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Parkey Gogoi
Department of Horticulture,
Assam Agricultural University,
Jorhat, Assam, India

DB Phookan
Department of Horticulture,
Assam Agricultural University,
Jorhat, Assam, India

Correspondence
Parkey Gogoi
Department of Horticulture,
Assam Agricultural University,
Jorhat, Assam, India

Effect of organic inputs and microbial consortium on yield and quality of Knolkhol (*Brassica oleracea* L.var. *gongylodes*)

Parkey Gogoi and DB Phookan

Abstract

The present investigation was carried out to study the yield and quality of knolkhol as influenced by organic inputs and microbial consortium at experimental farm, Department of Horticulture, Jorhat during 2014-15 and 2015-16. Pooled data over two years revealed that T_8 [RDF(80:60:60kg NPK + 10t FYM ha^{-1})] recorded the highest knob yield of 191.45q ha^{-1} which was followed by 169.73q ha^{-1} under T_7 (Enriched compost 5t ha^{-1}). Quality parameters studies revealed that ascorbic acid (63.54mg 100 g^{-1}), carbohydrate (6.74%), calcium (2.06%), phosphorus (0.69%) and potassium (4.62%) were found better in treatment treated with Enriched compost 5t ha^{-1} and consortium (T_7). However, crude fibre content of 10.13% and protein content of 2.98% were found to be better in T_8 [RDF (80:60:60 kg ha^{-1} NPK) + FYM @ 10t ha^{-1}].

Keywords: Organic, Vermicompost, Enriched Compost, Consortium, Quality parameters

Introduction

Knolkhol (*Brassica oleracea* L. var. *gongylodes*) is an important cole crop, which is a good source of vitamins, minerals and fibres. As the crop is a heavy feeder of nutrients and excavates N, P and K from soil to a great extent, judicious application of manures and biofertilizers is essential to obtain higher yield and enhanced soil health. In modern agriculture, continuous and indiscriminate use of chemical fertilizers, pesticides and herbicides deteriorates the soil health, causes human health hazards and creates imbalance in the environment. The continuous use of chemical fertilizers badly affects the texture and structure of soil, reduces soil organic matter and decreases microbial activity of soil (Alam *et al.*, 2007) [1]. This led many farmers to switch over to organic farming in recent times to produce safe foodstuff and to get higher price from the market. Suitable combination of organic nutrients for improvement of growth and yield of knolkhol has been a matter of interest to the farmers. But suitable recommendations are scarce especially for NE India. Keeping the above facts in view, the present study was carried out for future production.

Materials and methods

The experiment was conducted at the Experimental Farm, Department of Horticulture, Assam Agricultural University, Jorhat during 2014-15 and 2015-16 using the variety White Vienna. The experimental site was established under a Randomized Block Design with eight treatments and three replications under open condition. The treatments were: T_1 = Rock phosphate + Consortium, $T_2 = T_1$ + Compost (2.5t ha^{-1}), $T_3 = T_1$ + Compost (5t ha^{-1}), $T_4 = T_1$ + Vermicompost (2.5t ha^{-1}), $T_5 = T_1$ + Vermicompost (5t ha^{-1}), T_6 = Enriched compost (2.5t ha^{-1}), T_7 = Enriched compost (5t ha^{-1}) and T_8 = RDF (80:60:60 kg ha^{-1} NPK) + FYM @ 10t ha^{-1}. The recommended dose of fertilizer was applied in the form of urea (N – 46%), SSP (P – 16%) and MOP (K- 60%) along with borax (60kg ha^{-1}). All the organic manures were applied once as a basal dose and incorporated in the soil 15 days before transplanting of seedlings. Half dose of urea, full dose of SSP, MOP and borax were applied as basal dose and remaining half of urea was applied as top-dress at 30 days after transplanting. Except the inorganic treatment, all other treatments were mixed with a slurry of consortium before sowing. Seedlings were transplanted in the month of October with a spacing of 40 x 30cm. The observations were made by using standard procedures and the data were analysed as per statistical methods given by Panse and Sukhatme (1995).

Results and discussion

Knob Yield per hectare

It was revealed in Fig.1that knob yield ha^{-1} was found significant among the treatments. The highest knob yield ha^{-1} of 189.35q, 195.56q and 191.45q were recorded in T_8 [RDF (80:60:60kg NPK + 10t ha^{-1} FYM)] in the year 2014-2015, 2015-2016 and pooled data over two years respectively. This could be due to the rapid availability and utilization of nitrogen for various internal processes in the plant. The higher leaf number provided by this treatment facilitates larger photosynthetic area coupled with increased uptake of water and nutrients from soil might have resulted in increased production of photosynthates leading to better filling of knobs and thereby increasing yield. Also, long term fertilizer application along with FYM results in yield improvement (Swarup, 1998) [14]. Among the different organic treatments, T_7 (Enriched compost 5t ha^{-1}) exhibited the highest yield ha^{-1} of 168.07q, 171.45q and 169.73q in the year 2014-2015, 2015-2016 and pooled data over two years respectively. There were also significant differences among the other treatments. However, T_1 (Rock phosphate + Consortium) was recorded with significantly the lowest knob yield ha^{-1} of 46.99q. Increase in the yield was due to the supply of additional nutrient through organics as well as improvement in the physical and biological properties of soil (Sharma *et al.,* 2005) [12]. The increase also might be due to fact that these nutrients are being important constituents of nucleotides, proteins, chlorophyll and enzymes, involve in various metabolic process which have direct impact on vegetative and reproductive phase of the plants. Application of organic manure increases microbial population in soil that helps the soil to release various immobile nutrients. These microbes also produce PGRs that are important for plant growth and photosynthetic activity (Levy and Taylor, 2003) [8].

Ascorbic acid content (mg $100g^{-1}$)

The highest value of 64.22mg 100 g^{-1} and 62.87mg 100g $^{-1}$ ascorbic acid content of knob was obtained in T_7 (Enriched compost 5t ha^{-1}) in the first year and second year of experiment respectively. Pooled data over the years showed that the highest ascorbic acid content of knob was found in T_7 (63.54mg 100 g^{-1}) which was closely followed by T_6 (61.42mg $100g^{-1}$) and were at par. The lowest ascorbic acid content of 35.01mg $100g^{-1}$ was found in T_8[RDF (80:60:60kg NPK + 10t ha^{-1} FYM)] which was at par with T_1 (35.21mg 100 g^{-1}). A negative correlation between vitamin C content and level of applied nitrogen is often reported (Lee and Kader, 2000) [7]. This might be due to the fact that plants under organic treatments comparatively has inferior vegetative growth than inorganic treatments and lesser leaf area, so all leaves are well illuminated and act as a source of carbohydrate. Therefore, surplus amount of carbohydrates are available for their conversion to ascorbic acid synthesis, since carbohydrates are the starting material for ascorbic acid biosynthesis (Kumar *et al.,* 2016) [5]. Furthermore, soil microorganism affects soil dynamics and plant metabolisms and ultimately results in differences in plant composition and nutritional quality as reported by Worthington (2001) [17] and Jaipaul *et al*. (2011) [4].

Crude fibre content (%)

It is discernable from the pooled data that highest crude fibre content of 10.13% was recorded in T_8 [RDF (80:60:60kg NPK + 10t ha^{-1} FYM)] followed by 9.55% in T_1 (Rock phosphate + Consortium) and 9.07% in T_2 (T_1 + Compost 2.5t ha^{-1}). However, the crude fibre content of 7.57% in T_6 (Enriched compost 2.5t ha^{-1}) was at par with 7.52% in T_5 (T_1 + Vermicompost 5t ha^{-1}). Significantly, the lowest fibre content of 7.12% was observed in T_7 (Enriched Compost 5t ha^{-1}). T_8 receiving the least organic manure leads to compact soil (higher bulk density) and makes the plants less responsive towards overall growth but more fibre content. In contrast, treatment T_7 which received maximum organic manure and consortium tended to produce tender knobs with least fibre content due to the action of organic acids secreted by the microbes (Evers, 1989) [2].

Carbohydrate (%)

The highest carbohydrate content in knob was recorded in T_7 (Enriched Compost 5t ha^{-1}) of 6.69%, 6.80% and 6.74% respectively in the year 2014-2015, 2015-2016 and pooled data over two years. Pooled data revealed that carbohydrate content in T_2 (5.35%), T_3 (5.26%) and T_4 (5.44%) were at par. Significantly, the lowest carbohydrate content of 5.03% was observed in T_8 [RDF (80:60:60kg NPK + 10t FYM ha^{-1})] which was at par with 5.04% T_1 (Rock phosphate + Consortium). It might be due to the fact that when a plant is exposed to with more of nitrogen, it increases protein production and reduces carbohydrate concentration (Worthington, 2001) [17].

Protein content (%)

From the pooled data over two years, the highest protein content of 2.98% was recorded in T_8 [RDF (80:60:60kg NPK + 10t ha^{-1} FYM)] which was closely followed by 2.75% in T_7 (Enriched compost 5t ha^{-1}). Among the other treatments T_3 (2.37%), T_4 (2.48%) and T_6 (2.56%) were at par. The lowest protein content of 1.74% was recorded in T_1 (Rock phosphate + Consortium) which was at par with 1.78% in T_8 [RDF (80:60:60kg NPK + 10t FYM ha^{-1})]. The increase in protein content with higher dose of nitrogen content might be due to the fact that nitrogen is a major contributor of protein synthesis. When nitrogen is adequate, proteins are formed from the manufactured carbohydrate. A positive correlation between protein content and level of applied nitrogenous fertilizer was also found by Knorr and Vogtmann (1983) [6] and Weston and Barth (1997) [15].

Mineral content (%)

Calcium: Significant difference in calcium content in knob was observed among the treatments. The highest calcium content of 2.00%, 2.12% and 2.06% in T_7 (Enriched compost 5t ha^{-1}) in the year 2014-2015, 2015-2016 and pooled data over two years respectively. Results of two years pooled data revealed that all the treatments showed significant differences except for T_3 (1.36%) and T_4 (1.31%) being at par. The lowest calcium content in knob (0.89%) was recorded in the inorganic treatment *i.e.* T_8 [RDF (80:60:60 kg ha^{-1} NPK + 10t ha^{-1} FYM)].

Phosphorus: The highest phosphorus content of knob (0.66%), (0.72%) and (0.69%) was recorded in T_7 (Enriched Compost 5t ha^{-1}) in the year 2014-2015, 2015-2016 and pooled data over two years respectively. Pooled data revealed that T_4 (0.61%) was at par with T_5 (0.63%) and T_8 (0.62%). The lowest phosphorus content was recorded in T_2 (T_1 + Compost 2.5t ha^{-1}) of 0.22% which was at par with T_1 (0.23%).

Potassium: The highest potassium content of 4.58%, 4.66%

and 4.62% were recorded in T_7 (Enriched compost 5t ha^{-1}) in the year 2014-2015, 2015-2016 and pooled data over two years respectively. However, pooled data unveiled that there was no significant difference between T_5 (4.13%) and T_6 (4.17%). Significantly, the lowest potassium content observed was 2.53% in T_1 (Rock phosphate + Consortium) which was at par with 2.64% in T_2 (T_1 + Compost 2.5t ha^{-1}).

Application of compost enriched with consortium in soil increased the quality parameters of knolkhol because that soil has more beneficial microorganisms, which produce many compounds that influence the plant to absorb more micronutrients from soil. It is reported that substances such as citrate and lactate combine with the soil minerals and make them more available to plant roots. Mader *et al.* (1993) [9] reported 15% higher P content in beetroot treated with organic manures over conventional treatments. Similarly, an increase in mineral content of vegetables due to application of organic manures over conventional ones was earlier reported by Woese *et al.* (1997) [16] for P in potato; Shelke *et al.* (2001) [13] for Ca, P and Fe; Worthington (2001) [17] for Ca, Zn, Mn and Fe; Shankar *et al.* (2001) for Fe, Mg, Zn in spinach; Hassan *et al.* (2009) [3] for P and K in globe artichoke.

Table 1: Ascorbic acid, Crude fibre, Carbohydrate and Protein content

Treatments	Ascorbic acid content (mg 100g^{-1})			Crude fibre content (%)			Carbohydrate content (%)			Protein content (%)		
	2014-2015	2015-2016	Pooled	2014-2015	2015-2016	Pooled	2014-2015	2015-2016	Pooled	2014-2015	2015-2016	Pooled
T_1	35.35	35.07	35.21	9.37	9.74	9.55	5.03	5.05	5.04	1.68	1.81	1.74
T_2	39.16	40.05	39.60	8.98	9.17	9.07	5.33	5.38	5.35	1.75	1.82	1.78
T_3	43.50	44.66	44.08	8.44	8.65	8.54	5.23	5.29	5.26	2.15	1.93	2.04
T_4	46.85	48.23	47.55	7.85	7.89	7.87	5.42	5.45	5.44	2.25	2.50	2.37
T_5	51.66	53.84	52.75	7.41	7.63	7.52	6.05	6.19	6.12	2.33	2.64	2.48
T_6	62.48	60.37	61.42	7.42	7.65	7.57	6.30	6.35	6.32	2.51	2.61	2.56
T_7	64.22	62.87	63.54	7.03	7.20	7.12	6.69	6.80	6.74	2.64	2.82	2.75
T_8	33.37	36.65	35.01	10.00	10.26	10.13	5.02	5.05	5.03	2.92	3.05	2.98
S.Ed (±)	1.08	0.47	0.62	0.11	0.08	0.09	0.09	0.05	0.03	0.06	0.08	0.07
CD (5%)	2.99	1.30	1.73	0.30	0.25	0.28	0.22	0.12	0.19	0.18	0.26	0.22

Table 2: Calcium, Phosphorus and Potassium content

Treatments	Calcium content (%)			Phosphorus content (%)			Potassium content (%)		
	2014-2015	2015-2016	Pooled	2014-2015	2015-2016	Pooled	2014-2015	2015-2016	Pooled
T_1	1.51	1.55	1.52	0.21	0.26	0.23	2.50	2.56	2.53
T_2	1.11	1.18	1.14	0.18	0.26	0.22	2.69	2.60	2.64
T_3	1.33	1.39	1.36	0.56	0.51	0.53	3.06	2.87	2.96
T_4	1.28	135	1.31	0.59	0.64	0.61	3.58	3.90	3.74
T_5	1.77	1.70	1.74	0.61	0.66	0.63	4.08	4.19	4.13
T_6	1.89	2.04	1.96	0.48	0.49	0.48	4.13	4.21	4.17
T_7	2.00	2.12	2.06	0.66	0.72	0.69	4.58	4.66	4.62
T_8	0.86	0.92	0.89	0.60	0.65	0.62	3.92	3.91	3.91
S.Ed (±)	0.03	0.03	0.02	0.03	0.02	0.02	0.04	0.05	0.03
CD (5%)	0.09	0.08	0.06	0.07	0.06	0.04	0.17	0.19	0.15

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