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Standardization of agro-techniques to perk up quality and yield of knolkhol (*Brassica oleracea* var *gongylodes* L) in southern agro-climatic zone of Andhra Pradesh

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ABSTRACT

Investigations were carried out on standardization of agro-techniques to perk up quality and yield of knolkhol (*Brassica oleracea* var *gongylodes* L) test variety White Vienna. The treatments comprised three timings of planting, three spacing and five nitrogen doses. There was no perceptible change in TSS of the knolkhol knobs due to various timings of planting while the effect of staggered timings of planting on other quality parameters was conspicuous. The highest ascorbic acid and protein contents were registered with the crop planted during 1st fortnight of December and the highest crude fibre content during 1st fortnight of November. Improved quality of knolkhol knobs in terms of TSS, ascorbic acid content and protein content was with planting geometries of 30 x 30 cm followed by of 45 x 15 cm (S_3) and 30 x 15 cm (S_1) which in turn were on par with one another. The fibre content of knobs was highest with the crop geometry of 30 x 15 cm. A linear increase with respect to quality parameters viz TSS, ascorbic acid content and protein content was noticed from 0 to the highest level of nitrogen of 150 kg N/ha. The trend obtained with respect to fibre content of knobs was reverse to that of other quality parameters studied. With regard to interaction effect the higher crude protein content was at spacing of 45 x 15 cm and 30 x 30 cm coupled with higher nitrogen doses of 150 and 125 kg N/ha. During both the years the highest knob yield was in the crop planted during 1st fortnight of December. Significantly higher knob yield was observed at spacing of 30 x 15 cm, the highest nitrogen dose of 150 kg/ha and spacing of 30 x 15 cm.

Keywords: TSS ; vitamin C; protein; yield; date of planting; spacing; nitrogen; knolkhol

INTRODUCTION

Members of the genus *Brassica* such as cabbage, broccoli, brussels sprout, knolkhol etc have been widely regarded as potentially high healthy foods due to the presence of bioactive substances having potential to reduce physiological as well as oxidative stress-induced DNA damage (Soengas et al 2011).

Knolkhol (*Brassica oleracea* var *gongylodes* L) is one of the cool season crops which is gaining popularity due to its anti-hyperglycemic and anti-carcinogenic properties owing to higher antioxidant activity (530 micro moles/g fresh weight) because of rich antioxidant composition ie ascorbic acid (164 mg/100 g), carotenoids (54 mg/100 g) and total phenolic content (169 mg/100 g) (Ahmed and Beigh 2009).

Knolkhol or kohlrabi is not a common crop in southern agro-climatic zone of Andhra Pradesh. When a non-traditional crop is to be introduced in a new region for field cultivation it needs to be evaluated for the response to local climatic factors. For a plant to be successful in a given region the sequences of its growth phases must fit in the climate to ensure good growth and adequate production. Plant density is an important variable for achieving maximum yield and uniform vegetable maturity. Nitrogen is an important element for economic vegetable production that most frequently limits the production and is the key input in nutrient management. Hence the present investigations were carried out to standardize the time of transplanting, plant density and nitrogen dose of knolkhol in southern agro-climatic zone of Andhra Pradesh.

MATERIAL and METHODS

The investigations on standardization of agro-techniques to perk up quality and yield of knolkhol (*B oleracea* var *gongylodes* L) variety White Vienna were carried out in southern agro-climatic zone of Andhra Pradesh for two consecutive Rabi seasons viz 2014-15 and 2015-16 at Horticultural College and Research Institute, Anantharajupeta, Andhra Pradesh. The experimental design was split-split plot with three replications. The treatments comprised three timings of planting viz 1st fortnight of November (T_1), 2nd fortnight of November (T_2) and 1st fortnight of December (T_3) assigned to main plots, three spacing viz 30 x 15 cm (S_1), 30 x 30 cm (S_2) and 45 x 15 cm (S_3) allotted to sub-plots and five nitrogen doses viz 0 (N_1), 75 (N_2), 100 (N_3), 125 (N_4) and 150 kg N/ha (N_5) assigned to sub-sub-plots.

The soil of the experimental field was sandy clay loam in texture, low in organic carbon and available nitrogen and medium in available phosphorus and available potassium. During both the years of experimentation the nursery was raised under shade nets with staggered sowings so as to obtain 30 day old seedlings for respective planting. The crop was grown under open field condition by adopting the recommended cultural practices. Uniform doses of 60 kg P_2O_5 and 80 kg K_2O per ha through single super phosphate and muriate of potash respectively were applied as basal through band placement 5 cm away from the crop row uniformly to all the treatments. Half the dose of nitrogen was applied as basal and the remaining in two equal splits viz at 3 and 6 weeks after planting as per the treatments. Hand weeding was done twice at 15 and 30 days after transplanting.

For estimating total soluble solids (TSS) freshly harvested knolkhol knobs were ground using pestle and mortar to extract the juice and TSS content was recorded with the help of Atago digital refractometer. Vitamin C/ascorbic acid content was estimated by volumetric method as per the standard procedure (Anon 1960) and starch content by anthrone reagent method (Hedge and Hofreiter 1962). Oven-dried knob samples of knolkhol were finely powered and used for protein content analysis. Nitrogen content in plant samples was analyzed by the standard procedure outlined by Jackson (1973). The nitrogen content was multiplied by the factor 6.25 to arrive at the crude protein content of the sample. Crude fiber (CF) was estimated by treating the sample with 1.25 per cent H_2SO_4 and 1.25 per cent NaOH and the residue left was ashed in muffle furnace at 550-600°C. The loss due to ashing was considered as crude fibre.

$$\text{Crude fibre (\%)} = \frac{\text{Weight before ashing - Weight after ashing}}{\text{Weight of the sample taken}} \times 100$$

Knob yield was calculated from the weight of knobs harvested from the net plot area and expressed as tonnes/ha.

RESULTS and DISCUSSION

The effect of time of planting, spacing and nitrogen doses on TSS, vitamin C content, starch content, crude protein content, crude fibre content and yield of knolkhol knobs at harvest is given in Table 1 and the interaction effect of spacing and nitrogen doses on crude protein content and knob yield of knolkhol at harvest is depicted in Table 2.

Total soluble solids (TSS): The influence of different times of planting on TSS of knolkhol knobs was not statistically measurable but the effect of different spacing and nitrogen doses on TSS was significant during both the years of experimentation. The interaction effects of the first, second and third order treatments were not significant on the TSS of knolkhol knobs in the two years. Kumar et al (2007) also reported that the TSS was not influenced by planting date in broccoli. TSS recorded from the knobs planted at planting geometry of 30 x 30 cm (S_2) was significantly superior to that of 45 cm x 15 cm (S_3) and 30 cm x 15 cm (S_1) which in turn were on par with each other during both the years of study. An increasing trend was noticed in TSS of knolkhol knobs from 0 (N_1) to the highest level of nitrogen tried ie 150 kg N/ha (N_5) followed by 125 (N_4) and 100 kg N/ha (N_3) which stood statistically at par with one another. The superiority in TSS at higher levels of nitrogen in this study is in agreement with the findings of Saleh et al (2013) in kohlrabi.

Vitamin C content: Vitamin C or ascorbic acid content of knolkhol knobs at harvest was influenced by time of planting, spacing and nitrogen doses tested. However their interactions were not significant with respect to the vitamin C content during both the years of study. The effect of time of planting was not consistent on the vitamin C content. The highest ascorbic acid content was registered during first year

Table 1. Total soluble solids, vitamin C content, starch content, crude protein content, crude fibre content and knob yield of knolkhol at harvest as influenced by time of planting, spacing and nitrogen doses

		2014-15							2015-16						
		N_1	N_2	N_3	N_4	N_5	Mean (T)	Mean (S)	N_1	N_2	N_3	N_4	N_5	Mean (T)	Mean (S)
Total soluble solids (°Brix)															
T_1	S_1	5.9	6.2	6.3	6.2	6.2	6.2	6.3	5.9	6.1	6.2	6.1	6.1	6.2	6.3
	S_2	6.1	6.2	6.3	6.3	6.5			6.1	6.2	6.2	6.3	6.5		
	S_3	6.0	6.1	6.2	6.2	6.4			6.0	6.1	6.2	6.2	6.4		
T_2	S_1	6.0	6.3	6.4	6.4	6.4	6.3	6.4	6.2	6.3	6.4	6.5	6.4	6.4	6.4
	S_2	6.2	6.4	6.3	6.5	6.6			6.3	6.4	6.4	6.6	6.7		
	S_3	6.1	6.2	6.4	6.4	6.4			6.2	6.2	6.4	6.5	6.4		
T_3	S_1	6.2	6.4	6.5	6.5	6.5	6.4	6.3	6.2	6.4	6.5	6.6	6.5	6.5	6.3
	S_2	6.4	6.5	6.5	6.7	6.8			6.4	6.5	6.5	6.7	6.8		
	S_3	6.2	6.3	6.5	6.5	6.4			6.3	6.3	6.5	6.6	6.5		
Mean (N)		6.1	6.3	6.4	6.4	6.5	-	-	6.1	6.3	6.4	6.4	6.5	-	-
Vitamin C content (mg/100 g)															
T_1	S_1	45.7	47.3	49.2	50.8	52.5	58.2	50.1	43.4	44.8	47.3	49.0	50.6	56.3	48.7
	S_2	63.7	65.7	67.3	69.3	71.2			61.1	63.8	65.5	67.6	69.2		
	S_3	54.3	56.3	58.0	60.0	62.0			52.4	54.5	56.3	58.3	60.1		
T_2	S_1	47.3	49.3	50.5	52.2	54.2	59.2	68.2	45.5	47.4	48.8	50.3	52.2	57.3	66.3
	S_2	63.7	66.3	68.7	70.7	72.5			61.7	64.6	66.9	68.8	70.7		
	S_3	53.7	56.3	58.7	60.7	62.7			51.9	54.5	56.7	58.9	60.8		
T_3	S_1	47.3	49.0	50.5	52.2	53.8	59.6	58.7	53.5	47.2	48.6	50.3	52.0	58.3	56.9
	S_2	65.0	67.0	68.7	70.7	72.5			63.3	65.2	66.7	68.8	70.8		
	S_3	55.7	57.7	59.3	61.3	64.0			53.8	55.9	57.4	59.5	62.2		
Mean (N)		55.2	57.2	59.0	60.9	62.8	-	-	54.1	55.3	57.1	59.1	61.0	-	-
Starch content (%)															
T_1	S_1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
	S_2	1.5	1.5	1.5	1.5	1.5			1.5	1.5	1.5	1.5	1.5		
	S_3	1.5	1.5	1.5	1.5	1.5			1.5	1.5	1.5	1.5	1.5		
T_2	S_1	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.5	1.6	1.5	1.5	1.5
	S_2	1.5	1.5	1.5	1.5	1.5			1.5	1.5	1.5	1.5	1.5		
	S_3	1.6	1.5	1.6	1.5	1.5			1.5	1.5	1.5	1.5	1.5		
T_3	S_1	1.5	1.5	1.5	1.6	1.5	1.5	1.5	1.5	1.5	1.6	1.6	1.5	1.5	1.5
	S_2	1.5	1.5	1.5	1.5	1.4			1.5	1.5	1.5	1.5	1.5		
	S_3	1.5	1.5	1.5	1.5	1.5			1.5	1.5	1.5	1.5	1.5		
Mean (N)		1.5	1.5	1.5	1.5	1.5	-	-	1.5	1.5	1.5	1.5	1.5	-	-

Crude protein content (%)															
T_1	S_1	6.2	7.8	9.3	10.1	10.3	9.5	10.2	5.9	7.3	8.8	9.5	9.7	8.9	9.5
	S_2	6.6	8.9	10.9	12.0	12.3			6.3	8.4	10.2	11.4	11.6		
	S_3	6.5	8.1	10.0	11.5	11.6			6.1	7.7	9.4	10.8	10.9		
T_2	S_1	7.9	9.5	10.8	11.8	11.9	11.1	11.4	7.5	8.9	10.2	11.1	11.3	10.5	10.8
	S_2	7.7	10.5	12.5	13.7	14.0			7.1	10.0	11.8	13.0	13.2		
	S_3	8.2	10.0	11.7	13.1	13.2			7.7	9.5	11.0	12.4	12.5		
T_3	S_1	8.7	10.2	11.6	12.5	12.7	11.9	10.3	8.2	9.7	10.9	11.8	12.0	11.2	10.3
	S_2	8.2	11.3	13.3	14.5	14.7			7.7	10.7	12.5	13.7	13.9		
	S_3	9.0	10.7	12.4	13.9	14.0			8.5	10.2	11.7	13.1	13.2		
Mean (N)		7.7	9.7	11.4	12.6	12.7	-	-	7.2	9.1	10.7	11.9	12.0	-	-
Crude fibre content (%)															
T_1	S_1	31.2	30.6	29.5	28.8	29.7	28.5	27.3	33.7	33.3	32.2	31.4	32.4	31.1	29.9
	S_2	29.1	28.8	27.7	25.9	25.5			31.8	31.5	30.4	28.5	28.1		
	S_3	30.1	29.3	28.3	27.3	26.3			32.6	31.6	30.7	29.7	28.6		
T_2	S_1	29.4	28.6	27.6	26.6	26.3	26.5	25.6	31.9	31.1	30.4	29.3	28.8	29.1	28.2
	S_2	27.5	26.7	25.8	24.8	23.5			30.2	29.5	28.4	27.5	26.2		
	S_3	27.9	27.1	26.1	25.1	24.2			30.5	29.6	28.8	27.6	26.7		
T_3	S_1	27.5	26.9	25.8	17.0	23.9	24.1	26.2	30.1	29.5	28.4	19.5	26.4	26.6	28.7
	S_2	25.6	24.9	23.8	22.7	21.8			28.2	27.4	26.3	25.2	24.4		
	S_3	26.3	25.5	24.3	23.4	22.5			28.8	28.0	26.8	25.9	25.0		
Mean (N)		28.3	27.6	26.6	24.6	24.9	-	-	30.9	30.2	29.2	27.2	27.4	-	-
Knob yield (tonnes/ha)															
T_1	S_1	9.2	21.5	26.2	32.9	35.6	21.3	25.6	7.2	16.8	20.5	25.7	27.9	16.7	21.2
	S_2	6.3	14.6	19.6	21.4	23.7			4.9	11.4	15.3	16.8	18.6		
	S_3	9.1	18.2	24.0	27.0	29.7			7.1	14.3	18.8	21.1	23.3		
T_2	S_1	9.4	21.9	26.7	33.6	36.3	22.0	17.5	7.9	18.5	22.6	28.3	30.7	18.3	14.4
	S_2	6.4	14.9	20.0	21.8	24.2			5.4	12.6	16.9	18.4	20.4		
	S_3	9.3	18.6	24.5	27.6	30.3			7.8	15.7	20.7	23.3	25.6		
T_3	S_1	9.5	22.3	27.3	34.2	37.0	22.1	22.0	8.1	19.0	23.3	29.2	31.6	18.9	18.2
	S_2	6.5	15.2	20.4	22.3	24.7			5.6	13.0	17.4	19.0	21.0		
	S_3	9.4	19.0	25.0	28.1	30.9			8.0	16.2	21.3	24.0	26.6		
Mean (N)		8.3	18.5	23.7	27.6	30.3	-	-	6.9	15.3	19.6	22.9	25.0	-	-

	2014-15		2015-16		2014-15		2015-16		2014-15		2015-16	
	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$
	Total soluble solids				Vitamin C content				Starch content			
T	0.12	NS	0.17	NS	0.40	1.1	1.04	NS	0.01	NS	0.01	NS
S	0.03	0.1	0.02	0.1	0.40	1.1	0.52	1.6	0.01	NS	0.01	NS
N	0.04	0.1	0.04	0.1	0.51	1.5	0.43	1.2	0.02	NS	0.02	NS
T x S	0.04	NS	0.04	NS	0.69	NS	0.91	NS	0.02	NS	0.01	NS
T x N	0.07	NS	0.07	NS	0.89	NS	0.74	NS	0.04	NS	0.03	NS
S x N	0.07	NS	0.07	NS	0.89	NS	0.74	NS	0.04	NS	0.03	NS
T x S x N	0.12	NS	0.12	NS	1.54	NS	1.28	NS	0.07	NS	0.05	NS
	Crude protein content				Crude fibre content				Knob yield			
T	0.15	0.6	0.14	0.6	0.23	0.9	0.27	1.0	0.02	0.1	0.03	0.1
S	0.11	0.3	0.10	0.3	0.30	0.9	0.30	0.9	0.32	0.1	0.26	0.8
N	0.17	0.5	0.16	0.5	0.41	1.2	0.41	1.2	0.34	0.1	0.28	0.8
T x S	0.19	NS	0.18	NS	0.52	NS	0.53	NS	0.55	NS	0.46	NS
T x N	0.30	NS	0.28	NS	0.71	NS	0.71	NS	0.59	NS	0.48	NS
S x N	0.30	0.8	0.28	0.8	0.71	NS	0.71	NS	0.59	1.7	0.48	1.4
T x S x N	0.52	NS	0.49	NS	1.23	NS	1.23	NS	1.01	NS	0.84	NS

with the crop planted during first fortnight of December (T_3) which was statistically at par with that of T_2. The lowest ascorbic acid content was registered during first fortnight of November (T_1) which maintained parity with T_2 while during second year the time of planting could not exert significant influence on the ascorbic acid content. The increased ascorbic acid content in knobs harvested from first fortnight of December planting during first year of study might be due to lower canopy temperature during knob development. Similar trend of increase in ascorbic acid content with low temperatures was also reported by Thirupal (2014) and Singhal et al (2009) in broccoli. These results also confirm the earlier studies of Lee and Kader (2000) and Tamura (2004) who reported that lower temperature usually induced the accumulation of sugars and L-ascorbic acid in field crops. The plants grown at 30 x 30 cm (S_2) spacing produced knobs with significantly higher ascorbic acid content than that of 45 x 15 cm (S_3) and 30 x 15 cm (S_1) during both the years. The decrease in ascorbic acid content at closer spacing (30 x 15 cm) might be due to severe competition among knolkhol plants for light, water, nutrients and space resulting in reduced photosynthesis and accumulation of sugars as ascorbic acid is synthesized from sugars supplied through photosynthesis in plants. Similar tendency of decrease in ascorbic acid was observed by Thirupal (2014) in broccoli and Ewa and Katarzyna (2008) in garlic. A progressive increase was noticed with successive increase in nitrogen doses from 0 (N_1) to 150 kg N/ha (N_5) which may be attributed to enhanced photosynthesis and accumulation of sugars under adequate nitrogen nutrition since ascorbic acid is synthesized from sugars supplied through photosynthesis in plants. The superiority in ascorbic acid content at higher levels of nitrogen in this study is in agreement with the findings of Saleh et al (2013) in kohlrabi.

Starch content: The effect of treatment variables under scrutiny on starch content of knolkhol knobs was not statistically traceable during the two years of study.

Protein content: Crude protein content was significantly affected by the time of planting, spacing and nitrogen doses during both the years of experimentation while the interaction between spacing and nitrogen doses alone was significant. The highest protein content was with the crop planted during 1st fortnight of December (T_3). The higher protein content in later planting might be due to higher uptake of minerals facilitated by optimum environmental and edaphic factors coupled with longer duration. The higher protein content was associated with spacing of 30 x 30 cm (S_2). Lesser number of plants per unit area at spacing of 30 x 30 cm and consequent vigorous root growth and absorption of nutrients from larger volume of soil would have accumulated higher nitrogen content leading to production of higher protein. The highest protein content was recorded with 150 kg N/ha. Increasing level of applied nitrogen increased the protein content. This might be due to the fact that nitrogen is a fundamental component of amino acids which forms the proteins. Amino acid synthesis occupies a central position in the N metabolism of plants which are able to produce all the different forms of amino acids required for the specific protein. The experimental findings are in consonance with the findings of Rao (2015) and Brahma et al (2000) in broccoli. The interaction between spacing and nitrogen levels alone was consistent on protein content during both the years. During first year the higher protein content was obtained at wider spacing of 45 x 15 cm (S_3) coupled with higher nitrogen dose of 150 kg N/ha. However during second year the higher protein content was associated with a combination of 30 x 30 spacing and application of 150 kg N/ha.

Fibre content: Time of planting, spacing and nitrogen doses significantly influenced the crude fibre content of knolkhol with unaltered trend during both the years (Table 1) while the interactions could not bring out significant difference in the crude fibre content of knolkhol.

During both the years the highest crude fibre content was registered with the earliest crop planted during 1st FN of November followed by later plantings ie during 2nd FN of November (T_2) and 1st FN of December (T_3) with significant disparity between them. The lowest crude fibre content recorded in late planted crop might be due to the fact that more vegetative growth of crop led to higher uptake of nitrogen which is the constituent of amino acids and protein which in turn decreased the fibre constituents like pectin, celluloses and hemicelluloses. The highest crude fibre content was registered with spacing of 30 cm x 15 cm followed by other two spacing evaluated viz 30 x 30 cm and 45 x 15 cm which maintained parity with each other during both the years of research. The highest crude fibre content at 30 x 15 cm spacing might be due to the reduced vegetative growth of crop leading to lower uptake of nitrogen.

A linear decrease in crude fibre content of knolkhol was noticed with successive increase in nitrogen dose applied. The highest crude fibre content was observed at 0 (N_1) followed by 75 (N_2) and 100 kg N/ha (N_3) which were statistically dissimilar to one another only during second year of experimentation. Application of higher doses of nitrogen viz 150 (N_5) and 125 kg N/ha (N_4) resulted in lower crude fibre content than lower doses tested with significant parity between them during both the years. The lowest crude fibre content noticed with higher levels of nitrogen might be due to vigorous vegetative growth of crop with higher uptake of nitrogen.

Knob yield: Time of planting, spacing and nitrogen doses significantly influenced the knob yield during both the years. The interaction of spacing and nitrogen doses exerted significant influence on knob yield but other interactions failed to influence the knob yield significantly. During both the years the highest knob yield was in late planted crop ie during 1st fortnight of December (T_3). Higher knob yield due to late planting can be attributed to no water logging stress and longer vegetative phase leading to improvement in growth parameters like plant height, leaf length and width and dry matter production. Similar results of higher crop yield of broccoli planted during 1st fortnight of December compared to other four dates of planting tried during Rabi in southern agro-climatic zone of Andhra Pradesh were also reported by Thirupal (2014). Significant difference in knob yield due to different plant spacing studied was observed during both the years with unaltered trend. Significantly higher knob yield was observed at the closer spacing of 30 x 15 cm (S_1) followed by the wider of 45 x 15 cm (S_3). The lowest yield was recorded in widest spacing of 30 x 30 cm (S_2). The highest yield in closer spacing might be due to accommodation of more number of plants per unit area. The results are in conformity with the findings of Rai et al (2003) in knolkhol and Thirupal (2014) in broccoli. The highest nitrogen dose of 150 kg/ha (N_5) resulted in significantly higher knob yield compared to lower doses tested. The improvement in yield with enhanced nitrogen application might be attributed to better availability and uptake of nutrients which in turn led to efficient metabolism and higher biomass accrual which might be responsible for production of elevated level of yield stature. The results are in conformity with the findings

Table 2. Interaction effect of spacing and nitrogen doses on crude protein content and knob yield of knolkhol at harvest

	2014-15						2015-16					
	N_1	N_2	N_3	N_4	N_5	Mean (S)	N_1	N_2	N_3	N_4	N_5	Mean (S)
Crude protein content (%)												
S_1	6.48	8.26	10.06	11.19	11.39	9.47	7.20	8.64	9.96	10.82	10.97	9.52
S_2	7.93	10.00	11.67	12.87	13.02	11.10	7.05	9.66	11.53	12.67	12.91	10.76
S_3	8.62	10.74	12.41	13.64	13.81	11.85	7.46	9.10	10.73	12.12	12.21	10.32
Mean (N)	7.68	9.67	11.38	12.57	12.74		7.24	9.13	10.74	11.87	12.03	
Knob yield (tonnes/ha)												
S_1	9.4	21.9	26.7	33.6	36.3	25.6	7.7	18.1	22.1	27.7	30.1	21.2
S_2	6.4	14.9	20.0	21.8	24.2	17.5	5.3	12.3	16.5	18.1	20.0	14.4
S_3	9.3	18.6	24.5	27.5	30.3	22.0	7.7	15.4	20.3	22.8	25.1	18.2
Mean (N)	8.3	18.5	23.7	27.6	30.3	-	6.9	15.3	19.6	22.9	25.0	-

	Crude protein				Knob yield			
	2014-15		2015-16		2014-15		2015-16	
	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$	SEm±	$CD_{0.05}$
S x N	0.297	0.84	0.283	0.80	0.59	1.7	0.48	1.4

of Saleh et al (2013) and Ahmed et al (2003) in kohlrabi, Kumar and Rawat (2002) and Singh and Singh (2000) in cabbage.

Interaction between spacing and nitrogen doses alone was significant during both the years. The highest knob yield was with closer spacing of 30 x 15 cm coupled with the highest level of nitrogen ie 150 followed by 125 kg N/ha at same spacing. The results are in close proximity to that of Hosseini et al (2006).

CONCLUSION

The best performance of knolkhol with the highest yield and quality could be realized with planting during 1st fortnight of December at a closer spacing of 30 x 15 cm along with the application of 150 kg N/ha in the present domain of study. The above said package of agro-techniques was found to be the most efficient for enhancing the productivity and quality of knolkhol in the southern agro-climatic zone of Andhra Pradesh.

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