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Studies on effect of organic manures on growth and yield of beetroot (*Beta vulgaris* L.) cv. 'Lali'

Alok Tiwari and Dr. Rajendra Prasad

Abstract
The present field experiment entitled "Effect of organic manures on growth and yield of Beetroot (*Beta vulgaris* L.) cv. Lali" was carried out during Rabi season of the year 2021-2022 at K.A.P.G. College, Prayagraj U.P. The result and conclusion of the about experiment are briefly explain here. The experiment was laid out in a randomized block design with 3 replication 11 treatments *viz*., T1: FYM (100%), T2: Poultry manure (100%), T3: Green manure (100%), T4: Neem cake (100%), T5: Vermicompost (100%), T6:FYM (50%) + Poultry manure (50%), T7: FYM (50%) + Green manure (50%) T8: FYM (50%) + Neemcake (50%), T9: FYM (50%) + Vermicompost (50%), T10: RDF, T11: Control. The data were recorded on days required for germination of seedlings, plant height (cm), no of leaves per plant, crop growth rate (g m^{-2} d^{-1}), root length (cm), root diameter (cm),root yield per plot (kg $plot^{-1}$), root yield per ha (t ha^{-1}), harvest index (%). The early germination was recorded in T2: poultry manure (100%) and it was at per with T9: FYM (50%) + vermicompost (50%) and vermicompost (100%). The highest plant height and no. of leaves was recorded with T2: poultry manure (100%) which was at par with T6: FYM (50%) + poultry manure (50%). The highest crop growth rate, was recorded with poultry manure (100%).Among the yield parameters the root length and harvest index were maximum with T6: FYM (50%) + poultry manure (50%) whereas root diameter was maximum with poultry manure (100%). The highest root yield was recorded with T2: poultry manure (100%) which was at par with T5: vermicompost (100%).
The results of the present investigation revealed that among different organic manures tried, application ofT2: Poultry manure (100%) is reported higher plant growth, root yield, NPK uptake, maximum net returns whereas application of T8: FYM (50%) + neem cake (50%) recorded better quality of beetroot.

Keywords: Beetroot, growth, yield, organic manures, CGR

Introduction
Beetroot is one of the major root vegetables grown throughout the world and is mainly consumed as a salad vegetable, though the leaves can also be eaten as spinach. Beetroot belongs to Beta L. genus, the Betaoidide subfamily of the goosefoot family (Amaranthaceae). Beetroot is a vegetable consumed worldwide due to its high content of biologically active substance, such as minerals and vitamins present in the tuberous root. Beetroot (*Beta vulgaris* L.), is an alkaline food with pH in range 7.5 to 8.0 it is the taproot (bulb) portion of the beetroot plant. In India major beet root crop growing states are Haryana, Uttar Pradesh, Himachal Pradesh, West Bengal and Maharashtra. Nationally beetroot is grown in an area of 0.079 lakh hectares with an annual production of 1.51 lakh million tonnes and share of UP is 0.08 lakh hectares with an annual production of 0.15 lakh million tonnes (HAPIS portal database 2019-2020). It is grown in temperate countries and bienniel plant. The beetroot and its juice are freely consumed for its great taste. Nutritional benefit and flavour content. It contains vitamins, A, B, and C. it is also a good source of calcium, magnesium, copper, phosphorous, sodium, and iron. Its powder is used as a natural red food colorant which used to apply in dry mixes (soup, Indian curry mixes) sweets, jams, jelly etc. The bright red colour of beetroot is due to the red pigments known as a betalains.
Color of root is due to presence of:
a. Red violet pigment- Beta-cyanins
b. Yellow pigment- Beta-xanthins

Beetroot is also called as garden beet or table beet, is one of the major root vegetable belongs to the family Chenopodiaceae along with spinach, palak, swiss chard, parsley, celery and it has chromosome number of 2n=18 and is native to Western Europe. It is arich source of protein, carbohydrate, calcium, phosphorous and vitamin C, hence it is an ideal vegetable for health conscious people (Deuter and Grundy, 2004) [4].

Beetroot is an excellent source of fiber, folate, manganese, potassium, iron and vitamin-C. The carbohydrates in beetroot are mainly simple sugars like glucose and fructose. Beets are high in fiber content however, it have FODMAPs (Fermentable Oligosaccharides Disaccharides Mono saccharides and Polyols) which may cause digestive problems in some people. It was used as medicine in Indian ancient time specially to enhance the activity of steroid hormone. Beetroot is a rich source of folic acid which was useful for pregnant women. It makes an excellent dietary supplement being not only rich in minerals, nutrients and vitamins but also unique phyto constituents, which have several medicinal properties. Several parts of this plant are used in medicinal system such as anti-oxidant, anti-depressant, anti-microbial, antifungal, anti-inflammatory, diuretic, expectorant and carminative. It is one of the natural foods which boosts the energy in athletes as it has one of the highest nitrates and sugar containing plant (Yadav *et al*., 2016) [16].

Soils supplied with nitrogen (N), phosphorous (P), and potassium (K) through the addition of organic and inorganic fertilizers influence the growth and harvest of the beetroot crop. The climatic requirements of crop *viz*., temperature, humidity, light, CO_2 concentration and radiation should be in permissible range of the crop to obtain higher yield. The environmental factors can be controlled under protective cultivation and optimization of growing conditions enhances the production multifold, compared to open field conditions. In general, the main purpose of growing high value crops in protective environment is to obtain blemish free high quality produce. Beetroot responds well to increasing nitrogen, phosphorus and potassium levels, as these nutrients are essential to produce higher yield along with good quality. It is necessary to optimize fertilizer rates for beetroot in varying environments. Organic farming aims in creating a healthy soil, helps in proper energy flows in soil, crop, water, environment while the plant systems keeps biological life cycle alive and helps in sustaining considerable levels in yield (Lampkin, 1990) [17]. For a sustainable crop production system, chemical nutrients removed by the crop must be replenished and physical conditions of these oil is to be maintained. Organic nutrient management provides excellent opportunities to overcome all the imbalances besides sustaining soil health and enhancing crop production. This optimize the benefit from all possible sources of plant nutrients in an organic manner (Greenland, 1975) [18]. Organic manuring aims in creating a healthy soil, helps in proper energy flows in soil, crop, water, environment while the plant system keeps biological life cycle alive and helps in sustaining considerable levels in yield (Lampkin,1990)[17]. Many studies have also reported positive effect of organic manures and/or organic fertilizers on the yield of vegetables such as carrot, radish, cabbage, and tomato Adopting appropriate fertilizer management strategies results in significant economic benefits to producers Agriculture, as an economic sector, should operate profitably while adhering to the fundamental principles of sustainable agricultural production, with minimal environmental effect and judicious application of fertilizers. In addition to the nutrient requirements, the genetic characteristics of a variety determine the amount of yield. The variety should be selected as per the growing environment and season. Further, there has been limited research carried out on the available beetroot varieties as per the growing environment. To achieve more returns per unit area, the selection of a suitable variety as well as the good fertilization strategy combining the use of organic and inorganic nutrients is necessary.

Material and Methods

A field experiment was conducted during Rabi2021 to study the **"**Effect of organic manures on growth and yield of beetroot (*Beta vulgaris* L.) cv. Lali". The details of material and methods used and the experimental technique adopted during the course of investigation are described below. The experiment was laid out at the "college farm" K.A.P.G. College Prayagraj, Prof. Rajendra Singh (Rajju Bhaiya) University Prayagraj, Uttar Pradesh. This region falls under IV Agro climatic zone of Uttar Pradesh state. The experiment was laid out in a randomized block design with 3 replication 11 treatments *viz*., T1: FYM (100%), T2: Poultry manure (100%), T3: Green manure (100%), T4: Neem cake (100%), T5: Vermicompost (100%), T6: FYM (50%) + Poultry manure (50%), T7: FYM (50%) + Green manure (50%) T8: FYM (50%) + Neem cake (50%), T9: FYM (50%) + Vermicompost (50%), T10: RDF, T11: Control. Total no. of plots: 33, Row to Row distance: 50cm, Plant to plant distance: 10cm, Net plot size: 5m x 3m =15m^2, Observation intervals: 25 days.

The experimental site located at college farm, College of K.A.P.G College, Prayagraj comes under sub-tropical zone and is situated at altitude of 25.45$^{0'}$ N and longitude of 81.84$^{0'}$ E in the southern part of the Uttar Pradesh at the elevation of 98 meters(322ft) and stand at the confluence of two, the gangas and Yamuna. The altitude of the place is 90m (295ft) above mean sea level. The mean annual precipitation on the basis of last ten years is 767 mm (30.21 inches) which is received almost from South-West Monsoon during July to September. The average minimum and maximum temperatures recorded during crop growth period were 12.68°C and 32.67°C respectively. The average humidity ranges from 33.38% to 81.93%. Prayagraj (dist) thus has hot dry summer and moderate cold winter.

Seeds of beetroot (Variety 'LALI') were collected from KVK, Prayagraj, Uttar Pradesh.

Soil samples were taken from the top (0 to 30 cm) layer before the commencement of the experiment and analyzed for its some physical and chemical properties. Three composite soil samples were then prepared by mixing the collected subsamples before sowing. Each composite sample represented each block of the experimental design. Total N was determined by Macro–Kjeldahl method [22], available P by Olsen's bio-carbonate method, and available K by ammonium acetate method [23]. Organic matter was determined by Walkely and Black method [24], pH by Beckman Glass Electrode pH.

The plant height was measured from ground level to the tip of longest leaf at 25, 50 days after sowing and at harvest from five tagged plants and their mean was worked out. Total number of leaves counted for five randomly selected plants and counted at 25, 50 days after sowing and at harvest and their mean was worked out.

The SPAD value was calculated by using the SPAD meter. Leaf area of each plant was recorded with the help of a graphical method individually from the five tagged plants in each replication of all treatments at different intervals and average was worked out. It was expressed in square centimeters. The length of root from five randomly selected

plants in each plot was recorded by means of scale from apex to the base of the root and the average is expressed in centimeters. The root diameter was recorded with the help of vernier calipers and the average was expressed in cm. Root and shoot ratio was calculated for five randomly selected plants from each plot by measuring the root and shoot dry weight with the help of electronic balance.

For data collection, a set of 5 random plants from each plot excluding the border plants was taken during the crop growing period and after harvesting. The observations recorded during the crop growing period were plant height (cm), number of leaves per plant, leaf length (cm), and canopy diameter (cm). Similarly, after harvest, the measured parameters were beetroot diameter (mm), beetroot length (cm), economic yield (t ha^{-1}), biological yield (t ha^{-1}), root and leaf dry matter %, and physiological weight loss (%).

Results and Discussion

Growth and yield parameters

Number of days taken for germination, plant height, number of leaves, leaf length, leaf width and average leaf area are important growth characters. The observations were taken 25 days interval commencing from 25 days after sowing while the last observation was recorded after 75 days.

Number of days taken to seed germination

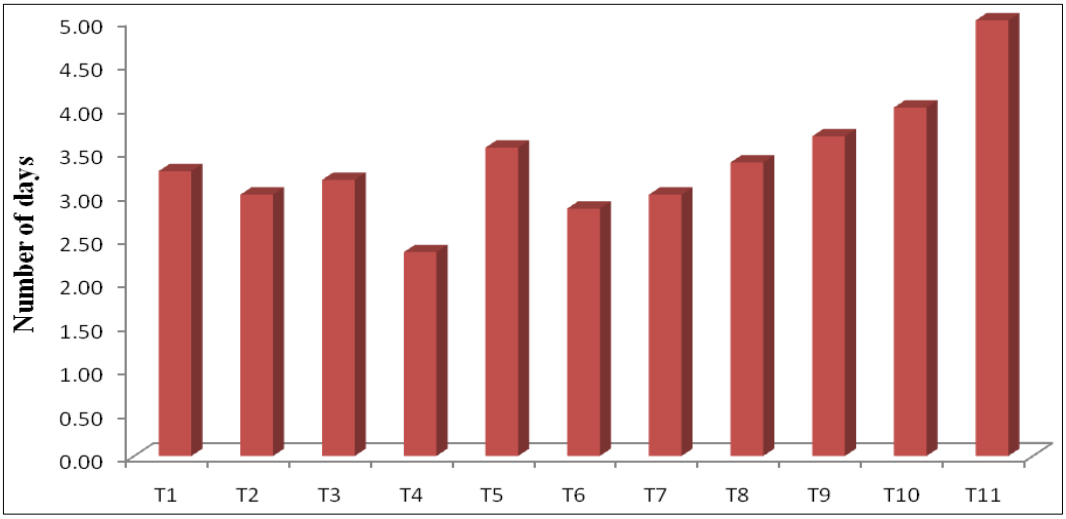
Days required for 80-85% germination of Beetroot seedlings was significantly influenced by the poultry manure (100%) and it was at par with all the organic sources applied treatments except T6 (3.42), T3 (3.59) and T7 (3.72).The results are presented in the Table 1

Among all the treatments T2 with poultry manure (100%) resulted early (2.39 days) germination and it was at par (2.89 days) with combined application of FYM (50% + Vermicompost (50%) and (3.07 days) Vermicompost (100%). RDF recorded comparatively more number of days (4.05 days) than the treatments applied with organic treatments. Highest number of days taken to germination was observed in (5.08) with control plots.

Madhavi M.2014, bandada *et al*. 1917, Suminarti *et al*. Stated that early germination of beetroot seeds in plots under poultry manure may be due to improvement in soil chemical properties such as soil pH, total N, available P, organic matter, exchangeable cations and cation exchange capacity etc. And also of its high content of nitrogen, phosphorus and Potasium may help in early germination in seedlings (Madhavi m 2014, Hrvastsko polje 2004, saha N. 1998). The results are in conformity with findings of (M siva Prasad 2014, Felipetal 2015, Mokadem 2000.) in *Amaranthus cadatus*, They observed application of poultry manure about 8-10 kg/ha resulted in high seed germination (about 85%).

Table 1: Effect of different organic manures number of days required for 80% germination of seedlings of Beetroot

Treatments	DAS (Days after sowing)
T1: FYM (100%)	3.32
T2: Poultry Manure (100%)	2.39
T3: Green manure (100%)	3.59
T4: Neemcake (100%)	3.22
T5: Vermicompost (100%)	3.06
T6: FYM (50%) + Poultry Manure (50%)	3.42
T7: FYM (50%) + Green Manure (50%)	3.72
T8: FYM (50%) + Neemcake (50%)	3.07
T9: FYM (50%) + Vermicompost (50%)	2.89
T10: RDF @ 75kg N; 100 kg P2O5; 75kg K2O	4.05
T11: Control	5.08
S. Ed. (±)	0.600
C. D. (P = 0.05)	1.238



Graph 1: Effect of different organic manures on number of days required for 80% germination of seedlings of Beetroot.

Plant height (cm)

Plant height is an important character of the vegetative phase and indirectly influences the yield components. The plant height was significantly increased by the application of poultry manure (100%) followed by FYM (50%) + poultry manure (50%) at different stages of plant growth. The data pertaining to plant height were recorded at 25, 50 and 75 days after sowing which were presented in Table2.

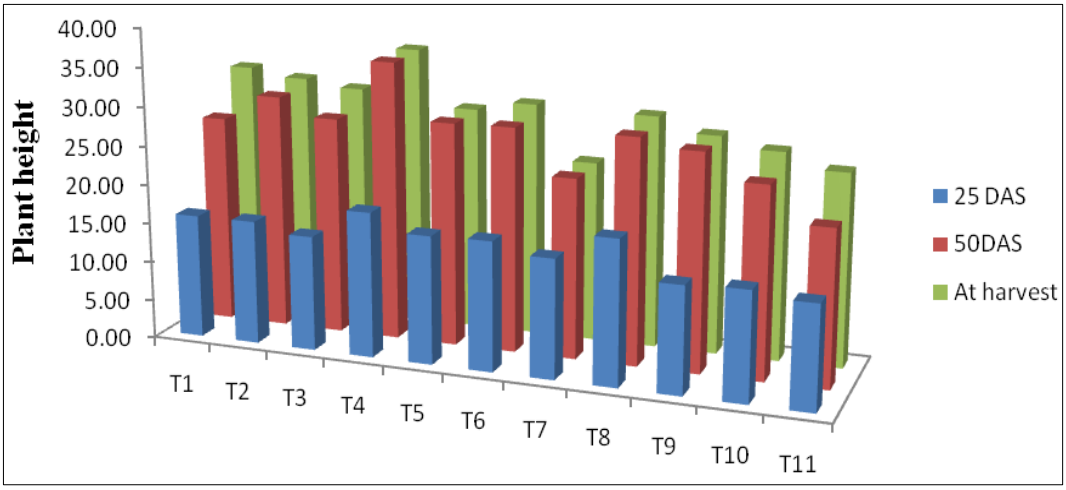
AT 25 DAYS the results showed that there was a significant difference among the treatments in plant height at 25 days after sowing (DAS). At 25 DAS the highest plant height (20.18 cm) was recorded in T2 with poultry manure (100%) and it was at par with T6 (19.39 cm) with FYM (50%) + poultry manure (50%) and T9 (17.36) with FYM (50%) + vermicompost (50%) but significantly superior to all other treatments. RDF (T10) recorded a plant height of 15.06 cm and the lowest was recorded in T11 (11.35 cm) under control condition.

AT 50 DAYS the results indicated that there was a significant difference among the treatments with respect to plant height at 50 DAS (Days after sowing). At 50 DAS the highest plant height (36.10 cm) was recorded in T2 with poultry manure (100%) which was significantly superior to all other treatments. RDF (T10) recorded a plant height of 25.37 cm and the lowest was recorded in T11 (25.57).

AT 75 DAS At harvest the highest plant height 36.52 cm was recorded in T2 with poultry manure (100%) which was significantly superior to all other treatments. RDF (T10) recorded a plant height of 27.09 cm and the lowest was recorded inT11 (25.57 cm). The plant height of beet root was significantly affected in all stages of crop growth with the application of organic manures. Among different organic manures soil application of poultry manure (100%) improved plant height at all the growth stages. Nitrogen being a major element has a profound effect on plant growth and development and as a constituent of proteins and also its effect on production of plant hormones in plants. The increased plant height with the application of poultry manure (100%) may be attributed to their higher N content of (1.18%). The positive effect of organic manure on plant height could be due to the contribution made by manure to fertility status of the soils as the soils were low in organic carbon content. Manure when decomposed increases both macro and micro nutrients as well as enhances the physico-chemical properties of the soil. This could have led to its high vegetative growth. The results are in support with findings of Tiamiyu *et al.*, 2012[15] in okra. Though the green manure contains high 'N' content (1.80%) than applied poultry manure (1.18%) it could not record maximum plant height over poultry manure (100%) may be because of slow release of nutrient availability. Okokoh and Bisong (2011) [9] reported similarly that application of 10 to 15t/ha of poultry manure resulted in increased height of amaranthus plants.

Table 2: Effect of different organic manures on plant height (cm) of Beetroot at different stages of crop growth.

Treatments	25 DAS	50 DAS	At harvest
T1: FYM (100%)	16.08	26.96	32.10
T2: Poultry Manure (100%)	20.18	32.10	36.52
T3: Green Manure (100%)	16.80	28.90	28.97
T4: Neem cake (100%)	15.30	28.12	30.54
T5: Vermicompost (100%)	16.10	30.52	31.32
T6: FYM (50%) + Poultry Manure (50%)	19.39	29.10	29.97
T7: FYM (50%) + Green Manure (50%)	14.10	27.96	28.10
T8: FYM (50%) + Neem cake (50%)	15.85	23.33	23.37
T9: FYM (50%) + Vermicompost (50%)	17.36	28.96	30.24
T10: RDF @ 75 kg N; 100 kg P_2O_5; 75 kg K_2O	15.06	25.37	27.09
T11: Control	11.35	20.10	25.57
S. Ed. (±)	1.055	0.822	1.744
C. D. (P = 0.05)	2.178	1.697	3.600



Graph 2: Effect of different organic manures on plant height (cm) of Beetroot at different stages of crop growth

Number of Leaves

Number of leaves were significantly affected by the application of organic manures their combinations at different stages of plant growth. Data on number of leaves per plant recorded at 25 DAS, 50 DAS and 75 DAS are presented in Table 3.

AT 25 DAS the results showed that there was a significant difference among the treatments for number of leaves at 25 days after sowing (DAS). At 25 DAS, maximum number (11.84) of leaves per plant was observed in T3 with Green Manure (100%) which was at par T2 (11.13) with all the other treatments except T4 (10.25) and T11 (9.64).

AT 50 DAS the results showed that there was a significant difference among the treatments for number of leaves at 25 days after sowing (DAS). At 50 DAS, the highest number of leaves was recorded in T2 (18.72) with poultry manure (100%) which was at par with T6 (18.39), T5 (17.76), T1 (17.52) and T9 (17.40), indicating significantly superior to all other treatments.

AT75DASAll the treatments significant difference among the treatments for number of leaves at 75 DAS (Days after sowing). At harvest, T2 with poultry manure (100%) recorded indicated highest number of leaves (21.87) which was at par with all the treatments except T4 (19.25), T8 (19.86) and control (18.35). The treatment RDF (T10) recorded 11.12, 17.00, and 21.22 numbers of leaves at 25 DAS, 50 DAS and harvesting stage respectively. The lowest number of leaves (9.64, 15.20 and 18.35) was observed in control at 25 DAS, 50 DAS and harvesting stages.

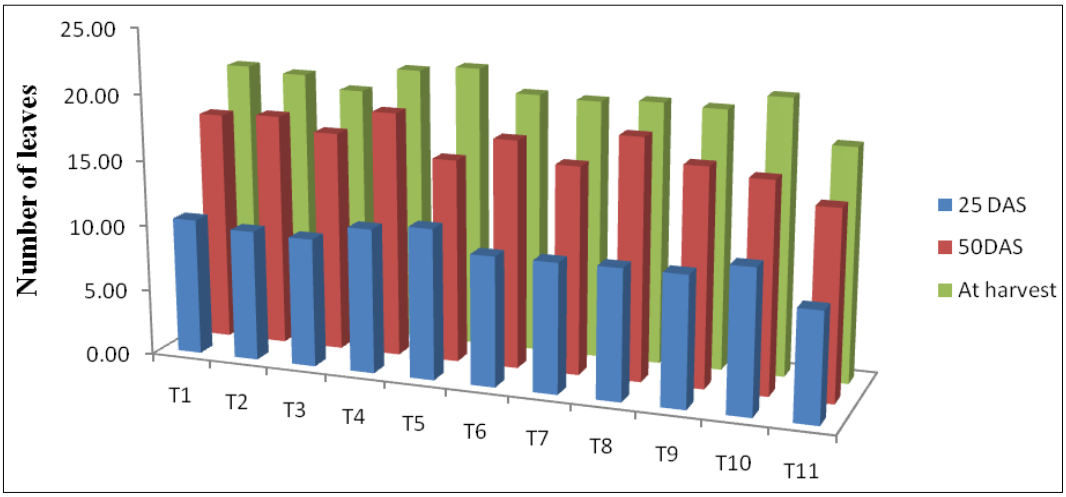
Among all the treatments, the number of leaves of beet root was higher with poultry manure (100%) during progressive growth stage up to 50 DAS but at harvesting stage it was at par with all other treatments except T4 (16.81), T8 (15.85) and control (T11).Application of organic manures to the soil,

physical condition of the soil will be improved by the better aggregation of soil particles (Sahabifar J 2019, Madavi M 2014). These aggregates effects the soil fertility and often determine their tention and movement of water, diffusion of gases, growth and development of roots in the soil which contributed to the growth of the plant Chitti jagadeesh, Madhavi M 2014,) Since, poultry manure (100%) contains high amount of major nutrients comparative to the other organic nutrients used as treatments probably which helps for the proper growth and development of vegetative structures (*i.e.*, leaves). The results were in conformity with findings of Tiamiyu *et al.*, 2012 [15] in okra.

Okokoh and Bisong (2011) [9] reported similar findings that application of 12 to 15 t/ha of poultry manure enhanced the performance of Amaranthus in a study in Calabar, Nigeria. Mean number of leaves per plant were found to be significantly influenced by poultry manure application in amaranthus.

Table 3: Effect of different organic manures on number of leaves per plant of Beetroot at different stages of crop growth.

Treatments	25 DAS	50 DAS	At harvest
T1: FYM (100%)	10.84	17.52	20.80
T2: Poultry Manure (100%)	11.13	18.72	21.87
T3: Green Manure (100%)	11.84	16.06	21.84
T4: Neem cake (100%)	10.25	16.81	19.25
T5: Vermicompost (100%)	10.14	17.76	20.44
T6: FYM (50%) + Poultry Manure (50%)	10.14	18.39	20.30
T7: FYM (50%) + Green Manure (50%)	10.14	16.71	20.04
T8: FYM (50%) + Neem cake (50%)	10.17	15.85	19.86
T9: FYM (50%) + Vermicompost (50%)	10.17	17.40	20.20
T10: RDF @ 75 kg N; 100 kg P2O5; 75 kg K2O	11.12	17.00	21.22
T11: Control	9.64	15.20	18.35
S. Ed. (±)	0.406	0.600	0.846
C. D. (P = 0.05)	0.839	1.238	1.745



Graph 3: Effect of different organic manures on number of leaves per plant of Beetroot at different stages of crop growth.

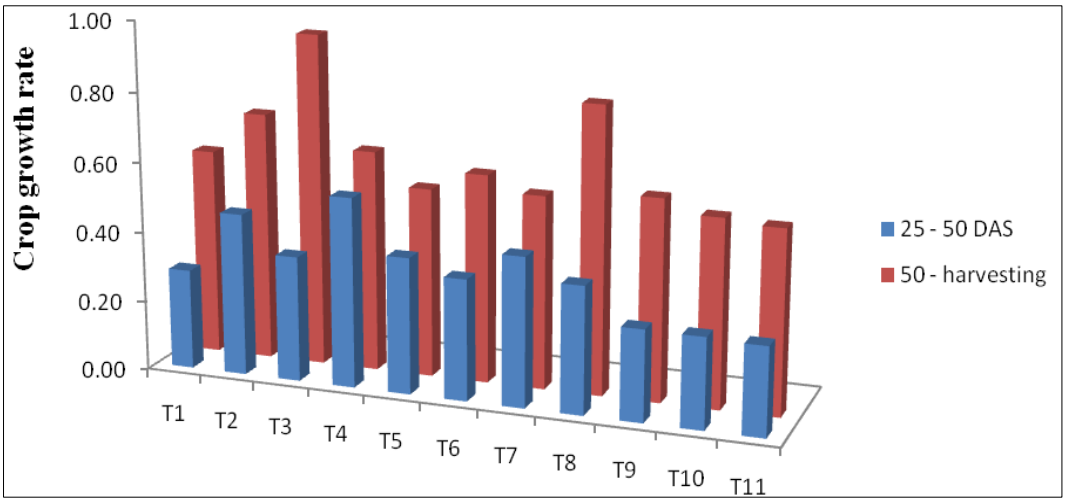
Crop growth rate (CGR) ($gm^{-2}d^{-1}$)

Crop growth rate is the gain in dry matter production on a unit of land in a unit of tune. The crop growth rate recorded during the growth periods of 25-50 DAS and 50 DAS – harvesting were statistically analyzed and presented in table.4.The crop growth rate was low during the early stage (25-50 DAS) of the plant growth but it increased gradually with the advancement of age of the plant. The highest crop growth rate during 25-50 DAS was recorded (0.62) in the treatment (T2) poultry manure (100%) closely followed by T2 (0.55) with vermicompost (100%)) and T8 (0.50) with (FYM (50%) + Neemcake (50%), which were statistically *at par*. During advanced stage of crop growth at 50 DAS- harvesting, the maximum crop growth rate (0.98) was recorded with T4 which was at par with T6 FYM (50%) + poultry manure (50%). In both the stages, crop growth rate enhanced with the increase in the quantity of different kinds of manures. This might be due to the availability of the required quantity of nutrients with increase in the quantity of different kinds of manures. However, the minimum crop growth rate (0.32 and 0.59) was, recorded in control at the said stages of crop growth i.e. 25-50 DAS and 50- harvest, respectively. Increased crop growth rate during growth phase of plant is a usual phenomenon for sufficient vegetative growth necessary for successful transformation for optimum yield. The influence of organic manures on leaf number LAI, DMP, was superior over inorganic fertilizer application (Subbarao and V V Padmaja 2014, Zhang K, White PJ 2007). Moreover, the results are in agreement with findings of Sambo BE, Subedi *et al*. in chilli.

Table 4: Effect of different organic manures on crop growth rate (gm-2 d-1) of Beet root at different stages of crop growth.

Treatments	25-50 DAS	50- At harvest DAS
T1: FYM (100%)	0.35	0.66
T2: Poultry Manure (100%)	0.60	0.66

T3: Green Manure (100%)	0.44	0.59
T4: Neemcake (100%)	0.41	0.98
T5: Vermicompost (100%)	0.55	0.78
T6: FYM (50%) + Poultry Manure (50%)	0.42	0.87
T7: FYM (50%) + Green Manure (50%)	0.33	0.63
T8: FYM (50%) + Neemcake (50%)	0.50	0.61
T9: FYM (50%) + Vermicompost (50%)	0.40	0.65
T10: RDF @ 75 kg N; 100 kg P2O5; 75 kg K2O	0.32	0.61
T11: Control	0.31	0.59
S. Ed. (±)	0.049	0.076
C. D. (P = 0.05)	0.101	0.157



Graph 4: Effect of different organic manures on crop growth rate (gm^{-2} d^{-1}) of Beetroot at different stages of crop growth.

Root length (cm)

The root length was significantly affected by the application of FYM, vermicom post, neem cake, poultry manure and green manure at different stages of plant growth. The results are presented in Table 5. The highest root length of 13.40 cm was recorded in T6 with FYM (50%) + poultry Manure (50%) was at par with T1 (12.88 cm) with FYM (100%), T5 vermicompost (100%), T4, T2 and T7. RDF recorded a root length of 9.87 cm at harvest. The lowest root length was recorded in T11 (9.55 cm) in control, which was on par with T10 (9.87), T3 (10.72), T9 (10.92) and T8 (11.12) treatments. Among all the treatments, the root length of beet root was higher with FYM (50%) in combination with Poultry Manure (50%).This may be due to the higher content of phosphorus (1.70%) in poultry manure. Phosphorus stimulates root growth, greater absorption and translocation of nutrients. It is also a part of various enzymes, co-enzymes and energy rich ATP resulting in increased root growth (Gajeswki *et al.*). Phosphorus also brings about improvement in the physic-chemical characteristics of the soil (Horvad T Petek M 2015). With the application of organic manures to the soil, physical condition of the soil will be improved by the better aggregation of soil particles (Bhatt G., Reddy NS. 2000). These aggregates effects the soil fertility and often determine the retention and movement of water, diffusion of gases, growth and development of roots in the soil which contributed to the growth of the plant (Petek M. 2015). In addition to this, application of organics helps the soil micro-organisms to produce polysaccharides and thus leads to better soil structure useful for root growth (Balasubramaniam, 1972).

Root diameter (cm)

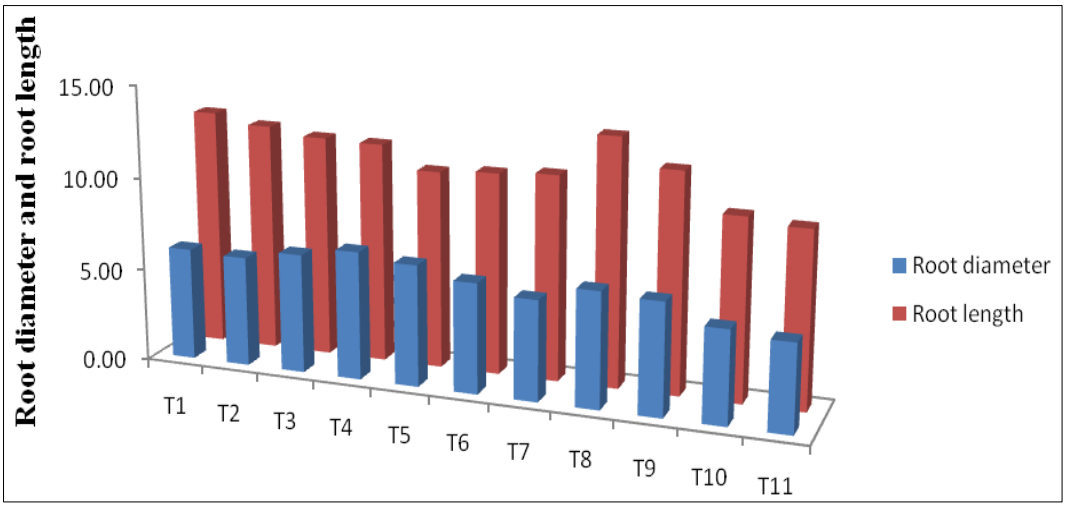
The root diameter was significantly affected by the application of poultry Manure (100%) and green manure (100%) The results are presented in Table5. The highest root diameter (6.96) was recorded in T2 with Poultry Manure (100%) which was at par T3 (6.60 cm) with green manure (100%), T4 (6.47), T1 (6.12), T5 (5.98) and T9 (6.02) significantly superior to all other treatments. RDF recorded a root diameter of 5.03 with RDF @ 75 kg N; 100 kg P2O5; 75 kg K2O. The lowest was recorded in T11 (4.74) in control (T11). The higher root diameter recorded may be attributed to enhanced cell division and quick cell multiplication. Okokoh and Bisong (2011) [9] reported poultry manure application had significant influence on stem diameter and the result showed that the application of 10, 15 and 20 t/ha of poultry manure resulted in sufficiently larger stem diameter than other treatments.

Harvest Index

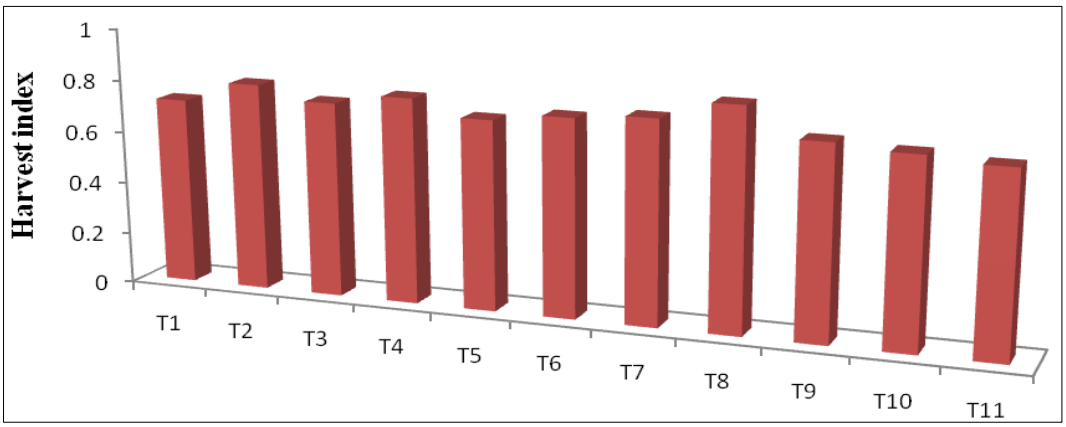
The Harvest index was significantly affected by the application of FYM (50%) + Poultry Manure (50%) at different stages of plant growth. The Results are presented in Table5. The highest harvest index (0.91) was recorded in T6 with FYM (50%) + Poultry Manure (50%) was at par T5 (0.86) with vermicompost (100%) and T2 with poultry manure (100%) which were significantly superior to all other treatments. RDF recorded harvest index 0.78 and T11 with control resulted lowest harvest index i.e. 0.76.

Table 5: Effect of different organic manures on root length (cm), root diameter (cm), harvest index of Beet root at harvest of crop growth.

Treatments	Root length	Root diameter	Harvest Index
T1: FYM (100%)	12.88	6.12	0.76
T2: Poultry Manure (100%)	11.92	6.96	0.84
T3: Green Manure (100%)	10.72	6.60	0.78
T4: Neemcake (100%)	12.01	6.47	0.81
T5: Vermicompost (100%)	12.39	5.98	0.86
T6: FYM (50%) + Poultry Manure (50%)	13.40	6.29	0.91
T7: FYM (50%) + Green Manure (50%)	11.92	6.12	0.79
T8: FYM (50%) + Neemcake (50%)	11.12	5.47	0.83
T9: FYM (50%) + Vermicompost (50%)	10.92	6.02	0.81
T10: RDF @ 75 kg N; 100 kg P2O5; 75 kg K2O	9.87	5.08	0.76
T11: Control	9.56	4.80	0.76
S. Ed. (±)	0.920	0.600	0.033
C. D. (P = 0.05)	1.899	1.238	0.068



Graph 5: Effect of different organic manures on root length (cm) and root diameter (cm) of Beetroot at harvest of crop growth



Graph 6: Effect of different organic manures on harvest index of Beet root at harvest of crop growth

Root yield (Kg/plot)

The total root yield (kg/plot) was significantly affected by the application of vermicompost, poultry manure and FYM (50%) + poultry manure (50%) at Different stages of plant growth. The results are presented in Table06. The highest root yield (7.62) was recorded in T2 with the application of poultry manure (100%) which was at a par with T5 (7.13) with vermicompost (100%) but significantly superior to all other treatments. RDF recorded a yield of 4.02 Kg/plot and the lowest was recorded in T11 (2.02).

Root yield (tha^{-1})

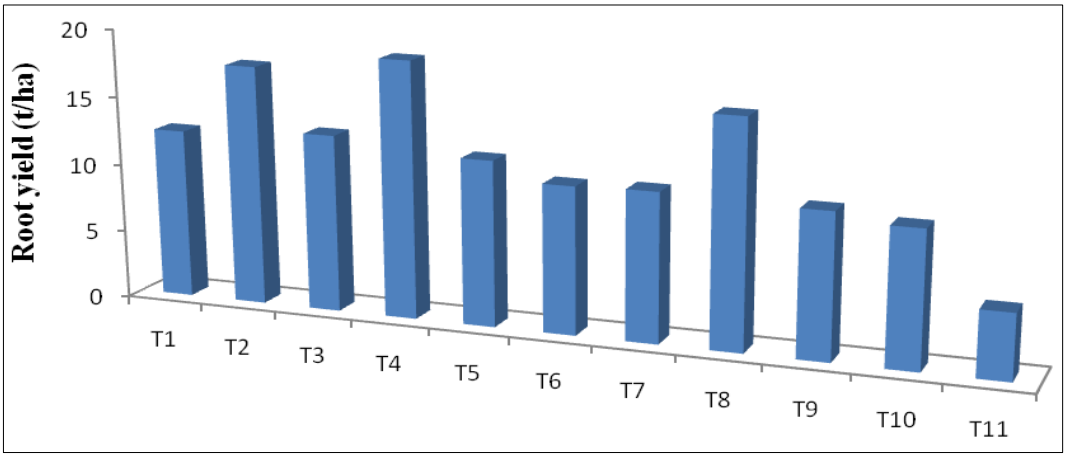
The total root yield was significantly affected by the application of vermicompost, poultry manure and FYM (50%) + poultry manure) at different Stages of plant growth. The results are presented in Table 06. The highest root yield (18.85) was recorded in T2 with the application of poultry manure (100%) followed by T5 (17.65) with vermicompost (100%) Highest yield with sole application of poultry manure (100%) may be positive effect of all yield components *viz*., root length, root diameter, fresh and dry weight of root in this treatment. The result can be attributed to slow release of nutrients from organic manures and their better utilization by beetroot throughout the growing period which might have resulted in higher root yields of beet root. The increased root yield with the application of poultry manure may be attributed

to their higher N content of 1.18%. Okokoh and Bisong (2011) [9] reported similar finding that higher yield of fresh leaf and fresh stem in Amaranth were obtained when 12 and 15 t/ha of poultry manure were used. It may be due to the fact that nitrogen is the major constituent of chlorophyll, proteins and amino acids, the synthesis of which is accelerated by the increased supply of nitrogen in soil (Ijoyah *et al*., Kiran et.al).Which were at par but significantly superior to all other treatments. RDF recorded an yield of 9.96 and the lowest was recorded in T11 (4.88) with control (T11).

Increased yield due to better availability of nutrients and the balanced C/N ratio might have increased the synthesis of carbohydrates which ultimately promoted greater yield (Dongawar *et al*., Ijoyah *et al*.). It can also be attributed to better carbon assimilation and better accumulation of carbohydrates in the plants. Similar findings with the application of organics were observed by Chitti jagadish, Madhavi M. 2014 in the tuber yields of potato. The translocation of photo-synthates from source (leaves) to sink (root) might have contributed to increased root length and diameter resulting in root yield. These findings are in conformity to the observation made by Singh and Taj.

Table 6: Effect of different organic manures on root yield (kg plot -1), root yield (t ha-1) of Beet root at harvest.

Treatments	Root Yield	Root Yield
T1: FYM (100%)	5.11	12.49
T2: PoultryManure (100%)	7.62	18.85
T3: GreenManure (100%)	5.21	12.15
T4: Neemcake (100%)	5.21	13.04
T5: Vermicompost (100%)	7.13	17.65
T6: FYM (50%) + Poultry Manure (50%)	6.66	16.57
T7: FYM (50%) + Green Manure (50%)	4.42	10.60
T8: FYM (50%) + Neemcake (50%)	10.92	10.92
T9: FYM (50%) + Vermicompost (50%)	10.81	10.81
T10: RDF @ 75 kg N; 100 kg P2O5; 75 kg K2O	4.02	9.96
T11: Control	2.02	4.88
S. Ed. (±)	0.600	1.245
C. D. (P = 0.05)	1.238	2.571



Graph 7: Effect of different organic manures on root yield (tha^{-1}) of Beetroot at Harvest.

Conclusion

In conclusion, all the growth and yield parameters of beet root were significantly influenced by the organic manures such as FYM, vermicompost, poultry manure, neem cake and green manure.

Among all the treatments, T2 with poultry manure (100%) resulted in early (2.39 days) germination and it was at par (2.89 days) with combined application of FYM (50%) + Vermicompost (50%) and (3.07 days) Vermicompost (100%). Among different organic manures, soil application of poultry manure (100%) improved plant height at all the growth stages each recorded the highest plant height of 20.18, 36.10, and 36.52 cm at 25, 50, and at harvest DAS respectively. Maximum number of leaves (11.84, 18.72, and 21.87) was recorded with the application of poultry manure (100%) each at 25, 50, and harvest DAS respectively. Among different organic manures, the highest crop growth rate during 20- 50 DAS was recorded (0.60) in poultry manure (100%) which was at par (0.55) with vermicompost (100%) and (0.50) with FYM (50%) + neem cake (50%). At 50 DAS - harvest the maximum crop growth rate (0.98) was recorded with neem cake (100%) which was at par with FYM (50% + poultry manure (50%). At harvest highest root length of 13.40 cm respectively was recorded with the application of FYM (50%) + poultry manure (50%) was at par 12.87 with FYM (100%). Maximum root diameter (6.96 cm) was recorded with poultry manure (100%) at harvest which was at par with green manure (100%), neem cake (100%), FYM (100%), vermicompost (100%) and FYM (50%) + vermicompost (50%). The highest total root yield (18.85 tha^{-1}) was recorded with the application of poultry manure (100%) which was at par with vermicompost (100%) (17.65 tha^{-1}). Higher harvest index (0.91) was recorded with the application of FYM (50%) + poultry manure (50%) was at par vermicompost (100%) and poultry manure (100%) (0.86).

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