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Effect of nutrient levels and planting geometry on yield, quality and economics of knol-khol (*Brassica oleraceae* var. *gongylodes* L.) under protected cultivation

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Abstract
An experiment entitled "Effect of nutrient levels and planting geometry on yield, quality and economics of knol-khol (*Brassica oleraceae* var. *gongylodes* L.) under protected cultivation" was conducted during the *Rabi* and Summer season of 2021-22 at Agricultural and Horticultural Research Station, Madikeri, Karnataka. The experiment consisted of nine treatment combinations involving three levels of nutrient *viz*., 100, 125 and 150 percent RDF and three planting geometry *viz*., 30 cm × 15 cm, 30 cm × 20 cm and 30 cm × 25 cm was laid out in Factorial Complete Randomized Design with three replications. The result revealed that crop fertilized with 150 percent of RDF was recorded significantly higher diameter and fresh weight of knob per plant (7.29 cm and 181.38 g, respectively), knob yield (29.22 t ha^{-1}), TSS content (7.09 0Brix), ascorbic acid content (41.80 mg 100 g^{-1}), shelf life of knob (6.81 days), net return (Rs. 8,24,925 ha^{-1}) and B:C ratio (3.40) which was on par with 125 percent of RDF. Among planting geometry, crop sown with a spacing of 30 cm × 25 cm was recorded significantly higher diameter and fresh weight of knob per plant (7.79 cm and 189.02 g, respectively), TSS content (7.29 0Brix), ascorbic acid content (42.89 mg 100 g^{-1}) and shelf life of knob (7.06 days) whereas, significantly higher knob yield (32.96 t ha^{-1}), net return (Rs. 9,71,977 ha^{-1}) and B:C ratio (3.81) recorded with a spacing of 30 cm × 15 cm.

Keywords: Nutrient levels, planting geometry, yield, knol-khol, *Brassica oleraceae* var. *gongylodes* L.

Introduction
Knol-khol (*Brassica oleracea* var. *gongylodes* L.) is a cool season crop belongs to the family *Cruciferae* and is originated from the coastal countries of Mediterranean region (Choudhary, 1967). This knob is harvested for human consumption as raw or cooked vegetable for making salad and pickles, young leaves are also cooked as vegetable (Talukder *et al.*, 2013) [24]. Knol-khol has enormous nutritional and medicinal values. It contains satisfactory amount of phosphorus (51 mg), potassium (372 mg), calcium (41 mg), iron (0.5 mg), vitamin-A (20 mg), thiamin (0.06 mg), riboflavin (0.04 mg), niacin (0.03 mg) and vitamin-C (66 mg) per 100 g of above ground stem (Duke and Ayensu, 1985) [9]. The presence of sulforaphane and other isothiocyanates which act as anti-oxidant and are believed to stimulate the production of protective enzyme in the body (Mishra *et al.*, 2012) [18]. The demand of crop is increasing now a day due to its anti-hyperglycemic and anti-carcinogenic properties.
In India, cultivation of knol-khol is mainly popular in Jammu & Kashmir, Himachal Pradesh, Assam, Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, West Bengal and Maharashtra. Among the Cole crops grown in our country, the demand for crop is increasing especially in parts of West Bengal, Kashmir and southern Karnataka (Mishra *et al*., 2014) [17].
Knol-khol is a heavy feeder and shows good response to fertilizer application (Shalini *et al.*, 2002) [22]. It requires nutrient for growth and development in the form of proper doses of NPK. Adequate supply of nitrogen enhances vegetative growth and favors the transformation of carbohydrates into proteins (Haque and Jakhro, 1996) [12]. Phosphorus plays a vital role in several key physiological processes, such as photosynthesis, respiration, energy storage and transfer, cell division and cell enlargement and it also stimulates root growth (Memon, 1996) [16]. Potassium is considered as essential in photosynthesis, sugar translocation, nitrogen metabolism, enzyme activation, stomatal opening, water relation and growth of meristematic tissues (Chandra, 1989) [5].

Keeping adequate plant population per unit area by maintaining proper spacing is most important agronomic practice for getting higher yield with good quality produce (Bairwa *et al.*, 2017) [1]. Under the wider spacing, plant was more vigorous in terms of vegetative growth due to lesser competition for available resources as compared to closer spacing (Rai *et al.*, 2003) [21]. Dense planting can produce higher yield due to more number of plants per unit area although they produce smaller size knobs (Rahman and Hossain, 2011) [20].

Cole crops in general are sensitive to weather conditions and sudden rise or fall in temperature, irregular rainfalls at any stage of crop growth can affect the normal growth and yield. The formation of knob is best seen at the temperature range of 15-18 °C but, the quality is better under lower temperature (Talukder *et al.*, 2013) [24]. Hence, cultivation of knol-khol under controlled environments is one of the most promising measures to overcome abiotic stresses like temperature, rainfall, humidity, light etc. and biotic stresses like pests, diseases, weeds etc. (Bhatnagar, 2014) [4]. Similarly, it enables us to grow in the off-season and also to extend the growing seasons for a much longer period than is possible under open field conditions.

Materials and Methods

The experiment was conducted at Agricultural and Horticultural Research Station, Madikeri, Karnataka during *Rabi* and summer of 2021-22. The location falls under Agro-Climatic Zone-IX (Hilly zone) of Karnataka which lies on latitude and longitude of 12.42551` N and 75.73152` E, respectively and an altitude of 1150 m. It experiences tropical climate with an average rainfall of 2500 mm. The mean daily temperature during the growing season fluctuated between 19.35 °C to 30.18 °C and relative humidity from 69 to 89 percent. The soil was loamy sand in texture, slightly acidic in reaction with medium available N (315.02 kg ha^{-1}), P2O5 (42.80 kg ha^{-1}) and K_2O content (232.78 kg ha^{-1}). The experiment was comprised of nine treatment combinations involving three levels of nutrient (100, 125 and 150% of RDF) and planting geometry (30 cm × 15 cm, 30 cm × 20 cm and 30 cm × 25 cm) was laid out in Factorial Complete Randomized Design with three replications.

The experiment was laid out in naturally ventilated polyhouse made up of galvanized iron pipe and covered with 800-gauge UV stabilized polythene film. The experimental plots were prepared by making raised beds of 30 cm height and each measuring 3.0 × 2.7 m2 gross plot size by mixing well rotten FYM in soil at the rate of 12.5 tons per hectare. Mulching was done prior to transplanting with black polythene sheet of 200-gauge thickness and holes were made appropriate distance as per the treatments. Twenty-eight days old seedlings of Early F1 hybrid were used for transplanting into main field. At the time of transplanting, half dose of nitrogen, full dose of phosphorus and potassium were applied in experimental plots and thoroughly mixed in soil. Remaining half dose of nitrogen was top-dressed four weeks after transplanting. All the crop management practices were adopted during cropping season. The knobs were harvested after attaining optimum stem size (5-8 cm). From each treatment five plants were selected randomly for recording observations during the both cropping periods. The field data were analyzed statistically as suggested by Gomez and Gomez (1984) [10] and the interaction effect of knob yield were separately subjected to Duncan's Multiple Range Test (DMRT).

Result and Discussion Yield and yield attributes

The pooled data pertaining to yield and yield parameters are significantly influenced by nutrient levels and planting geometry (Table 1). Among nutrient levels, application of 150 percent of RDF recorded significantly highest fresh weight of knob (181.38 g), diameter of knob (7.29 cm) and knob yield (29.22 t ha^{-1}) which was on par with 125 percent of RDF (176.15 g, 7.12 cm and 28.54 t ha^{-1}, respectively). Significantly lower values for fresh weight (166.61 g), diameter (6.70 cm) and knob yield (27.09 t ha^{-1}) recorded with 100 percent of RDF. Application of 125 and 150 percent of RDF registered a higher yield of 5.35 and 7.86 percent, respectively over 100 percent of RDF (Fig. 1). The increase in yield with each successive increment in nutrient level might be due to favorable effect of fertilizer on vegetative growth which improves the photosynthetic efficiency and translocation of photosynthates from source (leaves) to sink (knob). Consequently, more accumulation of food material and enlargement of knob size. These findings are in close conformity to Mishra *et al.* (2014) [17] in knol-khol and Baseerat *et al.* (2016) [2] in cabbage.

Among planting geometry, crop sown with a spacing of 30 cm × 25 cm recorded significantly superior values for fresh weight (189.02 g) and diameter of knob (7.49 cm) over rest of the treatments. The treatment with a spacing of 30 cm × 20 cm recorded significantly higher fresh weight (175.66 g) and diameter of knob (7.05 cm) over 30 cm × 15 cm (159.46 g and 6.58 cm, respectively) which was significantly inferior over all other levels of planting geometry. The above results indicated that the fresh weight and diameter of knob per plant increased with plant spacing due to increased vegetative growth, thereby more reserve of food in knobs, due to this the weight of knob probably increased which further shows more diameter of knob. These findings are in accordance with the findings of Bhangre *et al*. (2011) [3], Tejaswini *et al.* (2018) [25] in broccoli and Hange *et al.* (2019) [11] in knol-khol. Whereas, significantly higher knob yield (32.96 t ha^{-1}) recorded with 30 cm × 15 cm spacing over rest of the treatments. The treatment with a spacing of 30 cm × 20 cm spacing recorded significantly higher knob yield (27.92 t ha^{-1}) over 30 cm × 25 cm (23.96 t ha^{-1}) which was significantly inferior over rest of planting geometry. Total knob yield increased significantly with reduced plant spacing. At the present study, decreased plant spacing of 30 cm × 15 cm was accommodates more plants per unit area (33.73 and 66.92%, respectively) over 30 cm × 20 cm and 30 cm × 25 cm (Fig. 2). Hence, increase in yield of knol-khol under closer spacing due to increased number of plants per unit area, even though there was a decrease in size and weight of knob per plant which, was compensate with a greater number of knobs per unit areas it is depicted in the final yield. These findings are in close accordance with the finding of Rai *et al.* (2003) in knol-khol and Turbin *et al.* (2014) [27] in brussel sprout.

The interaction effect between nutrient levels and planting geometry was found non- significant with regard to knob yield. However, numerically highest knob yield (33.99 t ha^{-1}) recorded with interaction of 150 percent of RDF with a spacing of 30 cm × 15 cm followed by 125 percent of RDF with 30 cm × 15 cm (33.08 t ha^{-1}) and 100 percent of RDF with a spacing of 30 cm × 15 cm (31.81 t ha^{-1}). Whereas, numerically least knob yield (23.13 t ha^{-1}) recorded with interaction of 100 percent of RDF with 30 cm × 25 cm. The similar trend also reported by Manohar (2016) [14] in red cabbage and Hange *et al.* (2019) [11] in knol-khol.

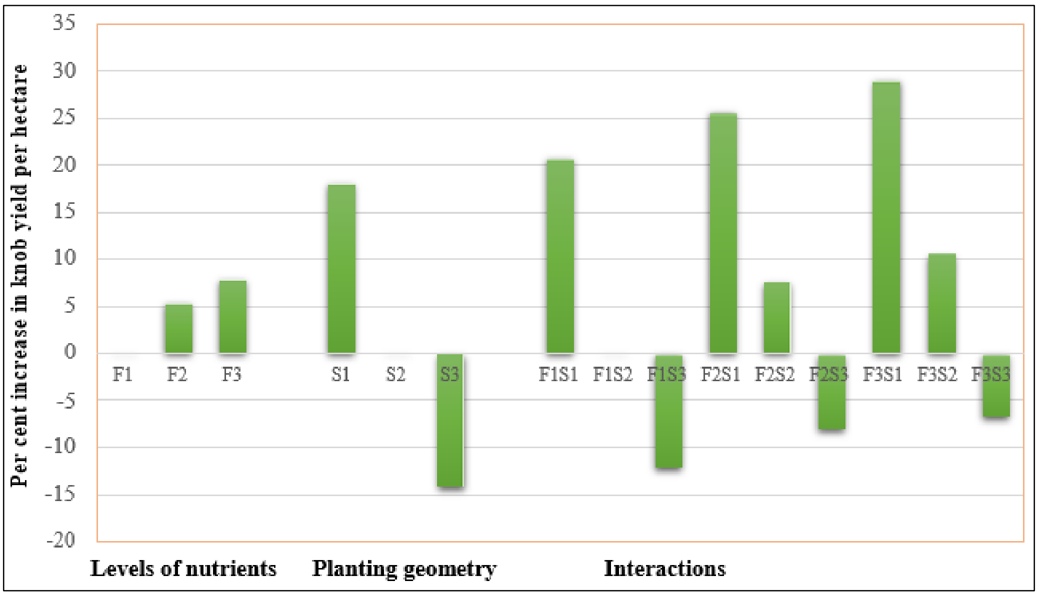

Fig 1: Percent increase in knob yield per hectare as influenced by nutrient levels and planting geometry under protected cultivation

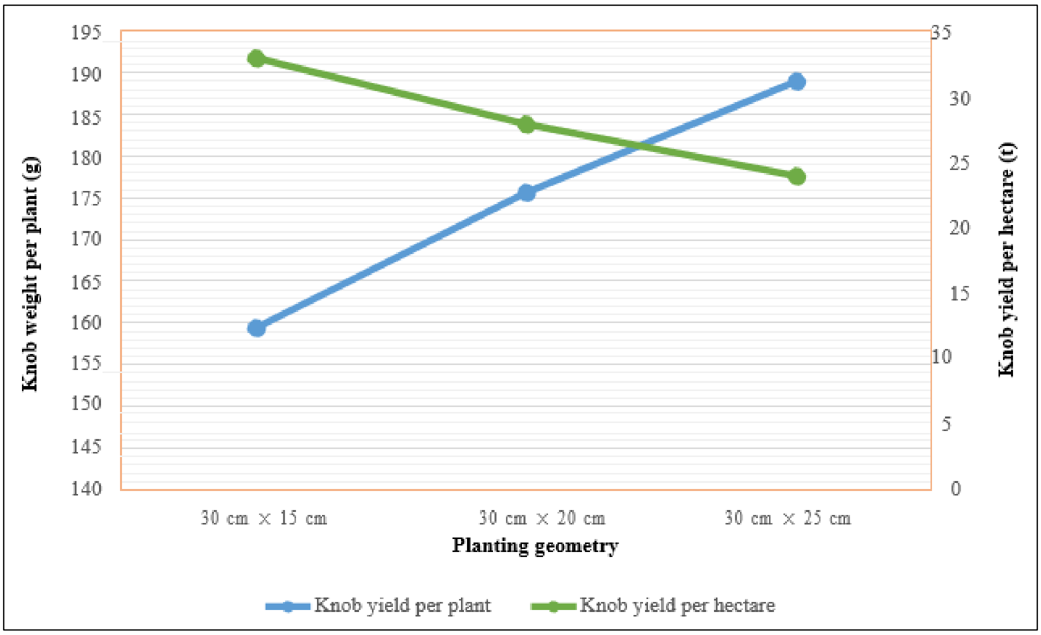

Fig 2: Knob weight per plant and knob yield per hectare as influenced by planting geometry under protected cultivation

Table 1: Yield and yield parameters of knol-khol as influenced by nutrient levels and planting geometry under protected cultivation

Treatments	Fresh weight of knob (g)			Diameter of knob (cc)			Total knob yield (t ha^{-1})		
	Rabi	Summer	Pooled	*Rabi*	Summer	Pooled	*Rabi*	Summer	Pooled
Levels of nutrient (F)									
F1: 100% RDF	164.25	168.98	166.61	6.61	6.80	6.70	26.68	27.50	27.09
F2: 125% RDF	173.97	178.33	176.15	7.03	7.22	7.12	28.17	28.90	28.54
F3: 150% RDF	179.97	182.79	181.38	7.20	7.37	7.29	28.98	29.45	29.22
S.E.M. (±)	2.99	3.01	2.87	0.12	0.13	0.12	0.47	0.44	0.45
C. D. (p=0.05)	8.94	9.02	8.58	0.37	0.37	0.37	1.40	1.32	1.36
Planting geometry (S)									
S1: 30 cm × 15 cm	156.75	162.17	159.46	6.44	6.72	6.58	32.44	33.48	32.96
S2: 30 cm × 20 cm	173.79	177.53	175.66	6.97	7.12	7.05	27.54	28.29	27.92
S3: 30 cm × 25 cm	187.64	190.40	189.02	7.42	7.56	7.49	23.85	24.08	23.96
S.E.M. (±)	2.99	3.01	2.87	0.12	0.13	0.12	0.47	0.44	0.45
C. D. (p=0.05)	8.94	9.02	8.58	0.37	0.37	0.37	1.40	1.32	1.36
Interaction (F×S)									
F1S1	148.33	154.73	151.53	6.15	6.40	6.28	31.17 b	32.46 a	31.81 a
F1S2	162.49	168.28	165.39	6.45	6.69	6.57	25.86 de	26.78 cd	26.32 cd
F1S3	181.92	183.92	182.92	7.21	7.31	7.26	23.02 f	23.25 e	23.14 e

F2S1	156.81	163.25	160.03	6.44	6.81	6.63	32.46 ab	33.69 a	33.08 a
F2S2	176.15	179.81	177.98	7.18	7.30	7.24	28.04 cd	28.62 bc	28.33 bc
F2S3	188.94	191.91	190.42	7.46	7.56	7.51	24.01 ef	24.39 e	24.20 de
F3S1	165.12	168.51	166.82	6.73	6.94	6.84	33.70 a	34.28 a	33.99 a
F3S2	182.73	184.49	183.61	7.29	7.37	7.33	28.73 c	29.47 b	29.10 b
F3S3	192.06	195.37	193.72	7.59	7.80	7.70	24.52 ef	24.59 de	24.56 de
S.E.M. (±)	5.17	5.22	4.97	0.21	0.22	0.22	0.81	0.76	0.78
C. D. (p=0.05)	NS	NS	NS	NS	NS	NS	-	-	-

Quality parameters

The pooled data pertaining to quality parameters are significantly influenced by nutrient levels and planting geometry (Table 2). Among levels of nutrient, crop fertilized with 150 percent of RDF significantly improved quality parameters *viz*., TSS,), ascorbic acid content and shelf life (7.09 0Brix, 41.80 mg 100 g^{-1} and 6.81 days, respectively) which was on par with 125 percent of RDF (6.94 0Brix, 41.24 mg 100 g^{-1} and 6.54 days, respectively). Significantly minimum TSS, ascorbic acid content and shelf life of knob (6.56 0Brix, 39.06 mg 100 g^{-1} and 6.10 days, respectively) was recorded with 100 percent of RDF. The increased nutrient availability and plant uptake influences the enzymatic activities and synthesis of amino acids, proteins and sugars in knob, which led to accumulation of more reserve substance in knob and finally improvement in quality of knob. These results agree with the present finding of Talat *et al.* (2014) and Mishra *et al*. (2014) [17].

Among planting geometry, crop sown with a spacing of 30 cm × 25 cm recorded significantly maximum TSS, ascorbic acid content and shelf life of knob (7.29 0Brix, 42.89 mg 100 g^{-1} and 7.06 days, respectively) over all other levels of planting geometry. Whereas, spacing of 30 cm × 20 cm was significantly higher for TSS, ascorbic acid content and shelf life of knob (6.89 0Brix, 40.71 mg 100 g^{-1} and 6.45 days, respectively) over 30 cm × 15 cm (6.42 0Brix, 38.50 mg 100 g^{-1} and 5.94 days, respectively) which was significantly inferior over rest of treatments. The increase in quality parameters at wider spacing might be due to lesser competition between the plants for light, water, nutrients and space which favored higher photosynthetic activity and accumulation of more food material *i.e.*, carbohydrates due to more synthesis of ascorbic acid and TSS. These findings are in close accordance with the finding of Kumar and Rawat (2002) [13] in cabbage, Thirupal *et al.* (2014) [26] in broccoli and Bairwa *et al.* (2017) [1] in knol-khol.

Economics

The pooled data with respect to economics of knol-khol cultivation are significantly influenced by nutrient levels and planting geometry (Table 3). Among nutrient levels, significantly highest gross return, net return and B:C ratio (Rs. 11,68,600 ha^{-1}, Rs. 8,24,925 ha^{-1} and 3.40, respectively) was observed when crop fertilized with 150 percent of RDF which on par with 125 percent of RDF (Rs. 11,41,400 ha^{-1}, Rs. 8,02,012 ha^{-1} and 3.36, respectively). Whereas, significantly least gross return, net return and B:C ratio (Rs. 10,83,600 ha^{-1}, Rs. 7,45,448 ha^{-1} and 3.20, respectively) observed when crop fertilized with 100 percent of RDF.

Table 2: Quality parameters of knol-khol as influenced by nutrient levels and planting geometry under protected cultivation

Treatments	TSS content in knob (0Brix)			Ascorbic acid content in knob (mg 100 g^{-1})			Shelf life of knob (days)		
	Rabi	Summer	Pooled	*Rabi*	Summer	Pooled	*Rabi*	Summer	Pooled
Levels of nutrient (F)									
F1: 100% RDF	6.50	6.62	6.56	38.75	39.37	39.06	6.48	5.71	6.10
F2: 125% RDF	6.87	7.02	6.94	40.90	41.58	41.24	6.89	6.19	6.54
F3: 150% RDF	7.04	7.14	7.09	41.38	42.22	41.80	7.20	6.41	6.81
S.E.M. (±)	0.12	0.12	0.12	0.69	0.69	0.69	0.12	0.11	0.11
C. D. (p=0.05)	0.35	0.36	0.36	2.06	2.06	2.06	0.35	0.33	0.33
Planting geometry (S)									
S1: 30 cm × 15 cm	6.36	6.48	6.42	38.11	38.88	38.50	6.40	5.49	5.94
S2: 30 cm × 20 cm	6.82	6.96	6.89	40.39	41.02	40.71	6.77	6.13	6.45
S3: 30 cm × 25 cm	7.23	7.34	7.29	42.52	43.26	42.89	7.41	6.70	7.06
S.E.M. (±)	0.12	0.12	0.12	0.69	0.69	0.69	0.12	0.11	0.11
C. D. (p=0.05)	0.35	0.36	0.36	2.06	2.06	2.06	0.35	0.33	0.33
Interaction (F×S)									
F1S1	6.10	6.28	6.19	36.79	37.21	37.00	5.95	5.21	5.58
F1S2	6.43	6.48	6.46	38.75	39.27	39.01	6.44	5.53	5.99
F1S3	6.96	7.11	7.04	40.71	41.62	41.17	7.04	6.40	6.72
F2S1	6.45	6.51	6.48	38.71	39.20	38.96	6.35	5.45	5.90
F2S2	6.81	7.10	6.96	40.68	41.61	41.14	6.81	6.38	6.60
F2S3	7.35	7.44	7.40	43.31	43.92	43.62	7.52	6.75	7.14
F3S1	6.53	6.65	6.59	38.84	40.23	39.54	6.89	5.81	6.35
F3S2	7.21	7.30	7.26	41.75	42.19	41.97	7.04	6.48	6.76
F3S3	7.38	7.47	7.43	43.56	44.23	43.90	7.67	6.95	7.31
S. Em. (±)	0.20	0.21	0.21	1.19	1.19	1.19	0.20	0.19	0.19
C. D. (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: RDF: recommended dose of fertilizer, DAT: Days after transplanting

Table 3: Economics of cultivation of knol-khol as influenced by nutrient levels and planting geometry under protected cultivation

Treatments		Gross return (Rs. ha^{-1})			Net return (Rs. ha^{-1})			B:C ratio	
	Rabi	Summer	Pooled	*Rabi*	Summer	Pooled	*Rabi*	Summer	Pooled
Levels of nutrient (F)									
F1: 100% RDF	10,67,333	10,99,867	10,83,600	7,29,182	7,61,715	7,45,448	3.15	3.24	3.20
F2: 125% RDF	11,26,800	11,56,000	11,41,400	7,87,412	8,16,612	8,02,012	3.32	3.40	3.36
F3: 150% RDF	11,59,333	11,77,867	11,68,600	8,15,658	8,34,192	8,24,925	3.37	3.42	3.40
S.E.M. (±)	15457.93	15828.79	15643.13	12671.71	13014.89	12842.71	0.04	0.04	0.04
C. D. (p=0.05)	46283.70	47394.12	46937.93	37941.29	38968.80	38453.27	0.12	0.12	0.12
Planting geometry (S)									
S1: 30 cm × 15 cm	12,97,733	13,39,067	13,18,400	9,51,310	9,92,643	9,71,977	3.76	3.86	3.81
S2: 30 cm × 20 cm	11,01,733	11,31,600	11,16,667	7,62,218	7,92,085	7,77,152	3.24	3.33	3.29
S3: 30 cm × 25 cm	9,54,000	9,63,066	9,58,533	6,18,724	6,27,791	6,23,257	2.85	2.87	2.86
S.E.M. (±)	15457.93	15828.79	15643.13	12671.71	13014.89	12842.71	0.04	0.04	0.04
C. D. (p=0.05)	46283.70	47394.12	46937.93	37941.29	38968.80	38453.27	0.12	0.12	0.12
Interaction (F×S)									
F1S1	12,46,800	12,98,400	12,72,600	9,02,854	9,54,454	9,28,654	3.63	3.77	3.70
F1S2	10,34,400	10,71,200	10,52,800	6,96,911	7,33,711	7,15,311	3.06	3.17	3.12
F1S3	9,20,800	9,30,000	9,25,400	5,87,780	5,96,980	5,92,380	2.76	2.79	2.78
F2S1	12,98,400	13,47,600	13,23,000	9,52,631	10,01,831	9,77,231	3.76	3.90	3.83
F2S2	11,21,600	11,44,800	11,33,200	7,83,259	8,06,459	7,94,859	3.32	3.38	3.35
F2S3	9,60,400	9,75,600	9,68,000	6,26,347	6,41,547	6,33,947	2.88	2.92	2.90
F3S1	13,48,000	13,71,200	13,59,600	9,98,445	10,21,645	10,10,045	3.87	3.92	3.90
F3S2	11,49,200	11,78,800	11,64,000	8,06,485	8,36,085	8,21,285	3.35	3.44	3.40
F3S3	9,80,800	9,83,600	9,82,200	6,42,045	6,44,845	6,43,445	2.90	2.90	2.90
S. Em. (±)	26773.92	27416.27	27094.53	21948.05	25542.44	22244.22	0.07	0.07	0.07
C. D. (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: RDF: Recommended Dose of Fertilizer, DAT: Days After Transplanting

The crop fertilized with 150 percent of RDF representing an increase of rupees 22,903 and 76,447 per hectare of net returns and 1.19 and 6.25 percent of B:C ratio, respectively over 125 and 100 percent of RDF.

Among planting geometry, significantly highest gross return, net return and B:C ratio (Rs. 13,18,400 ha^{-1}, Rs. 9,71,977 ha^{-1} and 3.81, respectively) recorded when crop sown with a spacing of 30 cm × 15 cm over rest of treatments. Whereas, spacing of 30 cm × 20 cm recorded significantly higher gross return, net return and B:C ratio (Rs. 11,16,667 ha^{-1}, Rs. 7,77,152 ha^{-1} and 3.29, respectively) over 30 cm × 25 cm (Rs. 9,58,533 ha^{-1}, Rs. 6,23,257 ha^{-1} and 2.86, respectively) which was significantly inferior to all other treatments. Th crop sown with a spacing of 30 cm × 15 cm representing a significant increase of rupees 1,94,825 and 3,48,720 per hectare of net returns, respectively over 30 cm × 20 cm and 30 cm × 25 cm. The narrow spacing (30 cm × 15 cm) recorded higher percent of net return (25.07 and 55.95%) and B:C ratio (15.80 and 33.21%) over wider spacing (30 cm × 20 cm and 30 cm × 25 cm, respectively).

The interaction effect between nutrient levels and planting geometry was found non- significant. However, interaction effect of 150 percent of RDF with 30 cm × 15 cm of spacing recorded numerically highest gross return, net return and B:C ratio (Rs. 13,59,600 ha^{-1}, Rs. 10,10,045 ha^{-1} and 3.90, respectively) followed by 125 percent of RDF with 30 cm × 15 cm (Rs. 13,23,000 ha^{-1}, Rs. 7,94,859 ha^{-1} and 3.83, respectively). The results indicated that higher level of nutrient and narrow spacing has significant influence on economics of knol-khol cultivation due to the increase in yield which fetches more prices in the market with less expenditure. The findings of this investigation were in close conformity with those of Dogra (2000) [8] in hybrid cabbage, Meena *et al.* (2017) [15] in cauliflower, Chouhan (2008) [7] in Chinese cabbage, Nagar (2016) [19] and Hange *et al.* (2019) [11] in knol-khol.

Conclusion

The present investigation entitled "Effect of nutrient levels and planting geometry on yield, quality and economics of knol-khol (*Brassica oleraceae* var. *gongylodes* L.) under protected cultivation" indicated that crop fertilized with 125 percent of RDF and planting at a spacing of 30 cm × 15 cm under protected cultivation was resulted in 25.68 and 36.62 percent improvement in the yield and net returns, respectively over the application of 100 percent of RDF with a spacing of 30 cm × 20 cm. From, it is possible to realize high net returns of rupees 9,77,231 per hectare and benefit-cost ratio of 3.83.

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