Original Research Article

Photosynthetic activity, nutrient concentration in leaves and soil properties altered by long term INM practices of knol khol (Brassica oleracea var. gongylodes L.) under acidic *Inceptisols*

ABSTRACT

A long-term field experiment was started in the campus of College of Agriculture, OUAT, Bhubaneswar, Odisha since kharif 2010 in a randomized block designs with 08 treatments and three replication under a cereal-vegetable-pulse cropping system. Different observations were taken in kharif 2018 to evaluate the package and practices with the test crop knol knol which was the 25th crop in the sequence. The treatments were T1: Control, T2: Soil Test Dose (STD), T3: STD + Farm Yard Manure (F), T4: STD + Vermi compost (VC), T5: STD + F + BFs, T6: STD + VC + BFs, T7: STD + F + L + BFs, T8: STD + VC + L + BFs which consisted of different combinations of inorganic fertilizers, organic manures (FYM and vermicompost), ameliorant (lime) and biofertilizers. Knolkhol crop was grown in the experimental plot with different organic and inorganic fertilizers as per the treatment plans. Leaf samples from different were collected at 45 DAP. The economic yield was highest in the treatment supplied with inorganic and organic source of nutrient with lime (T7) which was not significantly higher than T8 whereas significantly higher than rest other treatments. The highest values 2.68%, 1.11mg/kg of fresh weight and 46.34 were recorded for leaf nitrogen content , chlorophyll content and SPAD value respectively were recorded for the treatment T7 where as lowest value of 1.91%, 0.54 mg/g of fresh weight of leaves and 21.81 were recorded for leaf nitrogen content , chlorophyll content and SPAD value respectively with T1.

Keywords: Knol Khol, INM, Photosynthetic activity, Nutrient content

1. INTRODUCTION

Indiscriminate use of chemical fertilizers has caused serious damage to the yield soil health and ecology which also affects physico-chemical along with biological properties of soil. On the other hand, the organic sources of nutrients viz. FYM, poultry manure, neem cake etc., are gaining importance for sustainable crop production which should be integrated with chemical fertilizers for efficient utilisation of nutrients.

But these are not available in adequately due to increased mechanization and a decrease in farm animals. Thus, meeting the requirement of organic manures through composting and/or vermicomposting is one of the best wastes management practices for recycling these substantial amounts of organic residues (Patra et al. 2022). The vermicomposts are microbial activity and having plant growth regulators (Pandit et al 2020). Inoculation of microbes as biofertilizer also enhances the bioavailability of essential nutrients to the plant in adverse condition like acidic condition (Sethi et al. 2019b; Khuntia et al. 2022) and drought condition by producing exopolysaccharides (Sethi et al. 2019a). Organic matter plays an important role

in improving the physico-chemical and biological properties of soil along with development of an eco-friendly system for mutual benefit of organisms for better yield of crop and health of soil. The role of organic manure is more pronounced in vegetable production system than that of other cereal crops. Application of water-soluble fertilizers through foliar spray enhances the photosynthetic activity, yield, nutrient use efficiency and economics of rice (Monica et al. 2020).

Knol-khol (Brassica oleracea var. gongylodes L.) belongs to the family Brassicaceae that is the German name for cabbage turnip, also called kohlrabi which is generally used as a vegetable. It is high in minerals and vitamins A and C. It contains adequate amount of water (90.3 g), calories (29.0 g), protein (2.0 g), carbohydrate (6.6 g), fibre (1.0 g) and ash (l.0 g) per 100 g of edible stem. It also contains satisfactory amount of calcium (41.0 mg), phosphorus (51.0 mg), iron (0.5 mg), sodium (8.0 mg), potassium (372.0 mg), vitamin A (20.0 mg), thiamin (0.06 mg), riboflavin (0.04 mg), niacin (0.03 mg), and vitamin C (66.0 mg) per 100 g of above ground stem. Knol-khol is rich in carbohydrates and minerals. It also contains the antioxidant, vitamin A, C, E and carotene. It is good source of dietary fiber. It also contains sulphoraphanes and other isothiocyanates which are believed to stimulate the production of protective enzyme in the body (Mishra et al. 2012). Nutrient requirement of knol khol is also high which can be managed both by combined application for organic and inorganic source of nutrients. Information regarding the effect of organic as well as inorganic source of nutrients on knol khol yield was scanty for Odisha soil for which present investigation was conducted in the campus of the college of agriculture during 2010 in the long-term experimental plot.

2. MATERIAL AND METHODS

The present investigation was conducted with the long term experiment plot laid out in 2010 at College of Agriculture, Bhubaneswar. The experimental site is located at 20o 15□ 86□ □ north latitude and 85o 28□ 68□ □ east longitude and at an elevation of 25.9 m above mean sea level (MSL) and 60 kms. west of the Bay of Bengal. The climate was hot and humid sub-tropical with dry season prevailing from October to June and wet season from July to September. The soil of the experimental site belongs to order Inceptisols having loamy sand texture and comes under sub-group vertic ustochrept. The field experiment was conducted during kharif 2018 in a randomized block designs with 3 replications and 08 treatments such as T1: Control, T2: Soil Test Dose (STD), T3: STD + Farm Yard Manure(F), t4: STD + Vermi Compost (VC), T5: STD + F + Biofertilisers (BFs), T6: STD + VC + BFs, T7: STD + F + L + BFs, T8: STD + VC + L + BFs. The treatments were consisted of different combinations of inorganic fertilizers, organic manures (FYM and vermicompost), ameliorant (lime) and biofertilizers. As per the treatment plans knol khol crop was grown in the experimental plot with a spacing of 25 cm x 25 cm. Leaf samples were collected from different treatments for analysis of nitrogen and total chlorophyll content. Side by side SPAD value was recorded with the help of spadometer from different treatments as same date of growth stage of knoll khol.

Soil samples were collected from each plot at 0-15 cm before initiation of the sowing of crop and after harvest of crop. Processed soil samples were preserved in polythene bottles for analysis of different chemical parameters by using standard procedures. The observed values of different parameters were analyzed statistically as per the procedure outlined by Gomez and Gomez (1984).

3. RESULTS AND DISCUSSION

Effect on photosynthetic activity and nutrient content

The N content, chlorophyll content, SPAD value of leaves of knol khol at 45 DAP and the economic yield was presented in table1. The highest N content of leaves was recorded with T7 the highest in T7 (2.68%) which was significantly not higher than that of values of 2.56 and 2.49 % with T8 and T6 respectively. but significantly higher than rest of the treatment. The nitrogen content of 1.91% was lowest in T1(control) in case of knol khol leaves. The treatment which received only chemical fertilisers recorded low N content (.....) than that of other treatments receiving organic form of nutrients. The chlorophyll content was found to be significantly higher in the treatment with combined application of organic (FYM or VC), inorganic sources (STD) of nutrients with lime (T7 and T8) than rest of the treatment which was devoid of any of the above supplement.

The highest chlorophyll content of 1.11 mg g-1 of fresh leaves was found with the treatment T7 whereas lowest chlorophyll content of 0.54 mg g-1 of fresh leaves was found with the control. The chlorophyll content of T3 and T4 in which chemical fertilisers added along with only organics were at par with each other. The treatments with organics and biofertilisers was recorded more chlorophyll than that of other treatments without biofertilisers. The SPAD values of different treatments was followed the same trend with that of chlorophyll content of leaves. Significantly highest SPAD value of 46.34 was found with the treatment T7 whereas the lowest value (21.81) was observed with T1. Higher economic yield was recorded with the treatments getting integrated application of inorganic and organic source of nutrient with lime (T7 and T8) which were statistically and significantly higher than rest of the treatments.

The significant increase in amount of chlorophyll content might be due to application of organic manures which on decomposition releases magnesium and nitrogen for longer period and higher quantity. Nitrogen and magnesium are constituents of chlorophyll molecule and nitrogen is the main constituent of all amino acids and proteins which act as structural component of chloroplast. These results were in agreement with the findings of Nehra et al (2001) and Sanwal et al (2007). The higher availability of nutrients might have increased chlorophyll content thereby SPAD value under these treatments. These results corroborated with the result of Saleh et al (2013) and Mishra et al (2014).

Application of nutrients enhanced the Increase in economic yield might be due to more and longer period availability of the different macro and micro nutrients through decomposition which resulted in better root proliferation, rhizosphere development, uptake of nutrients as well as water, higher leaf area development along with higher rate of photosynthesis activity. The increase in average weight of knol khol knob due to INM has been also reported by Bahadur et al. 2003, Maurya et al. 2008 in broccoli, Padamwar and Dakore, 2009; Kumar et al. 2010 in cauliflower and Upadhyay et al. 2012 in cabbage.

Table 1. N, P, K and chlorophyll content of knol khol under the influence of INM

Sl. No.	INM practices	Nutrient content (%)			Total Chlorophyll content of leaves	SPAD value
		N	P	K		
1	Control	1.91	0.11	1.07	0.54	21.81
2	STD	2.35	0.16	1.18	0.60	23.37
3	STD+F	2.13	0.20	1.26	0.77	28.65
4	STD+VC	2.31	0.25	1.29	0.79	30.02
5	STD+F+BFs	2.39	0.30	1.54	0.85	35.98
6	STD+VC+BFs	2.49	0.34	1.60	0.93	39.26
7	STD+F+L+BFs	2.68	0.40	1.68	1.11	46.34
8	STD+VC+L+BFs	2.56	0.44	1.74	1.08	43.68
LSD	(P=0.05)	0.24	0.077	0.276	0.15	2.51
CV	(%)	6	15	11	10	5

Effect of INM on soil chemical properties

The data presented in table -2 indicated that the soil pH of the treatment plot ranged from 4.93 to 5.69. Significantly highest soil pH of 5.69 was recorded with the treatment receiving organics with lime and bf. The soil is more acidic in the treatment receiving only soil test based chemical fertilizers (pH 4.93). The next less strong acidity developed in the treatments receiving STD + organics and BFs together (pH 5.47-5.49). Only organic integrated treatments recorded less acidity (pH 5.24 and 5.46) as compared to STD + organics + BFs. In control treatment, acidity development was less as compared to other integrated and sole treatments. Soil acidity was neutralised due to application of lime which raised the soil pH to a level of 5.69. During the initial year the soluble salt content was 0.18 dSm-1. Due to continuous cropping, content of soluble salt varies from 0.03 to 0.05 dSm-1 in control and 0.05-0.07 dSm-1 in treatment getting all the ingredients. The organic carbon in the soil ranged from 5.6 to 6.07 g kg-1 soil. Integrated treatments receiving chemical fertilizers along with farmyard manure exhibited a considerable increase in organic C content over chemical fertilizer treatments might be due to addition of organic matter through FYM which stimulated higher root growth (Banswasi and Bajpai 2006).

Maximum available N content (304 kg ha-1) was recorded in the treatment receiving organic manure in the form of vermicompost, inorganic manure, microbial inoculants and lime application. Nitrogen status of soil before planting of knol khol was increased in all the treatments except control and combined application of inorganic fertiliser with FYM and vermicompost as compared to initial status of soil (207 kg ha-1). Available N content was not increased significantly due to application of organic manure along with inorganic fertilizer than that of STD alone. Whereas the increase was

significant due to Inclusion of biofertilizer. The increase in available N content with the incorporation of organic sources might be due to more N mineralisation (Sharma et al. 2008). Continuous removal by crops without external addition of fertilizers and FYM/VC over a period of time in control plot resulted in decline of soil available nitrogen. The result of the present study corroborated the result reported by Sharma et al. (2008). In INM treated with microbial consortia of Azotobacter, Azospirillum and PSB along with lime significantly increased the available nitrogen in soil, because of more nitrogen fixation, as well as mineralization which enhances release of plant growth regulating substances like IAA, NAA, GA, cytokinins along with production of antibiotics and biodegradation of organic matter (Sinha et al. 2014).

Significantly highest amount of available P was recorded with the treatment which received all the ingredients whereas lowest value was recorded with control. Higher available phosphorus contents in soil were observed in the treated plot having combined application of NPK fertilizer with FYM or vermicompost than that of single application of NPK. Increase in available P with FYM application could be attributed more solubilization of the native P in the soil through release of various organic acids (Tolanur and Badanur, 2003). The organic anions and hydroxyl acids, such as tartaric, citric, malonic and malic acids liberated during the decomposition of organic matter might form complexes or chelates along with Fe, Al and Ca there by preventing these cation to react with phosphate. This result corroborated the result of (Jagtap et al. 2007). Favourable effect of combined application of inorganic and organic source of nutrients in enhancing the availability of P was also reported by Prasad et al. (2010).

Significantly highest amount (136 kg ha-1) of available K was observed with treatment T7 which received all the organic and inorganic inputs whereas lowest value of 86 kg ha-1 was recorded with control (T1). The treatments with only organics have lower available K (136 and 139 kg ha-1) than that of organics with biofertlizers (158 and 155 kg ha-1).

The data revealed that significantly highest soil pH of 5.77 was recorded with T8 receiving organics along with lime and biofertilizers whereas lowest value of 4.33 was recorded with treatment receiving only soil test based chemical fertilizers changing the soil more acidic in control. Acidity was development in control treatment was comparatively less than that of other integrated and non-integrated treatments. During the cropping year soluble salt content was varied from 0.05 to 0.06 dSm-1min all the treatments. The organic carbon content in the soil after harvest of knol khol ranged from 5.4 to 6.9 g kg-1 soil. Combined application of chemical fertilizer along with farmyard manure exhibited a considerable increase in organic C content than that of chemical fertilizer treatment only. This increase might be attributed to the stimulated the better root growth as a result of more organic manure addition. This result was in conformity with Banswasi and Bajapi (2006).

Maximum available N (282 kg ha-1) was observed with the treatment receiving organic manure in the form of FYM, inorganic manre, microbial innoculants and lime application. Nitrogen status of soil after harvest of knolkhol was improved in all the treatments except control as compared to initial status of soil (207 kg ha-1) during 2010. There was no significant increase in available N due to combined application of organic manure along with inorganic fertilizer than that of inorganic fertilizer as per STD alone. Significantly highest amount of available P (26.24 kg ha-1) was recorded with the treatment receiving all the ingredients whereas value of 12.23 kg ha-1 was recorded with control. Higher available phosphorus content in soil was observed in the treatments having conjoint use of NPK fertilizer with FYM or vermicompost over single application of NPK. Significantly highest amount of available K (155 kg ha-1) was recorded with treatment T7 which received all the ingredient whereas lowest value of 130 kg ha-1 was recorded with control (T1). This might be due to continuous addition of more amount of root through higher crop growth which on decomposition increases the total available P & K in the soil.

Table :2: effect of INM on available nutrients in soil before planting of knolkhol

Sl No.	INM practices	pH		EC		OC (g/kg)		N (kg/ha)		P (kg/ha)		K (kg/ha)	
		Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
1	Control	5.47	5.57	0.05	0.05	5.60	5.40	193	245	11.7	12.23	86	130
2	STD	4.93	4.33	0.06	0.06	5.80	5.70	212	282	15.7	14.56	113	132

3	**STD+F**	5.24	5.43	0.04	0.04	6.40	6.10	206	320	17.5	16.50	136	143
4	**STD+VC**	5.46	5.22	0.05	0.05	6.23	5.70	203	278	18.3	18.38	139	141
5	**STD+F+BFs**	5.49	5.19	0.04	0.04	7.57	6.13	222	295	20.4	21.13	158	146
6	**STD+VC+BFs**	5.47	4.87	0.05	0.05	6.57	7.03	265	348	21.5	22.52	155	149
7	**STD+F+L+BFs**	5.35	5.38	0.05	0.05	5.67	6.70	287	282	21.8	25.89	172	150
8	**STD+VC+L+BFs**	5.69	5.77	0.05	0.05	6.07	6.90	304	267	24.6	26.24	191	155
LSD (P=0.05)		0.45	0.40	0.011	0.011	0.943	0.590	25	104	3.06	2.10	48.97	6.416
CV (%)		5	6	13	12	9	5	6	10	9	6.1	10	9
Initial Year (2010)		5.18		0.18		3.91		207		18.3		85	

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