Int.J.Curr.Microbiol.App.Sci (2018) Special Issue-7: 4748-4756

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Special Issue-7 pp. 4748-4756**
Journal homepage: http://www.ijcmas.com

Original Research Article

Response of Growth, Yield Attributes and Yield of Cabbage (*Brassica oleracea* var. *capitata*) to Different Organic and Inorganic Sources of Nutrients in Magadha Plain of Bihar

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A B S T R A C T

A field experiment was conducted at Nalanda College of Horticulture, Noorsarai, Nalanda during *rabi* 2016-17 to assess the effect of complementary and sole applications of organic and inorganic fertilizers on the growth and yield of cabbage. The experiment consists seven treatments *viz.*, T_1-Recommended dose of fertilizers (120:60:40); T_2-50%NPK through inorganic fertilizer+50%N through FYM; T_3-50% N through FYM+50% N through VC; T_4-1/3 of N through FYM + VC + Neemcake; T_5-50% N through FYM + PSB + Azotobactor; T_6-T_3+PSB + Azotobactor and T_7-T_4+PSB + Azotobactor. These seven treatments were replicated thrice in Randomized Block Design. Results revealed T_2-50%NPK through inorganic fertilizer+50%N through FYM recorded significantly higher head yield (47.07 tonnes ha^{-1}) over rest of the fertilizer sources, except RDF (44.87 tonnes ha^{-1}). Similarly, highest head weight (1.176 kg) was recorded in T_2-50%NPK through fertilizer+50%N through FYM, which was significantly higher over rest of the treatments except RDF (1.121 kg), while lowest was recorded in T_5-50% N through FYM + PSB + Azotobactor. Number of unwrapped leaves recorded significantly higher in T_4-1/3 of N each through FYM + VC + Neemcake (10.5) followed by T_5-50% N through FYM + PSB + Azotobactor (10.3), these both the treatments were significantly higher over T_2 and T_6. Although the number of wrapped leaves was recorded highest in RDF (49.1) which was significantly higher over rest of the fertilizer sources except T_2-50%NPK through fertilizer+50%N through FYM (45.4). Head length was recorded significantly highest in RDF (17.5 cm) over rest of the fertilizer sources but found at par with 50%NPK through fertilizer+50%N through FYM (16.6). Head diameter also recorded in same trend as length. Although stock diameter was recorded significantly higher in 50%NPK through fertilizer+50%N through FYM (3.5 cm) over rest of the fertilizer sources. Among organic treatments highest available N (271.34 kg ka^{-1}) was observed in T_3, while highest available P (17.74 kg ka^{-1}) and K (149.32 kg ka^{-1}) was found in T_6. In T_2 available N (273.52 kg ka^{-1}), P (17.20 kg ka^{-1}) and K (149.63 kg ka^{-1}) found which was statistically at par with recommended dose of fertilizer. On the basis result obtained T_2 as 50%NPK through fertilizer+50%N through FYM can be adapted as sustainable crop production.

Keywords

Okra, FYM, Vermicompost, Neemcake, Mineral fertilizer, RDF

Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the most important cool season leafy vegetables in India, as well as in the world, belongs to the family Cruciferae. Cabbage is believed to have originated in Western Europe and it was the first Cole crop to be cultivated. Prior to cultivation and use as food, cabbage was mainly used for medicinal purposes (Silva, 1986). In addition to the fresh market, cabbage is now processed into Kraut, egg rolls and cole slaws and there is the potential for other specialty markets for the various types including red, savoy and mini cabbage. Cabbage contains a range of essential vitamins and minerals as well as small amount of protein. It is an excellent source of Vitamin C having 36.6 mg. In addition to containing some B vitamins, cabbage supplies minerals like Potassium 170 mg, Calcium 40 mg, Phosphorus 26 mg and Magnesium 12 mg per 100 gram to the diet (USDA Nutrient Database, 2016). In India it is grown in an area of 0.399 million ha that produced 9.049 million tonnes (Anon., 2016-17)). Researches on various aspects of its production technology have been carried out worldwide, but limited number of works has been done on different organic sources of nutrients. Among the various factors involved in cabbage production, nutrient supply is an important for realizing higher cabbage yield. Experimental evidences showed that the response of cabbage is high to nitrogen application and moderate to phosphorus application. Several authors reported the importance of organic and inorganic fertilizer on the productivity and nutritional quality of cabbage. Soil management practices have recently changed dramatically including an increased use of synthetic fertilizers and pesticides to increase crop yields. The cultivation of crop requires balance supply of plant nutrients, but farmers applying only chemical fertilizer for fetching maximum yield. Furthermore, Obi and Ofonduro (1997) and Moyin-Jesu (2007) also reported that problems associated with continuous use of chemical fertilizers included nutrient imbalance, increased soil acidity, degradation in soil physical properties and loss of organic matter. Hence, the tendency to supply all plant nutrients through chemical fertilizer should be reconsidered in the future because of the deleterious effect on soil productivity on a long-term basis. However, these requirements of plants nutrients can be met by applying organic manure or in combination with inorganic fertilizer. Considering the demand of organic market, it is time to emphasize research towards organic sources because, residual effect of chemical substances used in the crop fields causes health hazards and environmental degradation. Growth and yield of this vegetable crops remarkably influenced by organic and inorganic nutrients management. Fertility of a particular soil is determined by the presence of organic matter, therefore, organic matter is needed to restore in soil either by supplying nutrient through organic source or through residue management. Organic manures contain all the essential plant nutrients, but after application they require time to convert it from unavailable to available form. That's why the response of crops to organic manures is initially low. But due to the residual and beneficial effects on soil properties, application of organic manures is needed to be encouraged. Application of both organic and inorganic fertilizer altogether can increase the yield as well as keep the environment sound (Hsieh *et al.*, 1995). Moyin-Jesu (2015), also reported that growth, yield parameters and head yield of cabbage showed significant increase over control, although application of poultry manure resulted more plant height, stem

girth, leaf number and head weight than NPK 15-15-15 (300 kg ha^{-1}). Hsieh (2004) reported that poultry manure treatted plot gave the highest head weight, head diameter and yield, followed by pig manure treated plot. Considering the above factors, the present experiment was undertaken with the objectives; to determine the suitable source and optimum dose of organic fertilizer better growth and yield of cabbage.

Materials and Methods

This experiment was conducted at Nalanda College of Horticulture, Noorsarai, Nalanda during *Rabi*, 2016-17, to assess the suitable source and optimum dose of organic fertilizer better growth and yield of cabbage. The soil of the experimental plot was clay loam with 7.47 pH, 0.21 EC and 0.62 % organic carbon, 262 kg, 14.60 kg and 142 kg ha^{-1} available N, P and K, respectively. The experiment was laid down in Randomized Block Design with three replications. There were seven treatments *viz.*, T_1-Recommended dose of fertilizers (120, 60, 40 kg N, P_2O_5 and K_2O), T_2-50%NPK through mineral fertilizer (MF)+50%N through FYM, T_3-50% N through FYM+50% N through VC, T_4-1/3 each through FYM+VC+Neemcake, T_5-50% N through FYM+biofertilizer, T_6-T3+biofertilizer and T_7-T4+biofertilizer, have been taken for study. There were three organic fertilizer sources viz., FYM, vermicompost, neem cake and biofertilizers namely azotobactor and PSB applied as per treatment. Recommended agronomical package of practices were followed excluding fertilizer treatments. Organic fertilizers were applied a week before sowing. It was uniformly spread on the plots and incorporated into the soil manually. Four weeks old seedling was planted at row and plant spacing of 50 and 45 cm respectively. Irrigation was given as per crop demand. Weeding was done manually at 25 days after transplanting followed by earthing up at at 30 day after transplanting. Harvesting of matured cabbage head started as they attain maturity in each experimental plot on treatment basis, and observations such as number of unwrapped and wrapped leaves, head length, head diameter, stalk length and stalk diameter and head weight per plot and yield per hectare were measured. After harvesting, soil samples were taken from each plot for routine laboratory analysis. Soil pH, organic C, N, P, and K were determined. The data collected on different aspect of experimentation, were analyzed with the help of computer applying analysis of variance technique given by Gomez and Gomez (1984).

Results and Discussion

Plant growth and yield

Number of leaves per plant specially wrapped, is an important parameter in cabbage considering the highest performance of head yield. The highest number of outer/unwrapped leaves per plant was found in T_5-50% N through FYM+ biofertilizers (10.5) followed by T_4-1/3 of N each through FYM+VC+NC (10.3), which was statistically to each other. It has been observed that maximum number of unwrapped leaves were found in organically treated plot as compared to recommended dose of fertilizer (8.1) and 50 % recommended fertilizer +50%N as FYM (9.6). This more number of unwrapped leaves in organically treated plot is due to less plant growth which is might be due to less availability of plant nutrient. In contrast to this, the number of inner/wrapped leaves found highest in recommended dose of fertilizer (49.1) followed by 50% recommended fertilizer +50%N as FYM

(45.4). The lowest number of inner leaves was found in T_5-50% N through FYM+biofertilizers (36.3). This highest number of inner leaves is mainly attributed to quick and timely supply of plant nutrient, that result proper plant growth, and timely wrapping of leaves. Head length of the cabbage is found highest (17.5 cm) in recommended dose of fertilizer, which was statistically at par (16.6 cm) with T_2-50% recommended fertilizer+50%N as FYM. Although, among organically treated plot T_6-T3+biofertilizers recorded highest length (16.1 cm) followed by T_7. Head diameter is also found in similar trend. Subhan (1988) observed that application of organic manure increased head diameter at 60 days after planting and the average number of leaves/plant and reduced the number of days to crop maturity. Stock length observed longest (10.3 cm) in T_2-50%NPK as fertilizer+50%N as FYM followed by T_1-Recommended dose of fertilizer (10 cm), T_7-T4+biofertilizers (9.6cm) and T_6-T3+biofertilizers (9.2cm) and found statistically at par to each other. Rest of the treatment found statistically inferior. Similarly, stock diameter also differed significantly and found highest in T_2-50%NPK as fertilizer+50%N as FYM (3.5cm), which was statistically superior over rest of the treatments.

Highest cabbage head yield was recorded in T_2-50%NPK as fertilizer+50%N as FYM (470.7 q ha^{-1}) which was significantly higher over rest of the treatment except T_1-Recommended dose of fertilizer (448.7 q ha^{-1}). This highest yield in T_2-50%NPK as fertilizer is might be due to balance supply of plant nutrient that resulted proper shape, size and compactness of head. Lathiff and Maraikar (2003) reported that cabbage and tomato gave comparable or sometimes higher yields when treated with manure than with NPK. (Zahradnik and Petrikova 2007) also reported that highest marketable yields were recorded with farmyard manure. Among organically treated head yield recorded highest in T_6-T_3+biofertilizers and T_7-T_4+ biofertilizers (387.3 q ha^{-1} and 371.5 q ha^{-1}) respectively, while, lowest was found in T_5-50% N through FYM+biofertilizers (284 q ha^{-1}). There was significant and positive correlation existed between cabbage head length, head diameter and wrapped leaves with head weight while, negative correlation observed with unwrapped leaves. (Fig.1).

Soil Chemical Properties

The effect of different treatments on soil chemical properties like pH, EC, OC, available N, P and K after harvesting of Cabbage shown in the Table 2. The maximum reduction in pH was less over initial value in the plots receiving chemical fertilizers. The higher reduction in pH of soil in the plots receiving organic manures may be due to production of organic acids, during decomposition of organic manures which neutralize the sodium salts present in the soil and increase the hydrogen ions concentration.

Maurya and Ghosh, (1972); Swarup and Singh (1989) also reported decrease in the soil pH by 0.3 to 0.9 unit after continuous application of chemical fertilizer along with green manure and FYM. The highest reduction over its initial value of the EC was recorded in the treatment T_5 with application of 50% N through FYM + bio-fertilizer. However, the reduction in EC was less over initial values in the plots receiving chemical fertilizers alone. Similar finding was also observed by Chaudhary *et al.,* (1992). Kumar and Yadav (1995) also reported that organic plus chemical fertilizer treatments decrease EC at faster rate than inorganic fertilizers alone.

Table.1 No. of leaves (outer and inner), head and stock's length and diameter and head yield as influenced by the application of organic and inorganic fertilizer sources in cabbage

Treatments	No. of Outer leaves	No. of inner leaves	Head length (cm)	Head diameter (cm)	Stock length (cm)	Stock Diameter (cm)	Head weight (g)	Head weight (q ha^{-1})
T_1-Recommended dose of fertilizer	8.1	49.1	17.5	14.7	10.0	3.2	1121.7	448.7
T_2-50%NPK as MF+50%N as FYM	9.6	45.4	16.6	14.6	10.3	3.5	1176.7	470.7
T_3-50% N as FYM+50% N as VC	9.7	41.2	15.6	13.4	8.5	3.0	903.3	361.3
T_4-1/3 of N each through FYM+VC+NC	10.5	40.5	15.3	14.3	8.4	3.2	882.0	352.8
T_5-50% N through FYM+ biofertilizer	10.3	36.3	14.1	11.0	8.4	2.8	710.0	284.0
T_6-T3+biofertilizer	8.4	38.8	16.1	14.3	9.2	3.2	968.3	387.3
T_7-T4+biofertilizer	9.5	37.3	16.0	14.2	9.6	3.3	928.7	371.5
SEm±	0.8	2.2	0.6	0.6	0.6	0.1	78.9	31.6
C D at 5%	1.7	4.8	1.3	1.4	1.3	0.2	172.1	68.8

FYM; Farm yard manure, VC; Vermicompost, NC; Neemcake

Table.2 pH, EC, OC, available N, P and K as influenced by the application of different organic and inorganic fertilizer sources in cabbage

Treatments	pH	EC	OC	Available N	Available P	Available K
T_1-Recommended dose of fertilizer	7.44	0.19	0.62	278.10	17.32	160.5
T_2-50%NPK as MF+50%N as FYM	7.42	0.18	0.63	273.52	17.20	149.63
T_3-50% N as FYM+50% N as VC	7.41	0.17	0.64	271.34	16.86	146.82
T_4-1/3 of N each through FYM+VC+NC	7.42	0.17	0.64	267.14	16.54	142.53
T_5-50% N through FYM+ biofertilizer	7.39	0.15	0.63	257.37	17.10	137.12
T_6-T3+biofertilizer	7.38	0.16	0.65	269.22	17.74	149.32
T_7-T4+biofertilizer	7.38	0.16	0.64	263.91	17.08	144.55
SEm±	0.06	0.02	0.02	9.09	0.85	8.82
C D at 5%	0.14	0.05	0.03	19.21	1.86	19.23

FYM; Farm yard manure, VC; Vermicompost, NC; Neemcake

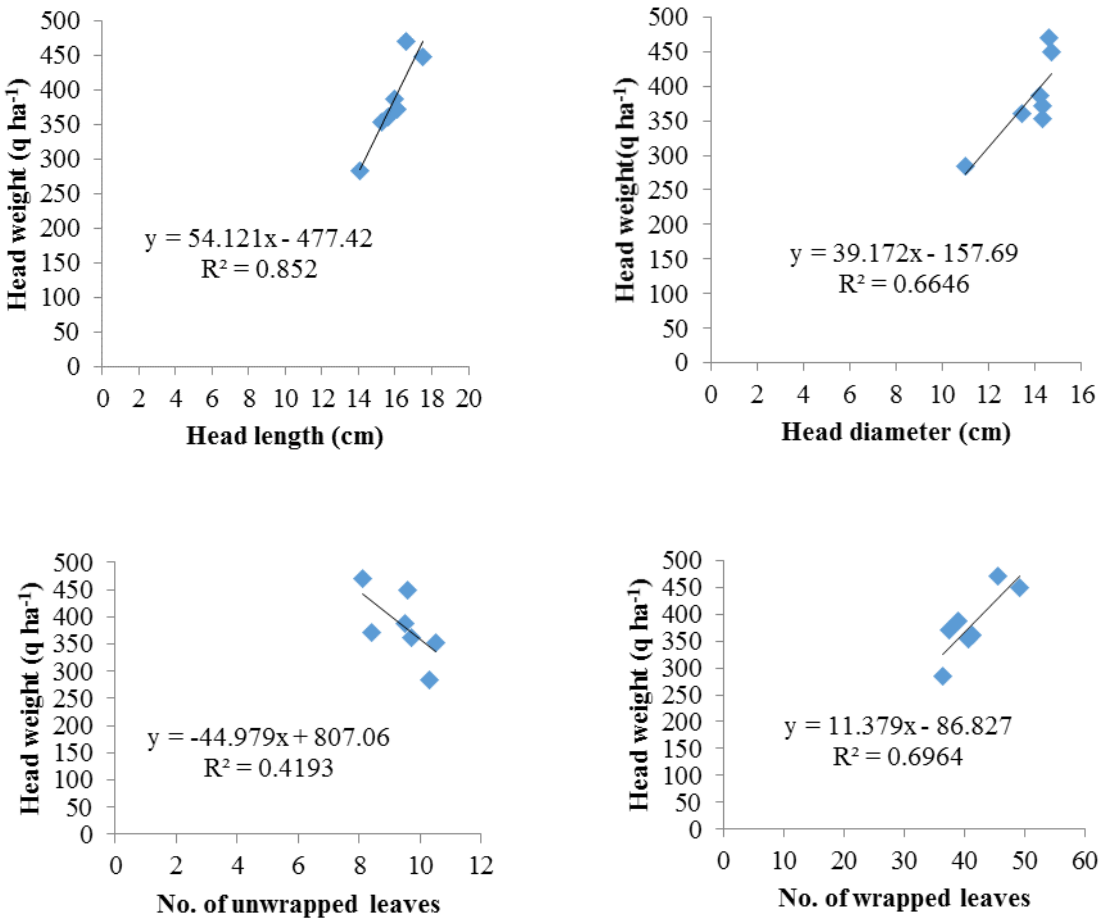

Fig.1 Regression equation and trend lines of cabbage head length, head diameter unwrapped leaves and wrapped leaves with head weight

Application of chemical fertilizer alone did not increase organic carbon content of the soil over its initial content, while, significant buildup was observed where, organic fertilizer were applied alone or along with bio-fertilizers. The maximum buildup of organic carbon was noticed in T_6 receiving 50% N through FYM+50% N through VC + PSB+ Azotobactor while, lowest (0.62 %) was measured with the treatment T_1- Recommended dose of fertilizers receiving 120, 60, 40 kg N, P_2O_5 and K_2O. The improved organic matter content of soil in the treatment having organic manure is attributed to direct incorporation of the organic matter in the soil. Soil organic carbon reported by (Swarup and Yaduvanshi, 2000), significantly lower in inorganic fertilizer treatments as compared to the treatments involving fertilizer with organic sources. These results corroborated with the finding of Numbiar and Abrol (1989), Bhandari *et al.,* (1992) and More (1994).

Change in Available Nitrogen, Phosphorus and Potassium

Manure contains many nutrients needed for crop production. Of these nutrients, nitrogen is one of the most important and is the most common added to soil for high yields. Nitrogen undergoes many transformations in soil as it is used, re-used, and made available by soil microbes. Maximum available N (278.10 kg ha^{-1}) was measured in the

treatment T_1 receiving recommended dose of fertilizer (Table 2) followed by T_2 50%NPK through inorganic fertilizer+50%N through FYM (273.52 kg ha^{-1}). The availability of N in soil increased in the treatments (T_1) because of 120, 60 and 40 kg ha^{-1} chemical fertilizer application that may be remained in the soil after crop harvest. Although, the buildup of nitrogen in rest of the treatments is also observed. Among organic treatments, maximum buildup of nitrogen is observed in T_3-50% N through FYM+50% N through (VC (271.34) followed by T_6-T3+biofertilizer and T_7-T4+biofertilizer. It may be due to application of FYM and Vermicompost. Since organic manures are rich in organic matter that increased N content in those treatments where FYM and vermicompost were added. Similar finding were also observed by Bhandari *et al.,* (1992), Kumar and Yadav (1995) and Sharma and Ghosh (2000). Highest reduction in available phosphorus (Table 2) was noticed in T_4-1/3 each through FYM+VC+Neemcake, while highest P was observed in all those treatment where biofertilizers were applied along with organic manure such as FYM, Vermicompost and Neem cake. The maximum buildup of available phosphorus (17.74 kg ha^{-1}) was observed under the treatment T_6- receiving 50% N as FYM+50% N as VC +biofertilizer. Increased availability of phosphorus in soil under treatments may be by increased solubility due to production of organic acids. Similar finding was also observed by Bhandari *et al.,* (1992); More (1994) and Kumar *et al.,* (2001). Recommended dose of fertilizer recorded significantly higher amount of available K (160.5 kg ha^{-1}), while lowest (137.12 kg ha^{-1}) was observed in T_5 50% N as FYM+ biofertilizers. The results (Table 2) clearly indicate that the build-up of available K observed in all organic treatments also. Increase in available potassium in T_1 and T_2 may be attributed to direct addition of potassium to the available pool of the soil. The beneficial effects of FYM, Vermicompost and Neem cake on available K may be ascribed to the reduction of fixation and release of K due to the interaction of organic matter with clay, besides the direct K addition to the available K pool of the soil. Increase in available potassium due to green manure and FYM was reported by many workers Bharadwaj and Omanwar (1994), Tolanur and Badanur (2003). On the basis result obtained T_2 as 50%NPK through fertilizer+50%N through FYM can be adapted as sustainable cabbage production, as it performed maximum head yield and also built-up appreciable amount of NPK which was at par with RDF. This is one year of study and need few more years research on organic.

References

Bhandari, A. L., Sood, A., Sharma, K. N. and Rana, D. S. 1992. Integrated nutrient management in a rice-wheat system. *Journal of Indian Society of Soil Science.* 40 (4):742-747.

Bhardwaj, V. and Omanvar, P. K. 1994. Long-term effect of continuous cropping and fertilization on crop yields and soil properties II. Effect on EC, pH, organic matter and available nutrients of soil. *Journal of Indian Society of Soil Science.* 42: 387-392

Chaudhary, M. R., Rafique, M.S., Younos, T., Diplas, P. and Mostaghimi, S. 1992. Efficiency of biological and chemical reclaimants in the reclamation of saline sodic soil. Land reclamation advance in research and technology, *Proceeding of the International Symposium*. 14-15 Dec. 1992, Nashville, Tennessee, 327-336.

Gomez K. A. and Gomez A. A. 1984 Statistical Procedures in Agricultural

Research, New York, Chichester, etc.: Wiley (1984), 2nd edition, paperback, pp. 680

Hsieh Chingfang, (2004). An xperiment on the organic farming of broccoli. Bulletin of Taichung District Agriculture Improvement Station. No.53 (35-40): 18.

Hsieh, C. F., H. C. Fang, K. Nan and K. N. Hsu. 1995. Effect of continuous use of organic manures on the growth and yield of vegetable soybean' and cabbage. Bulletin of Taichung District. Agric. Improvement Sta., Japan, 46: 1-10.

Kumar, A. and Yadav, D. S. 1995. Use of organic manures and fertilizer in rice-wheat cropping system for sustainability. *Indian J. Agric. Sci.* 65(10): 703-707

Kumar, N., Verma, L. P., Singh, Room and Prasad, K. 2001. Soil properties, nutrients uptake and productivity of rice under Integrated nutrient management system. *Annals of Plant and Soil research*, 3(1): 54-57

Lathiff, M. and Maraikar, J. (2003). Studies on the performance of some vegetable crops in organic farming systems. Peradeniya, Sri Lanka: Department of Agriculture. Annals-of-the-Sri-Lanka-Department-of-Agriculture. 2003; 5: 141-148

Maurya, P. R. and Ghosh, A. B. 1972. Effect of long-term manuring and rotational cropping on fertility status of alluvial calcareous soil. *Journal of Indian Society of Soil Science,* 20:31-43.

More, S. D. 1994. Effect of farm waste and organic manure on soil properties, nutrient availability and yield of rice-wheat grown on sodic vertisol. *Journal of Indian Society of Soil Science.* 42(2):253-256

Moyin-Jesu EI (2007) Use of plant residues for improving soil fertility, pod nutrients, root growth and pod weight of Okra (Abelmuschus esculentum L). Bioresour Technol 98(2007):2057–2064

Moyin-Jesu EI. 2015. Use of different organic fertilizers on soil fertility improvement, growth and head yield parameters of cabbage (Brassica oleraceae L). Int J Recycl Org Waste Agricult (2015) 4:291–298

Nambiar, K. K. M. and Abrol, I. P. 1989. Long- term fertilizer experiments in India-an overview. *Fertilizer News*, 34(4):11-20

Obi ME, Ofonduro CO (1997). The effects of soil amendments on soil physical properties of a severely degraded sandy loam soil in south Eastern Nigeria. Usman Danfodio University, Sokoto, pp 30–35 (March 2–7)

Sharma, A. R. and Ghosh, A. 2000. Effect of green manuring with Sesbania aculeata and nitrogen fertilizer on the performance of direct seeded flood prone low land rice, *Nutrient Cycling in Agroecosystem*, 57 (2):141-153

Silva, A. A. Jr. 1986. Mineral and organic fertilizing in cabbage. Commercial quality and the occurrence of Xanthomonas campestries cv. Campestris. Hort. Bras., 4(2): 10-12.

Subhan. 1988. Effect of organic materials on growth and production of cabbage (*Brassica oleracea* L.). Bull. Peletitian Hort., 16(4): 37--11.

Swarup A., Yaduvanshi, N. P. S. 2000. Effects of integrated nutrient management on soil properties and yield of rice in alkali soils. *Journal of the Indian Society of Soil Science.* 48 (2): 279- 282

Swarup, A. and Singh, K. N. 1989. Effect of 12 years rice-wheat cropping sequence and fertilizer use on soil properties and crop yields in a sodic soil. *Field Crop Research*, 21:227-287.

Tindall M (2000) Mineral and organic fertilizing in cabbage and their residual effect for commercial cultivation on yield and quality performance of cabbage. Hort Brass 6:15–20

Tolanur, S. I. and Badanur, V. P. 2003. Effect of integrated use of organic manure, green manure and fertilizer nitrogen on sustaining productivity of *rabi* sorghum-chickpea system and fertility of a *vertisol*. *Journal of Indian Society of Soil Science,* 51(1):41-44

Zahradnik, A. and Petrikova, K. (2007). Effect of alternative organic fertilizers on the nutritional value and yield of head cabbage. Zahradnictvi-Horticultural-Science. 2007; 34(2): 65-71.