) and micro-environment experienced by the seed due to its position on the parent plant. (Kortse P. Aloho and Oketa Anita, 2016)^[10].

2. Materials and Methods

Seeds of okra variety Arka Anamika was obtained from Indian Institute of Horticultural Research (IIHR), Hessaraghatta, Bengaluru. The field and laboratory experiments were conducted to study the nutrition and position of fruit on plant growth, seed yield and quality of okra at NSP, UAS, Bangalore. The experiment was laid out in FRCBD design with 12 treatment combinations replicated thrice which includes three different planting geometry S₀ (60 × 45 cm), S₁ (60 × 30 cm) and S₂ (60 × 60 cm), four levels of nutrients N₀ (100% RDF), N₁ (125% RDF), N₂ (150% RDF) and N₃ (200% RDF) (RDF: 156.25: 93.75: 78.75 kg NPK ha⁻¹) and Individual plant was divided into three parts (top, middle and bottom) harvested fruits separately and will be evaluated for following plant growth

and yield parameters

3. Results and Discussion

3.1 Plant height (cm)

The plant height at 30 days after sowing differed significantly due to planting geometry. The maximum plant height was recorded in spacing S₂ (14.61 cm) followed by S₀ (13.23 cm) and least was recorded in spacing S₁ (12.76 cm). There was significant difference in plant height was observed due to various levels of nutrients. Among the different nutritional levels, N₁ (125% RDF) recorded the highest plant height (16.27 cm) while, the lowest plant height was recorded in control (N₀) (11.77 cm). The plant height at 30 days after sowing was found to be differed significantly due to interaction of planting geometry and nutrition. The maximum plant height at 30 days after sowing was recorded in S₂N₁ (19.66 cm) and least recorded in S₁N₀ (11.20 cm). The plant height at 60 days after sowing differed significantly due to planting geometry. The maximum plant height was observed in spacing S₂ (41.45 cm) followed by S₀ (37.95 cm) and least was noticed in spacing S₁ (35.40 cm). There was a significant difference among different nutrient levels with respect to plant height at 60 DAS. Among different treatment N₁ (125% RDF) recorded the highest plant height (45.45 cm) while, the lowest plant height was recorded in control (N₀) (31.10 cm). The plant height at 60 days after sowing was found to be differed significantly due to interaction of planting geometry and nutrition. The maximum plant height at 60 days after sowing was recorded in S₂N₁ (53.47 cm) and least recorded in S₁N₀ (26.70 cm). The planting geometry significantly influenced the plant height at 90 DAS. Among the different plant geometry highest plant height was noticed in S₂ (128.00 cm) followed by S₀ (124.12 cm). However, less was in S₁ (114.63 cm). The results revealed that, there was significant difference with respect to plant height at 90 DAS due to influence of nutritional levels. Maximum plant height was recorded in N₁ (145.81 cm) followed by N₂ (118.24 cm). Whereas, least was in N₀ (109.94 cm). The interaction effects of planting geometry and nutrition found to be significant for plant height at 90 DAS. Highest plant height was registered in S₂N₁ (164.97 cm) followed by S₀N₁ (151.63 cm). While, least was in S₁N₀ (106.53 cm). Plant height differed significantly due to different planting geometry at harvest. Among them S₂ (136.82 cm) documented significantly higher plant height on par with S₀ (135.70 cm) and least was noticed in S₁ (123.51 cm). There was significant difference among the nutrient levels for plant height. Maximum plant height was in N₁ (155.84 cm) followed by N₂ (127.56 cm). While, minimum was in N₀ (120.27 cm). Statistically significant differences were found among interactions of planting geometry and nutrition with respect to plant height at harvest. Maximum plant height was documented in S₂N₁ (171.19 cm) and minimum was in S₁N₀ (114.61 cm). These results are in conformity with the findings of Feleafel *et al.* (2005)^[21], Harish chand Ram *et al.* (2013)^[6], Uddin *et al.* (2014)^[20], Inder Jeet Sharma *et al.* (2014)^[9], Vikash Kumar *et al.* (2016)^[19], and Amanga Okello Baw *et al.* (2017)^[1] in okra.

3.2 Number of branches

The observations regarding to number of branches as influenced by planting geometry and nutrition and their interactions were presented in the Table 2.

Table 1: Influence of planting geometry and nutrition on plant height (cm) at 30, 60, 90 DAS and at harvest of okra cv. Arka Anamika

Treatments	30 DAS	60 DAS	90 DAS	At harvest
Spacing (S)				
S ₀ : 60 × 45 cm	13.23	37.95	124.12	135.70
S ₁ : 60 × 30 cm	12.76	35.40	114.63	123.51
S ₂ : 60 × 60 cm	14.61	41.45	128.00	136.82
S.E.m±	0.43	0.97	3.29	3.42
C.D (P= 0.05)	1.25	2.84	9.66	10.03
Nutrition Levels (N)				
N ₀ : 100% RDF	11.77	31.10	109.94	120.27
N ₁ : 125% RDF	16.27	45.45	145.81	155.84
N ₂ : 150% RDF	13.20	39.50	118.24	127.56
N ₃ : 200% RDF	12.90	37.01	115.02	124.38
S.E.m±	0.49	1.12	3.80	3.95
C.D (P= 0.05)	1.45	3.28	11.16	11.58
Interaction (S × N)				
S ₀ N ₀	11.73	32.39	110.97	123.11
S ₀ N ₁	15.15	42.54	151.63	166.87
S ₀ N ₂	13.05	39.67	118.40	128.30
S ₀ N ₃	12.98	37.20	115.48	124.52
S ₁ N ₀	11.20	26.70	106.53	114.61
S ₁ N ₁	14.01	40.34	120.82	128.87
S ₁ N ₂	13.17	38.86	117.45	126.73
S ₁ N ₃	12.67	35.69	113.73	123.84
S ₂ N ₀	12.38	34.20	112.32	123.09
S ₂ N ₁	19.66	53.47	164.97	171.79
S ₂ N ₂	13.37	39.97	118.87	127.64
S ₂ N ₃	13.03	38.15	115.85	124.78
S.E.m	0.85	1.94	6.59	6.84
C.D (P= 0.05)	2.51	5.69	19.32	20.06
C.V (%)	11.41	9.27	9.62	9.14

(RDF: Recommended Dose of Fertilizer-125: 75: 63 kg of N: P₂O₅: K₂O ha⁻¹)

3.3 Number of branches at 30, 60, 90 and at harvest

Number of branches recorded zero at 30 days after sowing. Number of branches differed significantly among the planting geometry in which maximum number of branches noticed in spacing S₂ (2.34) followed by S₀ (1.99), however least was observed in S₁ (1.83). Significant difference noticed among different nutrient levels for number of branches per plant at 60 DAS. The number of branches per plant was maximum in N₁ (2.79). The least number of branches per plant were recorded in N₀ (1.42). The interaction of planting geometry and nutrition for number of branches was found to be differed significantly. Among the treatments, S₂N₁ (3.17) noted highest while S₁N₀ recorded a smaller number of branches (1.23). Number of branches was differed significantly among treatments. Highest number of branches was registered in S₂ (3.21). Whereas, lowest number of branches was noticed in S₁ (2.90). Significantly differed the number of leaves at 90 DAS among the treatments. The number of branches was maximum at N₁ (3.73). The lowest number of branches was observed in N₀ (1.99). The number of branches at 90 days after sowing was found to be differed significantly due to interaction of planting geometry and nutrition. Maximum number of branches per plant was noticed in S₂N₁ (3.90) which was statistically on par with S₀N₁ (3.73). Whereas, lowest number of branches per plant was registered in S₁N₀ (1.63). There was significant difference observed on number of

branches among treatments. Highest number of branches was cataloged in S₂ (3.21). Whereas, lowest number of branches was noticed in S₁ (2.90). Significantly differed the number of leaves at 90 DAS among the treatments. The number of branches were maximum at N₁ (3.73). The lowest number of branches was observed in N₀ (1.99). Significant difference was noticed for number of branches at harvest among the interaction of planting geometry and nutrition. Maximum number of branches per plant was noticed in S₂N₁ (3.90) which was statistically on par with S₀N₁ (3.73). Whereas, lowest number of branches per plant was cataloged in S₁N₀ (1.63). The result revealed that a greater number of branches produced under wider spacing (60 × 60 cm) and 125% RDF might be due to wider spacing helped the plant to utilize its energy properly in branching because there was neither much competition for light nor overlapping from adjacent okra plants within the row. Similar results were reported by Ijoyah *et al.* (2010) [23], Harish chand Ram *et al.* (2013) [6].

Table 2: Influence of planting geometry and nutrition on number of branches at 60, 90 DAS and at harvest of okra cv. Arka Anamika

Treatments	60 DAS	90 DAS	At Harvest
Spacing (S)			
S ₀ : 60 × 45 cm	1.99	2.90	2.90
S ₁ : 60 × 30 cm	1.83	2.72	2.72
S ₂ : 60 × 60 cm	2.34	3.21	3.21
S.E.m±	0.06	0.06	0.06
C.D (P= 0.05)	0.16	0.18	0.18
Nutrition Levels (N)			
N ₀ : 100% RDF	1.42	1.99	1.99
N ₁ : 125% RDF	2.79	3.73	3.73
N ₂ : 150% RDF	2.31	3.39	3.39
N ₃ : 200% RDF	1.69	2.66	2.66
S.E.m±	0.06	0.07	0.07
C.D (P= 0.05)	0.19	0.21	0.21
Interaction (S × N)			
S ₀ N ₀	1.50	2.13	2.13
S ₀ N ₁	2.73	3.73	3.73
S ₀ N ₂	2.33	3.33	3.33
S ₀ N ₃	1.40	2.40	2.40
S ₁ N ₀	1.23	1.63	1.63
S ₁ N ₁	2.47	3.57	3.57
S ₁ N ₂	2.13	3.30	3.30
S ₁ N ₃	1.47	2.37	2.37
S ₂ N ₀	1.53	2.20	2.20
S ₂ N ₁	3.17	3.90	3.90
S ₂ N ₂	2.47	3.53	3.53
S ₂ N ₃	2.20	3.20	3.20
S.E.m±	0.11	0.12	0.12
C.D (P= 0.05)	0.33	0.36	0.36
C.V (%)	10.25	7.54	7.54

(RDF: Recommended Dose of Fertilizer-125: 75: 63 kg of N: P₂O₅: K₂O ha⁻¹)

3.4 Chlorophyll content (SPAD value)

The observations on chlorophyll content (SPAD value) as influenced by planting geometry, nutrition and their interactions were furnished in the Table 3. SPAD value was differed significantly among treatments. Highest chlorophyll content was reported in S₂ (50.99) which was statistically on par with S₀ (50.01). Whereas, lowest chlorophyll content

was noticed in S_1 (47.24). There was significant difference observed for chlorophyll content among the nutrient levels. Highest chlorophyll content recorded in N_1 (56.08 SPAD units). While, the minimum chlorophyll content was noticed in control (N_0) (45.99 SPAD units). The interaction of planting geometry and nutrition for chlorophyll content was found to be significant. The highest chlorophyll content was recorded in S_2N_1 (60.83 SPAD units) on par with S_0N_1

(58.23 SPAD units) and the lowest was reported in S_1N_0 (45.61 SPAD units). The improvement in morphological parameters under the wider spacing and higher level of NPK application might have resulted in larger canopy development and presumably higher chlorophyll content of leaves as nutrients actively participate in its formation. Similar result obtained by Jana *et al.* (2010) [22] in okra.

Table 3: Influence of planting geometry and nutrition on chlorophyll content (SPAD units), days to 50 per cent flowering and days to maturity of okra cv. Arka Anamika

Treatments	Chlorophyll content (SPAD units)	Days to 50% flowering	Days to maturity
Spacing (S)			
S_0 : 60 × 45 cm	50.01	45.17	110.42
S_1 : 60 × 30 cm	47.24	45.00	110.58
S_2 : 60 × 60 cm	50.99	45.33	110.42
S.Em±	0.87	0.47	1.01
C.D (P= 0.05)	2.56	NS	NS
Nutrition Levels (N)			
N_0 : 100% RDF	45.99	45.11	110.44
N_1 : 125% RDF	56.08	45.33	110.56
N_2 : 150% RDF	48.55	45.22	110.56
N_3 : 200% RDF	47.04	45.00	110.33
S.Em±	1.01	0.54	1.17
C.D (P= 0.05)	2.95	NS	NS
Interaction (S × N)			
S_0N_0	45.90	44.67	111.00
S_0N_1	58.23	45.67	110.67
S_0N_2	48.70	45.33	110.33
S_0N_3	47.20	45.00	109.67
S_1N_0	45.61	46.00	110.33
S_1N_1	49.17	44.33	110.33
S_1N_2	47.64	45.00	110.67
S_1N_3	46.53	44.67	111.00
S_2N_0	46.45	44.67	110.00
S_2N_1	60.83	46.00	110.67
S_2N_2	49.31	45.33	110.67
S_2N_3	47.38	45.33	110.33
S.Em±	1.74	0.94	2.02
C.D (P= 0.05)	5.11	NS	NS
C.V (%)	6.21	3.63	3.28

(RDF: Recommended Dose of Fertilizer-125: 75: 63 kg of N: P₂O₅: K₂O ha⁻¹)

3.5 Days to 50 per cent flowering

The reviewed results pertaining on days to 50 per cent flowering as influenced by planting geometry, nutrition and their interactions are presented in Table 3. The data revealed that days to 50 per cent flowering did not show significant difference among the plant spacings. However, the days to 50 per cent flowering was ranged from 45.00 to 45.33 days among the treatments. Days to 50 per cent flowering did not differ significantly among the nutrient levels. However, number of days to 50 per cent flowering was ranged from 45.00 to 45.33 days. The interaction of planting geometry and nutrition for days to 50 per cent flowering was found to be significant. Days to 50 per cent flowering was ranged from 44.33 to 46.00 days among the interactions. The result showed that days to 50 per cent flowering statistically non-significant might be due to flowering behavior neither affected by spacing nor nutrition because of supremacy of varietal character and genetic constitution. Similar trend noted by Sharma *et al.* (2016) [25] in okra. Pruthvishree *et*

al., (2025a, 2025b) [28, 29]

3.6 Days to maturity

The observations on days to maturity as influenced by planting geometry, nutrition and their interactions are presented in Table 3. Days to maturity did not show any significant difference among the treatments. However, maximum number of days to maturity was ranged from 110.42 to 110.58 days. Days to maturity did not differ significantly among the nutrient levels. However, the days to maturity was ranged from 110.33 to 110.56 days among the treatments. The interaction of planting geometry and nutrition for days to maturity was found to be significant days to maturity was ranged from 109.67 to 111.00 days among the interactions. There was no significant difference for days to maturity might be due to dominant effect of varietal character and moreover it is influenced by number of factors especially weather and climatic condition in an area. Simililar result reported by Narendra Kumar Meena *et*

al. (2017) ^[26] and Gangaraju *et al.*, (2023) ^[27] in Maize.

4. Seed yield plant⁻¹ (g)

The results on seed yield per plant as influenced by planting geometry, nutrition and interaction are presented in Table 4. Seed yield per plant had significant differences due to planting geometry. Highest seed yield per plant was obtained in S₂ (42.11 g) followed by S₀ (35.15 g). However, lowest was in S₁ (30.67 g). There were significant differences among the nutrition with respect to seed yield per plant. Highest seed yield per plant was proclaimed in N₁

(53.42 g) followed by N₂ (36.69 g). While, lowest was noticed in N₀ (24.36 g). Seed yield per plant showed statistically significant differences due to interaction effect of plant geometry and nutrition. Highest seed yield per plant obtained S₂N₁ (69.06 g) followed by S₀N₁ (51.08 g) and least was noted in S₁N₀ (20.86 g). Maximum seed yield per plant might be due to a greater number of fruits and maximum fruit length and diameter resulting from wider spacing and balanced fertilization. The results uphold the findings of Humayun Khan *et al.* (2000) ^[8], Soni *et al.* (2006) ^[18] and Priyanka *et al.*, (2017) ^[30].

Table 4: Influence of planting geometry and nutrition on seed yield plant⁻¹, seed yield plot⁻¹ and seed yield ha⁻¹ of okra cv. Arka Anamika

Treatments	Seed yield plant ⁻¹ (g)	Seed yield plot ⁻¹ (g)	Seed yieldha ⁻¹ (q)
Spacing (S)			
S ₀ : 60 × 45 cm	35.15	827.32	14.36
S ₁ : 60 × 30 cm	30.67	800.31	13.89
S ₂ : 60 × 60 cm	42.11	881.28	15.30
S.Em±	1.15	16.55	0.29
C.D (P= 0.05)	3.36	48.55	0.84
Nutrition Levels (N)			
N ₀ : 100% RDF	24.36	688.73	11.96
N ₁ : 125% RDF	53.42	982.94	17.06
N ₂ : 150% RDF	36.69	876.09	15.21
N ₃ : 200% RDF	29.44	797.45	13.84
S.Em±	1.32	19.12	0.33
C.D (P= 0.05)	3.88	56.06	0.97
Interaction (S × N)			
S ₀ N ₀	24.27	685.52	11.90
S ₀ N ₁	51.08	951.98	16.53
S ₀ N ₂	35.54	877.71	15.24
S ₀ N ₃	29.69	794.05	13.79
S ₁ N ₀	20.86	681.62	11.83
S ₁ N ₁	40.13	881.40	15.30
S ₁ N ₂	35.64	860.31	14.94
S ₁ N ₃	26.06	777.92	13.51
S ₂ N ₀	27.94	699.04	12.14
S ₂ N ₁	69.06	1115.45	19.36
S ₂ N ₂	38.87	890.26	15.46
S ₂ N ₃	32.56	820.38	14.24
S.Em±	2.29	33.11	0.57
C.D (P= 0.05)	6.72	97.10	1.68
C.V (%)	12.06	10.05	10.04

(RDF: Recommended Dose of Fertilizer-125: 75: 63 kg of N: P₂O₅: K₂O ha⁻¹)

5. Seed yield plot⁻¹ (g)

The observation regarding seed yield per plot as influenced by planting geometry, nutrition and interaction are presented in Table 4. Significant differences were found for seed yield per plot in different planting geometry. Highest seed yield per plot was recorded in S₂ (881.28 g). However, least was observed in S₁ (800.31 g). Influence of different nutrient levels exhibited significant effect on seed yield per plot. Maximum seed yield per plot was observed in N₁ (982.94 g) while, minimum was in N₀ (688.73 g). The interaction effects between planting geometry and nutrition regarding seed yield per plot were found to be significant. Highest seed yield per plot was noticed in S₂N₁ (1115.45 g), while, lowest was in S₁N₀ (681.62 g). This increase in seed yield might be due to healthy and luxuriant plants had grown under wider spacing and higher NPK vigorous vegetative growth with accelerated photosynthetic activities thereby

increases the abundant supply of carbohydrates to the plant and synthesized photosynthates might have translocated in growing fruits having more demand of assimilates, which consequently led to production bold and heavier seed resulted in higher seed yield per plot. The results are in conformity with those of Humayun Khan *et al.* (2000) ^[8], Soni *et al.* (2006) ^[18], Inder Jeet Sharma *et al.* (2014) ^[9].

6. Seed yield ha⁻¹ (q)

The data pertaining to seed yield per ha as influenced by planting geometry, nutrition and interaction are depicted in Table 4. The influence of plant geometry on seed yield per ha was differed significantly. seed yield per ha was more in S₂ (15.30 q). Whereas less was in S₁ (13.89 q). Seed yield per ha showed statistically significant differences due to influence of nutrient levels. Maximum seed yield per ha was recorded in N₁ (17.06 q) while, minimum was in N₀ (11.96

q). Significant differences were observed for seed yield per ha due to interaction effect of planting geometry and nutrition. S_2N_1 (19.36 q ha^{-1}) and least was in S_1N_0 (11.83 q). Higher number of seeds per fruit, more boldness of seed imparting weight and increasing the seed yield per plant and strengthens the fact that less competition resulted in higher availability of resources meant for more partitioning of inputs in yield factors such as nutrients, moisture and sunlight per plant due to less plant density. It is an established fact that nitrogen promotes vegetative growth consequently resulting in more yields. P and K are also responsible for better growth, maturity seed yield. All these three nutrients affected positively on the performance of plant and yield contributing traits which resulted in higher seed yield per ha. These findings are in agreement with the results of Humayun Khan *et al.* (2000) ^[8], Soni *et al.* (2006) ^[18], Moniruzzaman *et al.* (2007) ^[11], Inder Jeet Sharma *et al.* (2014) ^[9], Navdeep Singh Brar and Daljeet Singh (2016) ^[12].

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