ORGANIC STUDIES IN RADISH (*Raphanus sativus* L.) VARIETIES

Thesis submitted to the
University of Agricultural Sciences, Dharwad
In partial fulfillment of the requirements for the
Degree of

MASTER OF SCIENCE (AGRICULTURE)

IN

HORTICULTURE

By

DHANANJAYA

DEPARTMENT OF HORTICULTURE
COLLEGE OF AGRICULTURE, DHARWAD
UNIVERSITY OF AGRICULTURAL SCIENCES,
DHARWAD – 580 005

SEPTEMBER, 2007

ADVISORY COMMITTEE

DHARWAD
SEPTEMBER, 2007

(SATISH S. PATIL)
CHAIRMAN

Approved by:

Chairman: _____
(SATISH S. PATIL)

Members: 1. _____
(A.A. PATIL)

2. _____
(J.C. MATHAD)

3. _____
(D.S. UPPAR)

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

1. INTRODUCTION

Radish (*Raphanus sativus* L.) belongs to the family Brassicaceae. It is a popular root vegetable in both tropical and temperate regions. It can be cultivated under cover for early production but large scale production in field is more common in India. In Karnataka, radish is grown in 8,278 ha with a production of 3,60,093 tonnes (Anon., 1995).

Radish is grown for its young tender tuberous root which are consumed either cooked or raw. It is a good source of vitamin C (ascorbic acid) and minerals like calcium, potassium and phosphorus. It has got refreshing and diuretic properties. In homeopathy, it is used for neurological, headache, sleeplessness and chronic diarrhea. The roots are also useful in urinary complaints and piles. The leaves of radish are good source for extraction of protein on a commercial scale and radish seeds are potential source of non-drying fatty oil suitable for soap making illuminating and edible purposes.

Radish is predominantly a cool season vegetable crop. But, Asiatic types can tolerate higher temperature than European varieties. Being a cool season crop, it is sown during winter from September to January in northern plains. In the mild climate of peninsular India, radish can be grown almost all the year round except for few months of summer. It is an annual or biennial depending upon the type for the purpose it is grown.

The growth and yield of radish greatly depends on soil and climatic conditions. Different varieties have different soil and climatic requirements for their optimum performance. India being a vast country with varied agro-climatic regions *viz.,* temperate, subtropical, tropical and coastal tropical humid regions, a single variety may not be suitable for all the agro-climatic regions. Hence, different varieties have to be identified for specific regions.

Among the agro-techniques, nutrition is one of the main factor which governs the growth and yield of radish. Nutrition requirement of the crop varies with soil type, soil fertility, agro-climatic conditions and varieties. Being a short-duration and quick growing crop, the root growth should be rapid and uninterrupted. Hence, for the production of good quality radish optimum fertilization through organic, inorganic and biofertilizers are essential.

Organic agriculture is derived as a production system which largely excludes or completely avoids the use of synthetically compounded pesticides, fertilizers, growth regulators, preservatives and livestock feed additives, organic agriculture practices thus rely upon recycling of crop residues, animal manure, off-farm organic residues and wastes.

Organic agriculture is gaining movement in India due to the individual as well as group efforts to conserve environments and avoid contamination of the farm produce from the use of chemical fertilizers and pesticides. The important tenet of organic food movement is that promotes ecological soundness and sustainable use of natural resources, also a maintenance of crop diversity.

The problem of high cost of chemical fertilizers fully meet out nutrient requirement of crop by single source therefore integrated nutrient management such as organic matters like farmyard manure, vermicompost, poultry manure and biofertilizer uses has become necessary.

Farmyard manure being a bulky organic material releases the soil compaction and improves the aeration in addition to the supply of essential plant nutrients and organic matter, thereby increasing the soil microbial establishment along with accumulation of excess humus content.

Vermicompost provides vital macronutrients (N, P_2O_5, K_2O, Ca and Mg) and micronutrients Fe, Mn, Zn and Cu). The chemical analysis of vermicompost reveals that the N, P_2O_5, K_2O content was 0.8, 1.1, 0.5, respectively (Giraddi *et al*., 1993).

The poultry manure estimated, contains 60 per cent of organic N due to rapid mineralization poultry manure was recognized as a valuable source of plant nutrient for all crops.

Under normal agro-climatic conditions, the variety which is most suitable and in which organic manure is supplied are the two chief factors which influence yield and quality of radish. In view of higher cost of organic fertilizers and its contribution to ill-health of soil and water it becomes imperative for to go in for alternative and cheaper source like organic manures so as to partially reduce the cost and fulfill the crop requirement.

With this background, the present investigation was aimed with the following objectives.

1. To study the performance of different radish cultivars/genotypes under Dharwad condition.

2. To study the influence of organic manures on growth and yield of radish.

2. REVIEW OF LITERATURE

The literature pertaining to the "Organic studies in radish (*Raphanus sativus* L.) varieties" is very meager so the combined effect of organics on radish as well as few of the related crop species have reviewed and presented in this chapter.

Concept of organic farming

Organic farming is a production system which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock feed additives upon crop rotations, crop residues, animal manures, legume green manures, off-farm organic waste, mineral bearing rocks and biofertilziers to maintain soil productivity, tilth and to supply plant nutrients and biological means to control insects, weed and other pests.

Organic farming in both a philosophy and a system of agriculture. The objective of environments, social and economic sustainability lies at the heart of organic farming and are the major factors determining the acceptability or otherwise of specific production practices (Stockdale *et al.*, 2001).

In simple words, organic farming is the cultivation of crops by addition of organic inputs with an intensity to minimize the use of chemical fertilizers and pesticides that is hazardous to the environment. Organic materials such as bio-digested slurry, poultry manure, green leaf manure and FYM can substitute for inorganic fertilizers to maintain productivity and environmental quality (Choudhary *et al.*, 2002). Although, the organic manures contain plant nutrients in small quantities as compared to the fertilizers and also contain growth promoting substances like enzymes and hormones, besides plant nutrients make them essential for improvement of soil fertility and productivity (Bhuma, 2001).

2.1 Performance of different radish cultivars under Dharwad condition

Yousef and Shafi (1969) reported that French break fast, scarlet globe and sparkler were considered best interms of appearance, earliness (25 – 28 days) and acceptable root weight of Pusa chetki in white cultivar of the tropical radish group maturing in 40 to 45 days after sowing. It may be planted as a summer and monsoon crop from April to September and average yield varied from 200 to 300 quintals per ha (Choudhary and Shirohi, 1975).

Nautiyal *et al.* (1977) evaluated 14 radish cultivars for germination percentage, leaf number, length and width, root length and girth, top and fresh weight and root yield. The two highest yielding cultivars were Newari (88.89 q/ha) and Kalyanpur type (85.9 q/ha). Pujari *et al.* (1977) reported that Pusa Himani, Pusa Reshmi, Japanese white and Nanthnagar local were high yielders compared to others. They had upright to semi-spreading type plants. Cultivars with spreading type of plant habit *viz.,* Muli, Nepali and Kanilal Bobai recorded low yield. The higher root weight recorded in Pusa Himani, Pusa Reshmi, Japanese white and Nanthanagar local was responsible for increased root to shoot ratio.

Rajagopal *et al.* (1979) evaluated 11 varieties of radish obtained form different parts of India for their performance at the Tamil Nadu Agriculture University and revealed that Pusa chetki and Pusa safed recorded higher yield (17.9 and 16.7 t/ha). Punjab safed had highest root length of 25.9 cm and lowest in RS-13 (13.4 cm). Highest yield recorded in HR-1 (594.98 q/ha) followed by Kalyanpur Type-1 (585.88 q/ha) and Punjab safed (540.65 q/ha) among the six varieties of radish evaluated.

Dixit *et al.* (1980) evaluated seven radish cultivars cv. Japanese white gave highest yield (56.11 q/ha) followed by Kalyanpur Type-1 (44.17 q/ha) and scarlet long (37.21 q/ha). Singh *et al.* (1980) reported that highest yielding cultivars were PS-5, Sutton long white, Pusa Reshmi, Jaunpuri and Newari with 400, 365, 356, 333 and 332 q per ha, respectively.

The lowest yielding cultivars were Ambersari and Barsati with 133 and 178 q per ha, respectively.

Sirohi *et al.* (1992) reported that Pusa desi a white cultivar of the tropical radish group maturing of 50 to 55 days after sowing. The roots are white 30 to 35 cm long, tapering, medium thick, mildly pungent and average yielding, vary from 30 to 35 t per ha. Lingaiah *et al.* (1992) evaluated four cultivars of radish for growth and yield components Pusa chetki and Arka Nishant gave the highest mean yields of 16.9 and 13.4 t per ha, respectively. The root to leaf ratio was highest in Pusa chetki.

Deotale *et al.* (1994) reported that Pusa Reshmi was the best cultivar with aspect to the root length at 45 days after sowing which was 23.0 cm compared with 3.01 to 3.50 cm weight per plant of 299.12 g compared with 216.1 to 278.12 g and yield 27.14 t per ha for other cultivars. Baramasi produced the highest root weight per plant of 219.14 g compared with 108.11 to 142.33 g for other cultivars. Pusa chetki produced the highest leaf weight per plant of 136.56 g compared with 106.34 to 135.20 g for the other cultivars.

Kumar *et al.* (1995) reported that Pusa Himani recorded significantly highest plant height, number of leaves per plant, root length, root diameter, root weight and yield compared to the white Icickle. Pusa Himani was recommended for sowing during spring season.

Gupta *et al.* (1974) reported that the yield and growth characteristics of four varieties were investigated and results are tabulated. The results showed that Japanese white and Pusa Himani are the highest yielding under local conditions. The early variety white Icicle was most suitable for kitchen gardens and intercropping with other vegetables.

Shridhar (1998) conducted an experiment during the dry season (December – January) and rainy season (June – July) in 1989-90 in Port Blair, Andaman and Nicobar Islands to evaluate the growth and yield characteristics of radish cultivars. Pusa Himani, Pusa Chetki, Japanese white, Pusa Reshmi, Jaunpuri safed and Bombay red. The rainy season crop was grown as rainfed while dry season crop was well irrigated. Pusa chetki had the highest yield compared to other cultivars in both the season. On an average, it produced maximum root yield (267.50 q/ha), root diameter (3.88 cm), root weight per plant (83.35 g) and less leaf/root ratio (0.72) followed by Pusa Reshmi (207.57 q/ha, 3.23 cm, 62.35 g and 1.55, respectively). The lowest yield (134.31 q/ha), root weight (40.30 g) and root length (10.30 cm) was recorded by Jaunapuri in both the seasons. Bombay red (commonly grown) exhibited an almost consistent performance irrespective of the seasons. The performance of Jaunapuri and Punjab safed was much lower than their main land yield levels indicating that both cultivars seemed to be strongly thermosensitive. The maximum root length was observed in Pusa Himani (14.2 cm) and Japanese white (14.2 cm), but was at par with Pusa chetki (13.2 cm) and Pusa Reshmi (13.3 cm) in both the seasons.

Sharma *et al.* (2002) twenty eight radish cultivars were evaluated for root yield and component traits during 1996-97 in Palampur, Himachal Pradesh, India. The cultivars significantly varied in terms of root weight, length, girth diameter and yield. Among Asian cultivars, mino early weight had the highest root weight (186.13 g), length (18.65 cm) and yield per plot (18.82 kg). Whereas, Sutton's long white had the longest roots (19.85 cm). Among the European cultivars, Palm Hirday (DPR-1) had the highest root diameter (5.10 cm), girth (14.67 cm) and yield per plot (10.95 kg). The superior cultivars were Mino early white, Sutton's long white and Nadauni among Asian cultivars and Palam Hirday among the European cultivars.

Li-Xian Hong *et al.* (2005) reported that Qiufeng 2 is a new radish F1 variety in China characterized by high yielding potential, long storage life and vigorous growth. This mid to late maturing cultivar produces globose fleshy root with a red, smooth pericarp. The white and tender flesh has a moderate water content. The crop matures in approximately 90 days.

2.2 Effect of organics on growth and yield of radish

2.2.1 Manurial value of FYM

The nutrient content of FYM varies with the constituent of FYM. The nutrient content of FYM in a study conducted by Chatterjee *et al.* (1979) was found to be 0.64 per cent of N, 0.07 per cent of P and 0.29 per cent K. Whereas, Sharma and Mitra (1989) reported that FYM contained 26.1 per cent of C, 1.71 per cent of N, 0.24 per cent of P and 2.04 per cent of K on dry weight basis the C:N ratio was 15.1 and the nutrients added from 2.5 t of FYM were 42.7, 5.9 and 51.1 kg N, P and K per ha. The FYM used in the trials of Sriramachandrasekaharan *et al.* (1996) had 1.2 per cent N, 0.21 per cent P, 1.96 per cent K, 26.90 per cent C with C:N ratio of 22.4:1.0.

The farmyard manure seems to act directly by increasing the crop or seed yield either by accelerating the respiration process through cell permeability or by hormone growth action. It supply nitrogen, phosphorus and sulphur in available forms to the plants through biological decomposition indirectly it improves the physical properties of soil such as aggregation, aeration, permeability and water holding capacity (Chandramohan, 2002).

2.2.1.1 Effect of FYM on growth and yield parameters

Madhu *et al.* (1997) conducted experiment at CSWCRTI Research Centre, Udhagamadalam, India to study the long term effect of continuous fertilizer and manure application on crop, growth and soil physico-chemical properties. Potato yields were significantly improved by applying either NPK or fertilizer (rate calculated from soil test data) plus 5 t FYM per ha or a recommended dose of NPK rec fertilizer (recommended rate) plus 5 t FYM per ha or organic fertilizer in the form of vegetable mixture No. 4 (6:12:6). Recommended dose of fertilizer in the form of vegetable No. 5 (9:9:9) and NPk calc fertilizer plus 5 t FYM per ha gave higher yields of radish. After five years of the study, the total N content was found to be decreasing in all treatments except control, increase in P and K content was noted for sites with combined applications of NPK fertilizer and FYM.

Sittirungsum *et al.* (2001) conducted experiment during 1998 at Hokkaido in Japan to study the influence of farmyard manure on the yield and quality of Pak-choi (*Brassica chinensis*) and Japanese radish (*Raphanus sativus*) grown without application of chemical pesticides. The yields of pak-choi were highest in control plots cultivated with standard chemical fertilizers (360.5 g/plant) followed by plots treated with 5 t farmyard manure (342.0 g), 3 t farmyard manure plus chemical fertilizer at half the standard rate (320.1 g/plant) and 3 t farmyard manure (274.5 g/plant). The yield of Japanese radish at each treatment plot were 1012 to 1127 g per plant with 3 t farmyard manure resulting in the highest yields. The yields of Japanese radish in the treatment plots were 90 to 95 per cent of the yield obtained in the control plot. N content in Pak-Choi and Japanese radish was highest in the control plot and lowest in plots treated with 3 t farmyard manure. Nitrate nitrogen concentration of the vegetables decreased with decrease in N application. Whereas, the total sugar content increased. Ascorbic acid content increased with application of farmyard manure.

Hayworth *et al.* (1966) showed the beneficial effect of FYM on yield of carrot roots. Luxxati *et al.* (1975) found that organic manure did not generally increased the yield of carrot.

Shanmugasundaram and Savithri (2004) noticed that application of nitrogen at 120 kg per ha with FYM (10 t/ha) and $MgSO_4$ (2% as foliar spray) recorded higher amount of nitrogen content and uptake of nitrogen in foliage as well as in carrot root.

Damke *et al.* (1988) observed enhanced plant height of chilli with application of FYM @ 9 t per ha along with 50 kg each of N, P_2O_5 and K_2O. Similarly, Surlekar and Pankov (1989) reported greater plant height, number of branches and number of leaves per plant in chilli with application of farmyard manure @ 20 t per ha along with 100:80:100 kg N, P_2O_5 and K_2O per ha.

Sundharaiya *et al.* (2003) reported that in sweet basil, application of FYM (12.5 t/ha) + wettable sulphur (20 kg/ha) + urea (60 kg/ha) resulted in higher plant height, number of leaves and herbage yield over other treatments.

Sharma *et al.* (1979) indicated that in potato crop continuous application of farmyard manure produced higher yield than the combined application of P and K as inorganic fertilizers. Sharma *et al.* (1980) observed that there is significant and positive effect of FYM in summer corp.

Grewal and Trehan (1984) showed that application of FYM in potato crop at 75 and 30 tonnes per ha increased the tuber yield by 39 and 40 per cent. Further, opined tat higher yield was due to improved in tuber size.

Chavan *et al.* (1997) found that combined application of nitrogen through FYM and urea was more beneficial compared to fertilizer alone in order to increase the yield and quality of chilli.

Shashidhara (2000) reported that application of FYM (5 t/ha) + RDF (100:50:50 kg NPK/ha) significantly produced higher yield (794.08 kg/ha) and yield attributes of chilli when compared to application of inorganic fertilizer (629.15 kg/ha) alone.

Suresh (2000) observed that combined application of RDF (100:50:50 kg NPK/ha) + FYM recorded significantly higher dry chilli fruits as compared to RDF alone (11.28 q/ha).

Gupta *et al.* (1999) reported that application of FYM @ 72.0 q per ha along with ammonium sulphate @ 565 kg per ha were effective in increasing the growth and yield in onion.

Geetha *et al.* (2000) reported that FYM @ 25 t per ha and 200 kg K per ha increased the shoot and bulb yield of onion.

2.2.2 Vermicompost

2.2.2.1 Manurial values of vermicompost

The complex organic residues are biodegraded by symbotic association between earthworm and microbes and in the process where vermicompost or vermocastings are produced. The vermicast apart from increasing the density of microbes also provide sufficient energy for them to remain active. Vermicasting can provide the required nutrients to the plants. It provides the vital macro elements such as N, P_2O_5, KwO, Ca, Mg and micronutrients such as Fe, Mo, Zn, Cu etc. The chemical analysis of vermicompost reveals that the per cent N, P_2O_5 and K_2O content was 0.8, 1.1 and 0.5, respectively (Giraddi (1993). The vermicompost not only contains higher nitrate nitrogen at the start but it also has greater nitrifying capacity than the corresponding soil nitrogen production from mucus, dead earthworm tissue and vermicasts amounted to 180 kg per ha per year.

Kale *et al.* (1992) opined that vermicompost is like any other organic manure and depend son the nature of waste used as feed for worms and the nitrogen content varied between 0.5 to 2.0 per cent. Similar variations with respect to phosphorus and potassium content have been observed.

Bakthavathsalam *et al.* (2004) conducted experiment to determine the vegetative growth of radish using vermicomposts obtained from the culture study of earthworm (*Lampito mauritii*) using paddy chaff and weed plants. The pH values measured in the fresh paddy samples obtained before vermicomposting showed slightly acidic in nature but the sample obtained after a month of vermicomposting showed somewhat more acidic than the fresh samples as revealed by their lower pH values. Of the three macronutrients (N, P and K) analysed in the samples. The levels of K were relatively high when compared to N and P. NPK values were relatively high in weed plant materials than in paddy chaff powder. The plants raised in soil alone showed poor growth values over the organic materials. The results revealed a different effect on the height and weight of radish plant cultivated in fresh organic manures and vermicompost. Plants that were grown in PSR media of fresh organic manures

showed relatively lesser growth values than the plants raised in vermicompost. The results proved that the application of vermicompost had a positive role on the growth parameters of radish.

Reddy and Reddy (2005) a study was conducted in Andhra Pradesh, India during 1996-98 to determine the effect of different levels of vermicompost (0, 10, 20 and 30 t/ha) and nitrogen fertilizer (0, 50, 100, 150 and 200 kg/ha) on the growth and yield of onion (cv. N-53) and their residual effects on succeeding radish in an onion-radish (cv. Sel-7) cropping system. The plant height, number of leaves per plant, leaf area, bulb length, diameter and weight and yield of onion increased significantly with increasing level of vermicompost (from 10 to 30 t/ha) and nitrogen fertilizer from 50 to 200 kg per ha. A similar increase in radish yield was also observed due to the residual effect of different levels of vermicompost and nitrogen applied to the preceding crop (onion). Among the various treatment combinations, vermicompost at 30 t per ha plus 200 kg N per ha recorded the highest plant height and number of leaves per plant with the treatment with vermicompost at 30 t per ha + 50 kg N per ha in terms of bulb length, bulb weight and onion yield were recorded.

Vadiraj *et al.* (1992) observed that application of vermicompost as potting mixture for cardamom gives significant increase in plant height, number of leaves per plant, number of root per plant and root length. Patil (1995) reported that application of vermnicompost at 75 and 95 days after planting helps in obtaining maximum plant height in onion. Patil (1995) indicated that application of vermicompost and 50 per cent of recommended dose of fertilizer compared to control helps in increasing number of leaves per plant in potato.

Kale *et al.* (1991) observed that use of vermicompost is helpful reducing basal dose of fertilizer to 25 per cent in tomato, radish, carrot and brinjal. Sendur *et al.* (1998) showed that use of organic manure like Azospirillum, FYM and vermicompost combined with recommended dose of inorganic fertilizers showed better performance in terms of growth and fruit yield of tomato.

Tomar *et al.* (1998) indicated that brinjal and carrot plants were grown in pots containing soil alone and addition of FYM or urea. Vermicompost and vermicompost + FYM (1:1) recorded maximum yield with soil amended with FYM and vermicompost compared to unamended soil.

Vadiraj *et al.* (1998) opined that soil applied with vermicompost (10 t/ha) not only increased the growth and yield of turmeric but also helped to keep soil fertile and productive.

In an experiment conducted by Renuka and Ravishankar (1998), the application of biogas slurry + FYM, vermicompost alone have recorded maximum fruit size, more number of fruits per plant, while inorganic fertilizers (NPK) recorded the minimum fruit size. It is inferred that tomato crop would respond well to the application of organic manures either in combination with FYM or alone. Further, organic manure application helps to maintain soil health.

Yadav and Vijayakumari (2003) conducted an experiment to evaluate the effect of vermicompost and inorganic fertilizers on the yield parameters of chilli. They reported that higher number of fruits per plant, fruit weight, fruit length and fruit diameter were obtained by applying vermicompost alone.

2.2.3 Poultry manure

2.2.3.1 Manurial value of poultry manure

Poultry manure generally referred to experiment as voided by the animal. Manure characteristics are influence by animal species, age, diet, health, farm management and environment. The total N and P content of poultry manure and litters are among the highest of all animal manures. Composting or the controlled biological decomposition of organic waste has investigated as a method of stabilizing poultry litter and manure prior to land preparation. This process produced a material with several disadvantages with respect to handling by

reducing volume, mass of dry matter, odours, fly attraction and weed seed viability (Sweeten, 1980).

Costellanos and Pratt (1981) estimated that 60 per cent of the organic N in poultry manure was available. Due to its rapid mineralization, poultry manure was recognized as a valuable source of plant nutrients for corps. The nitrogen (60%) is present as uric acid, 30 per cent as more stable organic nitrogen and the balance as mineral nitrogen (Srivastava, 1988).

Zhou-Dongmei *et al.* (2005) conducted experiment on effect of applicaiton of livestock and poultry manures on growth of radish (*Raphanus sativus* L.) and pakchoi (*Brassica chinensis* L.) as well as their Cu and Zn uptake. The results exhibit that the manure improved the growth of radish and pakchoi. The difference of biomass among the same manure treatments containing different concentrations of Cu and Zn, however was insignificant. In addition, application of the livestock and poultry manure significantly increased soil pH and electrical conductivity (EC) compared with the control which ascribed that these manures had high pH and contained large amounts of inorganic ions.

Chezhiyan *et al.* (2003) indicated that application of poultry manure with Azospirillum (2 kg/ha) and phosphobacter (2 kg/ha) helped in obtaining higher number of branches per plant, number of leaves per plant, specific leaf area, plant spread, fresh weight per plant, dry weight of leaf per plant and dry weight of root per plant in Bhunmalaki.

Pimpini *et al.* (1992) reported that poultry manure and mineral fertilizer combinations (equivalent) to 140 kg N + 140 kg P_2O_5 + 100 kg K_2O per ha and 210 kg N + 210 kg P_2O_5 + 150 kg K_2O per ha) were compared with a non-fertilized control and with the control (RDF). All the fertilizer treatment increased the size of onion bulbs.

Abbey (2000) reported that application of 3 t per ha poultry manure plus 100 kg NPK, a combination of poultry manure and NPk fertilizer gave highest bulb yield of 12.4 t per ha in onion.

Espitiru *et al.* (1995) reported that the crop yield improvement due to addition of poultry manure was attributed to the presence of both readily available and slow release nitrogen.

Govindasamy *et al.* (1994) while studying the optimal combinations of N in the form of urea and poultry manure reported that use of poultry manure in more economical at high targeted yields than at low targeted yields.

The performance of poultry manure was better than FYM. One kg of nitrogen from FYM and poultry manure is able to produce 15 and 28 kg of potato tubers, respectively (Srivastava, 1998).

The application of dairy cattle waste and poultry waste composts released approximately 31.5 and 51.3 per cent nitrogen, respectively and had decreased nitrate leaching to deeper soil layer in Kyushu area (Yanwang *et al.*, 2002).

Incorporation of organic substances could increase the micronutrient status in soil depending upon the supply of reducing and chelating substances. In this regard, the studies of Bijay Sijngh *et al.* (1998) observed that the higher concentrations of micronutrients were observed in the soil tested with poultry manure and *Sesbania aculatae*.

2.3 Effect of chemical fertilizers on growth and yield of radish

Muttusamy and Muthukrishnan (1971) reported that nitrogen and phosphorus alone affected the fresh weight of the top. Nitrogen increased the fresh top weight and root weight. The effect of potassium did not reveal any trend. The fresh weight of root showed a significant reponse to phosphorous-potassium interaction and the response of nitrogen was significant also in dry weight of tops and roots, which were applied at the rate of 50:100:100 kg per ha.

The effect of N (30, 50 or 70 kg/ha) and P_2O_5 (15 or 30 kg/ha) on the yield of three radish cultivars Japanese white, Pusa Himani and Chinese pink were investigated during *rabi* 1994 at Jammu and Kashmir. Pusa Himani produced higher yields (37.3 t/ha) than either Japanese white or chinese pink. The addition of phosphorus had no significant influence on yield, but yield increased with increasing rate of N. The highest yield (38.4 t/ha) was recorded with highest N rate of 70 kg per ha (Bhat, 1996).

A field experiment conducted on radish cultivar Japanese white during the *rabi* season of 1987-88 revealed that inter and intra row spacing of 10 and 5 cm and application of 90 kg N and 30 kg P_2O_5 produced the highest root yield per ha (Joshi and Patil, 1992 and Dwivedi *et al*., 1995).

Singh *et al.* (1990) observed that application of 120 kg nitrogen per ha increased the plant height (143.28 cm) and delayed the 50 per cent flowering (42.4 days), whereas significantly more number of branches (40.57) were recorded with the application of 80 kg nitrogen per ha in radish cv. Japanese white.

Sharma and Kanaujia (1992) recorded more plant height (106 cm), number of branches (12.2), diameter of shoot (2.45 m), delayed bolting (82.9 days) and flowering (100.2 days) with the application of 200 kg nitrogen per ha in radish.

Mishra (1987) obtained more plant height (170.0 cm) and number of branches (12.94/plant when radish crop cv. Pusa Reshmi was nourished with 80, 40 and 40 kg of nitrogen, phosphorus and potassium per ha, respectively.

Jadhao *et al.* (1999) noticed that application of 100 kg nitrogen, 50 kg phosphorus and 25 kg potash increased the plant height (147.8 cm) and number of branches (17.8/plant) in radish cv. Pusa chetki.

Sharma (2000) noticed that the application of nitrogen at the rate of 200 kg per ha significantly increased the plant height (133.2 cm) but more number of branches (8.43) were found with 150 kg nitrogen per ha and application of 30 kg phosphorus per ha increased the number of branches per plant (8.03) but the maximum plant height (123.2 cm) was observed with application of 90 kg phosphorus per ha in radish cv. Japanese white.

2.4 Effect of seasons

Mol and Stolk (1979) brief descriptions are given of the characteristics of 14 radish cultivars sown between 20 March and 5 May under glass or in the open. Americano, Radar, Korda, Schoro and Rota were evaluated the best.

Choudhary and Sirohi (1975) reported that Pusa chetki is an early maturing (40 – 45 days) variety suited to tropical conditions with thick, medium long, soft textured roots. It may be cultivated from April to September under Northern Indian conditions, when sown from June to August at New Delhi. It gives higher yields than Pusa desi and Pusa Reshmi but sown later than August gives lower yields than these varieties.

Jaiswal *et al.* (1996) conducted pre-production trials on off-season (summer) radish and carrot. The radish cultivar Tokinashi was found to be suitable for off-season cultivation. It produces about 623 per cent more root yield than Minu early averaged across sites and was much preferred by farmers for its blotting resistance, fibre less roots, marketable root size and shape, low damage in transportation and ability to grow even under moisture stress conditions. The pre-mature blotting in minu early was 15 to 100 per cent. Whereas, in Tokinashi it ranged from 0 to 5 per cent. Application of NPK fertilizers N, P_2O_5, K_2O at the rate of 80:40:30 kg per ha in addition to compost (40 t/ha) increased root yield by 49 per cent.

Majkowska and Wierzbicka (2005) evaluated two radish cultivar (Agata and Murzynka) were grown in Olsztyn, Poland during the spring summer and summer-autum seasons of 2001-03. Total and marketable yields, dry matter content, vitamin C content and concentrations of total sugar and organic acidsand nitrate in edible parts were evaluated after harvest. The cultivars growing season and their interactions had significant effects on the total

and marketable yields of radish roots. The yields of Murzynka harvested in the autum, increased in successive years. Dry matter content, vitamin C content and concentrations of total sugars and nitrates were also affected by the experimental factors. Radish roots harvested in summer compared with those harvested in autum, contained higher amounts of nutrients. Nitrate accumulation was significantly higher in the edible parts of radish grown in the summer-autum season.

Vong *et al.* (2001) reported Japanese processing white radish cultivar, Hoshiriso was grown in spring, summer, autum and winter on the central coast of New South Wales Australia and accumulation of the characteristics pungent flavour component, 4-methylthio-3 trans butenyl isothiocynate (MTBITC) during growth was determined. MTBITC concentration was found to be higher in root grown in autumn and spring than in winter and summer. There was considerable change in MTBITC concentrations during growth in all seasons with a maximum concentration occurring nine weeks after sowing for roots grown in autumn and winter and after 13 weeks for spring and summer grown roots.

3. MATERIAL AND METHODS

A field experiment on "Organic studies in radish (*Raphanus sativus* L.) varieties" was carried during winter and summer seasons of 2006-07. The details of the materials and methods pertaining to this study are presented in this chapter.

3.1 Experimental site

The experiment was conducted in Saidapur Farm Unit, Department of Horticulture, College of Agriculture, Dharwad. The soils of experimental site comprised of red soils.

3.2 Location of experimental site and climate

The experiment site is situated in the agro-climatic zone-8 (Northern Transitional Zone) of Karnataka state. Geographically, Dharwad is located at $15^0$28' north latitude, $76^0$27' east longitude and altitude of 678 m above mean sea level.

The average total rainfall of last 52 years (1952-2006) is 798.75 m, fairly well distributed from April to October. The mean monthly maximum temperature ranges between 27.2^0C (August) to 37.10^0C (April), while mean monthly minimum temperature ranges from 13.14^0C (December) to 21.45^0C (May). The mean monthly relative humidity (RH) ranges between 51.25 per cent (February) and 87.88 per cent (July).

During the experimentation period (January to May), total rainfall of 85.5 mm was received. The details of the meteorological data for the year (2006-07) and the average of last 53 years as recorded at meteorological observatory of Main Agricultural Research Station, University of Agricultural Sciences, Dharwad is presented in Appendix I.

The experimental material comprised of two varieties of radish *viz.,* Japanese white and Pusa chetki (round). They were evaluated for their performance with eight levels of organic manures. Certified seeds of the above said varieties were used in the trial. The details or description of the variety are as follows.

3.2.1 Japanese white

Released by IARI, it is an upright variety producing green wavy leaves, roots are cylindrical pure white 20 to 25 cm long mildly pungent and with blunt end. It matures in 60 to 65 days.

3.2.2 Pusa chetki

Developed at IARI, roots medium long, white textured smooth and mildly pungent it mature in 40 to 45 days.

3.2.3 Experimental details

3.2.3.1 Treatment details

There were 16 treatments comprising of two varieties, seven levels of organic manures and one RDF.

Factor-I (varieties)

V_1 : Japanese white

V_2 : Pusa chetki (Round)

Plate 1. General view of the experimental site

Factor-II (Organics) (N equivalent)

1. RDF
2. Vermicompost
3. FYM
4. Poultry manure
5. Bhumilabha
6. Vermicompost (50%) + FYM (50%)
7. FYM (50%) + poultry manure (50%)
8. Poultry (50%) + vermicompost (50%)

3.2.3.2 Treatment combination

T_1 : Japanese white + RDF

T_2 : Japanese white + Vermicompost

T_3 : Japanese white + FYM

T_4 : Japanese white +Poultry manure

T_5 : Japanese white + Bhumilabha

T_6 : Japanese white + Vermicompost (50%) + FYM (50%)

T_7 : Japanese white + FYM (50%) + Poultry manure (50%)

T_8 : Japanese white + Poultry manure (50%) + vermicompost (50%)

T_9 : Pusa chetki + RDF)

T_{10} : Pusa chetki + Vermicompost

T_{11} : Pusa chetki + FYM

T_{12} : Pusa chetki + Poultry manure

T_{13} : Pusa chetki + Bhumilabha

T_{14} : Pusa chetki + Vermicompost (50%) + FYM (50%)

T_{15} : Pusa chetki + FYM (50%) + Poultry manure (50%)

T_{16} : Pusa chetki + Poultry manure (50%) + Vermicompost (50%)

3.2.3.3 Design and layout

Design : Factorial randomized complete block design

No. of treatments : 16

No. of replications : 3

Gross plot size : 3.0 × 1.0 m

Net plot size : 2.4 × 0.8 m

Spacing : 30 cm × 10 cm

3.3 Cultural operations

3.3.1 Land preparation

The land was ploughed once and harrowed twice. The wooden planking was done to bring the land to fine tilth. The ridges and furrows were made 30 cm apart in each plot and irrigation channels were provided for proper irrigation.

3.3.2 Application of manures

The crop was well manured with the different organic manures such as farmyard manure, vermicompost, poultry manure and Bhumilabha was incorporated in the field at the 15 days before sowing as per the treatments.

3.3.3 Application of fertilizers

The crop was fertilized with recommended nitrogen, phosphorus and potassium at 75:37.5:37.5 kg NPK per ha in the form of urea, single superphosphate and muriate of potash, respectively as a basal dose as per the treatments.

3.3.4 Spacing

Inter row spacing : 30 cm

Intra row spacing : 10 cm

3.3.5 Sowing

Sowing was done on January during rabi/winter season and on April during summer season. Seeds were dibbled half way down the ridges at a distance of 10 cm in the soil. Thinning was done at 8 days after sowing by retain one seedling per hill.

Japanese white

Pusa chetki

Plate 3. Cultivars of radish

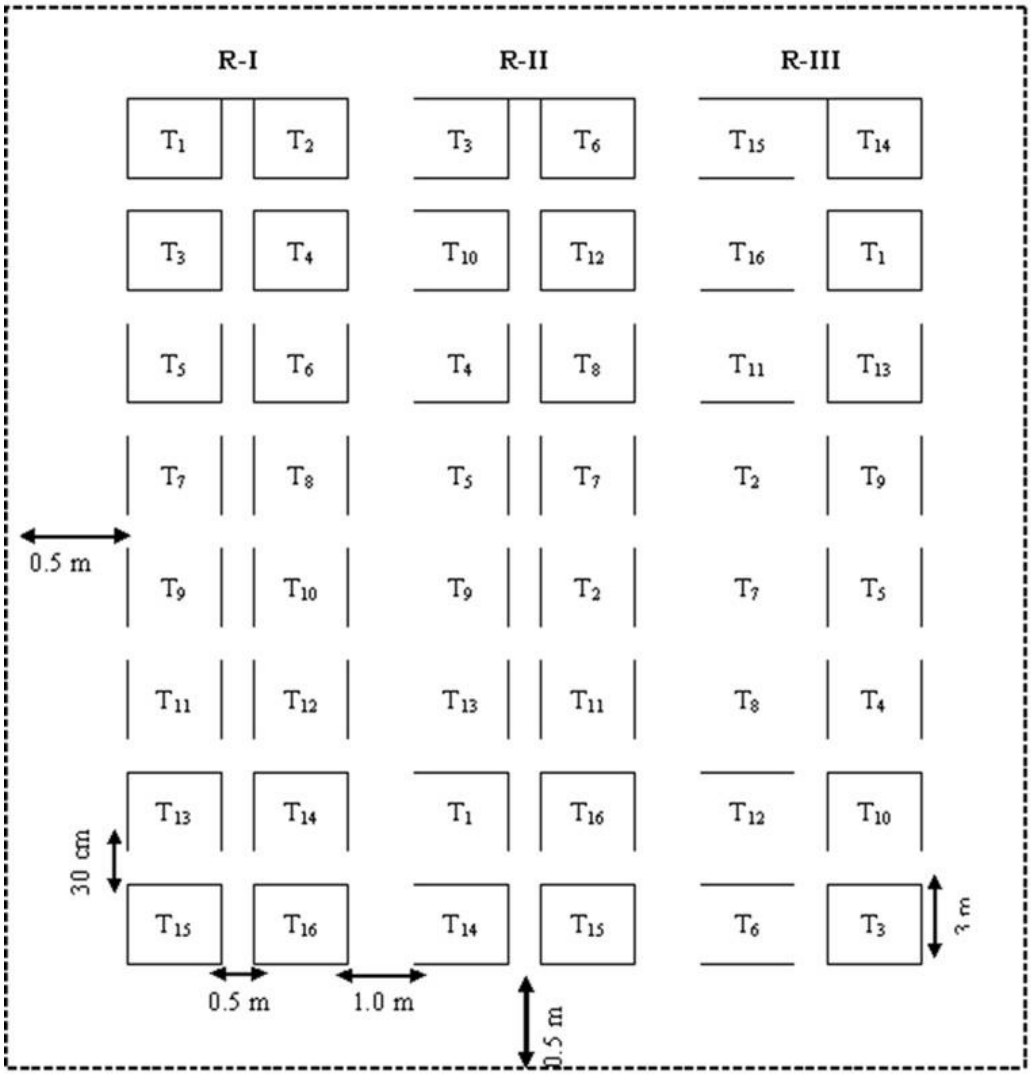


Fig. 1: Plan of layout

Fig 1. Plan of layout

3.3.6 Intercultivation

In order to keep the soil porous and also free from weeds, earthing up was done twice, once at 30 days after sowing and another at 40 days after sowing.

3.3.7 Irrigation

The irrigations were given at an interval of 4 to 6 days depending upon the weather and soil conditions.

3.3.8 Plant protection

To control the pest and disease, necessary plant protection measures were take up as per the recommended package of practices for radish.

3.3.9 Harvesting

The crop was harvested at full maturity, when the soil moisture was optimum. The plants were pulled out without damaging the roots from the net plots. The soil adhering to the roots was removed.

3.3.10 Collection of experimental data

Observations were recorded at five randomly selected and labeled plants from each treatment and each replications for growth and yield parameters 25 days after sowing and at harvest.

3.4 Growth parameters

3.4.1 Number of leaves

The number of leaves were counted from randomly selected and labeled plants. Then the average number of leaves per plant worked out.

3.4.2 Leaf area per plant (cm^2)

Leaf area per plant (cm^2) was estimated by using leaf area meter (LICOR 3000) in randomly selected plant and expressed in square centimeters.

3.5 Yield parameters

3.5.1 Root length (cm)

Length of root of all five randomly selected and labeled plants was recorded and mean values were computed.

3.5.2 Root diameter (cm)

Diameter of root of all the five randomly selected and labeled plants were recorded by using vernier calliperse and the mean values were computed.

3.5.3 Fresh weight of leaves (g)

Fresh weight of leaves per plant were recorded from the five randomly selected and labeled plants and mean values were computed.

3.5.4 Dry matter content of leaves (g)

The leaves collected from the labeled plants were kept in hot air oven at 70^0C for 24 hours and their dry weight was recorded.

3.5.5 Fresh weight of roots (g)

Fresh weight of root from five randomly selected and labeled plants was recorded and mean values were computed.

3.5.6 Dry matter content of roots

The roots collected from the five labeled plants were kept in hot air oven at 70^0C for 24 hours and their dry weight was recorded.

3.5.7 Total fresh weight of plants (g)

Total fresh weight of five randomly selected plants was recorded and the mean values were computed.

3.5.8 Total dry weight of plants (g)

The five labeled plants were collected and kept in hot air oven at 70^0C for 24 hours and their dry weight was recorded.

3.5.9 Yield per hectare (tonnes)

The weight of roots was recorded treatment-wise from each net plot and from each replication. Radish crop utilized only 80 per cent of the land and the remaining 20 per cent of the land was used for irrigation channels and bund. Keeping this in mid, the total yield per hectare in tonnes was calculated using the formula,

$$\text{Yield per ha (t)} = \frac{\text{Yield per net plot (kg)}}{\text{Net area of the plot } (m^2)} \times \frac{10000}{1000}$$

3.6 Statistical analysis

The mean data was statistically analysed by adapting the appropriate methods outlined by Panse and Sukhatme (1978) and Sundarrajan *et al*. (1972). The critical differences were calculated at 5 per cent level of probability wherever 'F' test was significant, the percentage data was transformed into arc sine transformation, whenever it was applicable, then statistical analysis was made.

4. EXPERIMENTAL RESULTS

4.1 Growth parameters

Number of leaves per plant

The data on number of leaves did not vary significantly between varieties tried in both the seasons at both stages of crop growth (Table 1). However at harvest, the variety Japanese white recorded the maximum leaf number (3.48 and 3.18) during *rabi* and summer, respectively compared to Pusa chetki (3.26 and 2.88) during *rabi* and summer, respectively.

The number of leaves differed significantly due to different sources of organics and their combinations in both the seasons and at both the stages of crop growth. Among the treatments, application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded maximum number of leaves (3.57 and 3.29 at 25 DAS and 3.74 and 3.36 at harvest) during *rabi* and summer, respectively which was followed by application of RDF 3.37 and 3.28 at 25 DAS and 3.55 and 3.30 at harvest. The minimum number of leaves was recorded with application of FYM @ 20 t per ha (100%) that is 2.97 and 2.41 at 25 DAS and 3.07 and 2.68 at harvest during *rabi* and summer seasons.

The interaction between varieties and treatments were found to be non-significant both at 25 DAS and at harvest during *rabi* and summer as well. However, the treatment with poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded the highest number of leaves in both the varieties at 25 DAS and at harvest in *rabi* as well as summer crop. This treatment was followed by application of RDF. In general, the number of leaves was higher in variety Japanese white during both the seasons.

Leaf area per plant (cm^2)

The data on leaf area per plant was significant between varieties in both the seasons at both stages of crop growth (Table 2). However at harvest, the variety Japanese white recorded higher leaf area (308.93 cm and 339.46 cm^2) during *rabi* and summer, respectively compared to Pusa chetki (216.26 and 165.65 cm^2) during *rabi* and summer, respectively.

The leaf area per plant were found to be significant due to different source of organics and their combinations in both seasons and at both the stages of corp growth. Among the treatments application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded significantly higher leaf area per plant (342.18 and 407.08 cm^2 at 25 DAS and 331.50 and 333.08 cm^2 at harvest) during *rabi* and summer season, which was on par with RDF 334.94 and 303.99 cm^2 at 25 DAS and 330.14 cm^2 and 323.06 cm^2 at harvest) during *rabi* and summer season significantly lowest leaf area at FYM @ 20 t per ha (100%), 166.85 and 134.44 cm^2 at 25 DAS and 163.31 and 187.30 cm^2 at harvest) during both seasons.

Interaction between varieties and treatments were found to be non-significant both at 25 DAS and at harvest during *rabi* and summer season. However, the treatment with poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded the higher leaf area (418.63 cm^2 and 407.08 cm^2 at 25 DAS and 380.00 cm^2 and 413.95 cm^2 at harvest) in Japanese white (265.72 and 229.62 cm^2 at 25 DAs and 282.15 and 252.21 cm^2 at harvest) in Pusa chetki during *rabi* and summer season.

4.2 Yield parameters

Fresh weight of leaves per plant (g)

The data on fresh weight of leaves per plant was significant between varieties tried in both the seasons at both stages of crop growth (Table 3). However at harvest, the variety Japanese white recorded the maximum fresh weight (86.32 and 16.97 g) during *rabi* and

Table 1: Effect of organic manures and inorganics on number of leaves per plant in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	3.62	3.23	3.37 (10.64)	3.82	3.28	3.55 (11.45)	3.39	3.16	3.27 (10.19)	3.43	3.16	3.30 (10.40)
T_2 : Vermicompost (100%)	3.23	3.15	3.22 (10.03)	3.26	3.18	3.22 (10.03)	2.93	2.63	2.78 (7.25)	3.15	2.78	2.96 (8.52)
T_3 : FYM (100%)	2.88	3.06	2.97 (8.54)	3.02	3.13	3.07 (9.07)	2.71	2.10	2.40 (6.00)	2.65	2.71	2.68 (6.70)
T_4 : Poultry manure (100%)	3.30	3.16	3.24 (10.10)	3.35	3.19	3.27 (10.19)	2.97	2.67	2.82 (8.11)	3.17	2.81	2.99 (8.60)
T_5 : Bhumilabha (100%)	3.14	3.14	3.15 (9.02)	3.23	3.14	3.18 (9.11)	2.86	2.62	2.74 (7.05)	2.85	2.73	2.79 (7.17)
T_6 : Vermicompost (50%) + FYM (50%)	3.31	3.17	3.21 (10.00)	3.65	3.22	3.43 (11.05)	3.30	2.70	3.00 (8.60)	3.31	2.82	3.08 (8.85)
T_7 : FYM (50%) + Poultry manure (50%)	3.45	3.18	3.34 (10.52)	3.70	3.29	3.49 (11.25)	3.31	2.71	3.01 (8.82)	3.33	2.85	3.09 (8.86)
T_8 : Poultry manure (50%) + Vermicompost (50%)	3.71	3.43	3.57 (11.51)	3.83	3.66	3.74 (11.70)	3.40	3.17	3.29 (10.36)	3.52	3.20	3.36 (10.84)
Mean	**3.33 (10.49)**	**3.19 (9.13)**	**3.26 (10.16)**	**3.48 (11.21)**	**3.26 (10.16)**	**3.36 (10.84)**	**3.11 (9.32)**	**2.72 (6.99)**	**2.91 (8.36)**	**3.18 (9.11)**	**2.88 (8.28)**	**3.03 (8.70)**
Factors	SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD at 5%	
Variety	0.02	0.07		0.02	0.07		0.03	0.11		0.03	0.09	
Treatments	0.04	0.14		0.04	0.14		0.07	0.22		0.06	0.19	
T x V	0.06	NS		0.06	NS		0.10	NS		0.09	NS	

V_1 – Japanese white V_2 – Pusa chetki

NS – Non-significant DAS – Days after sowing

Figures in the parentheses are $\sqrt{x + 0.5}$ transformed values

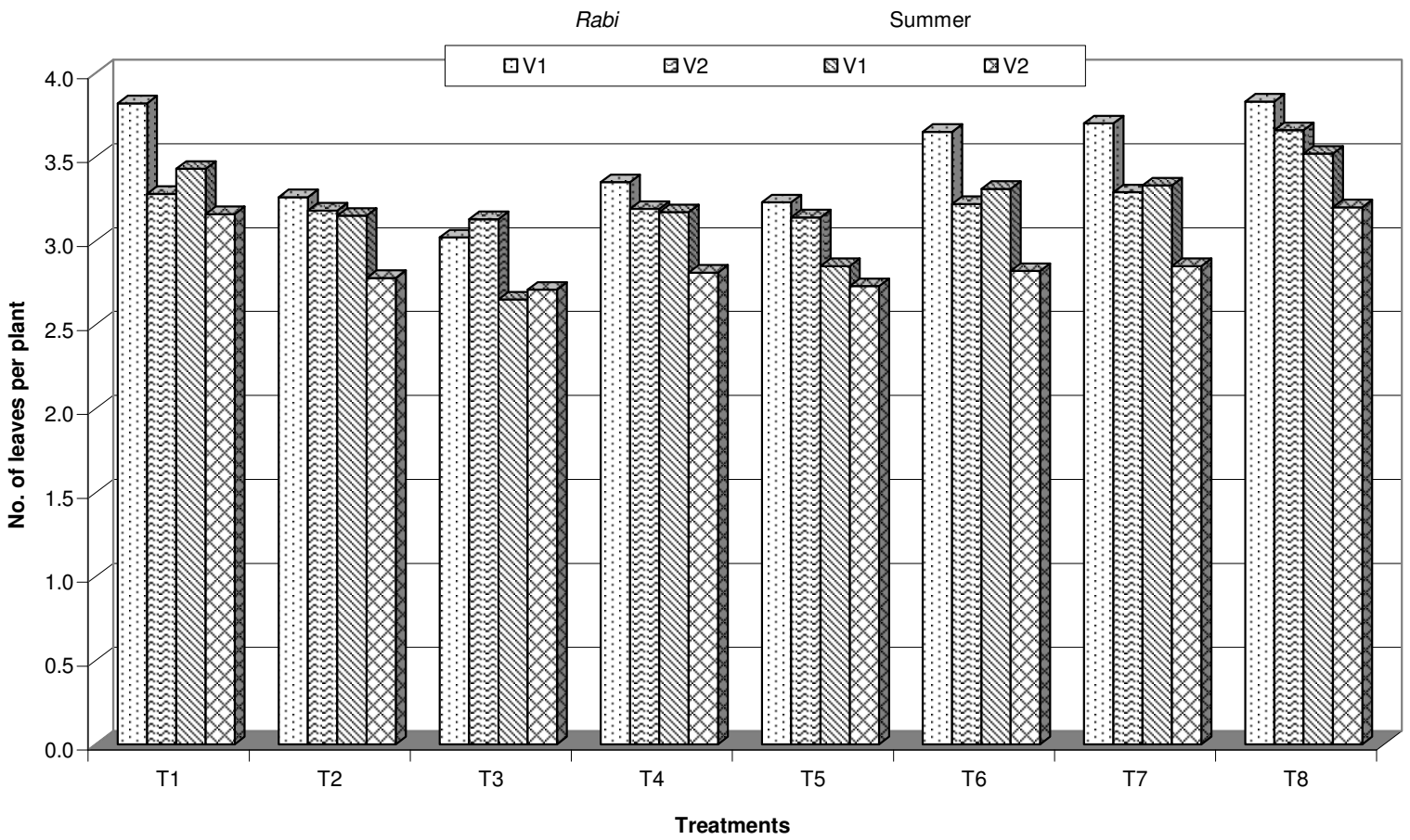


Fig. 2: Effect of organic manures and inorganics on number of leaves per plant in radish varieties at harvest

Fig. 2: Effect of organic manures and in organics on number of leaves per plant in radish varieties at harvest

Table 2: Effect of organic manures and inorganics on leaf area per plant (cm^2) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	417.10	252.78	334.94	380.14	280.13	330.14	380.57	227.42	303.99	397.35	248.76	323.06
T_2 : Vermicompost (100%)	253.02	169.71	211.37	273.72	172.26	215.60	252.29	155.34	203.81	305.89	138.37	222.29
T_3 : FYM (100%)	209.51	124.18	166.85	196.92	129.70	163.31	166.19	102.68	134.44	261.40	113.21	187.30
T_4 : Poultry manure (100%)	262.98	179.60	221.29	274.60	181.39	227.55	256.05	157.36	206.70	314.03	138.69	226.20
T_5 : Bhumilabha (100%)	233.22	127.63	180.42	258.93	138.73	206.66	226.01	104.87	165.44	282.92	119.89	201.41
T_6 : Vermicompost (50%) + FYM (50%)	313.86	182.44	248.15	352.15	272.56	312.36	321.37	175.72	248.55	361.12	156.07	258.59
T_7 : FYM (50%) + Poultry manure (50%)	370.20	223.51	296.86	354.16	273.19	313.68	324.41	177.36	250.89	379.04	158.04	268.54
T_8 : Poultry manure (50%) + Vermicompost (50%)	418.63	265.72	342.18	380.84	282.15	331.50	407.08	229.62	318.35	413.95	252.21	333.08
Mean	**309.82**	**190.70**	**250.26**	**308.93**	**216.26**	**262.60**	**291.75**	**166.30**	**229.02**	**339.46**	**165.65**	**252.56**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety	3.83	11.35	2.61	7.75	4.32	12.80	4.73	14.00
Treatments	7.67	22.69	5.23	15.50	8.64	25.60	9.46	28.01
T x V	10.84	NS	7.41	NS	12.23	NS	13.38	NS

V_1 – Japanese white V_2 – Pusa chetki
NS – Non-significant DAS – Days after sowing

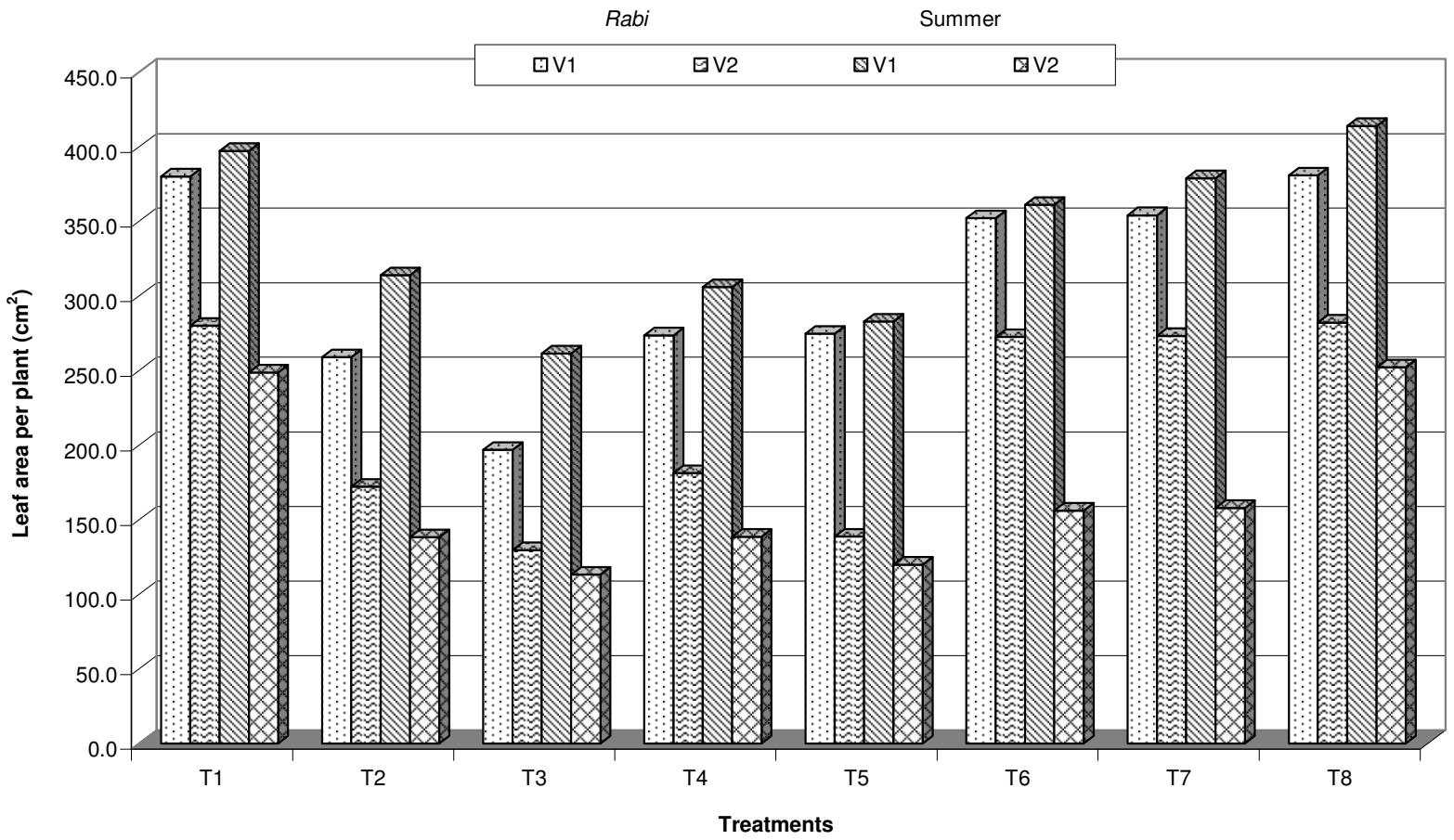


Fig. 3: Effect of organic manures and inorganics on leaf area per plant (cm^2) in radish varieties at harvest

Fig. 3: Effect of organic manures and inorganics on leaf area per plant (cm2) in radish varieties at harvest

summer, respectively compared to Pusa chetki (71.46 and 14.03 g) during *rabi* and summer, respectively.

The fresh weight of leaves differed significantly due to different sources of organics and their combinations in both seasons and at both stages of crop growth. Among the treatments, application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded significantly higher fresh weight 18.85 and 16.76 g at 25 DAs and 107.04 g and 21.07 g at harvest) during *rabi* and summer seasons, which was on par with application of RDF (18.21 and 14.67 g at 25 DAS and 103.80 and 19.49 g at harvest). The differences were significant between all other treatments.

The interaction between varieties and treatments were found to be non-significant at 25 DAS during both seasons but at harvesting stage due to the effect of organic manures were statistically significant during *rabi* and summer as well significantly higher fresh weight of leaves of plant was observed in treatment with application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) (120.82 and 21.51 g) in Japanese white and 93.26 and 20.63 g in Pusa chetki at harvest with similar treatments during *rabi* and summer seasons, which was followed by RDF (117.53 and 19.86 g) in Japanese white and 90.07 and 19.12 g in Pusa chetki during *rabi* and summer, respectively.

Fresh weight of root per plant

The data on fresh weight of root per plant was significant between varieties in both the seasons at both stages of crop growth (Table 4). However at harvest, the variety Pusa chetki recorded significantly higher fresh weight of root per plant (88.42 and 81.27 g) during *rabi* and summer, respectively compared to the Japanese white (78.44 and 72.18 g) during *rabi* and summer, respectively.

The fresh weight of root per plant were found to be significant due to different sources of organics and their combinations in both seasons and at both stages of crop growth. Among the treatments, application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded significantly higher fresh weight of root (19.35 and 15.28 g at 25 DAS and 99.07 and 91.62 g at harvest) during *rabi* and summer season, which was on par with application of RDF (18.85 and 14.67 g at 25 DAS and 98.40 and 90.05 g at harvest). However, lowest was recorded at FYM @ 20 t per ha (100%) (11.19 and 9.76 g at 25 DAS and 66.50 and 61.56 g at harvest) during *rabi* and summer, respectively.

The interaction between varieties and treatments were found to be non-significant at 25 DAS during both seasons but at harvesting stage were statistically significant. However, higher fresh weight of root per plant recorded with application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) (107.46 and 99.77 g) in Pusa chetki (90.69 and 83.46 g) in Japanese white at harvest with similar treatments during *rabi* and summer seasons which was on par with RDF (106.41 g) and 98.72 g in Pusa chetki and 90.39 and 81.38 g at harvest in Japanese white during *rabi* and summer seasons.

Dry weight of leaves per plant (g)

The data on dry weight of leaves per plant was significant between varieties tried in both the seasons at both stages of crop growth (Table 5). However at harvest, the variety Japanese white recorded higher dry weight of leaves per plant (13.33 and 11.80 g) during *rabi* and summer, respectively compared to Pusa chetki (7.88 and 7.11 g) during *rabi* and summer, respectively.

The dry weight of leaves per plant were found to be significant due to different sources of organics and their combinations in both seasons and at both stages of crop growth. Among the treatments, application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded significantly highest dry weight of leaves (2.02 and 1.73 g at 25 DAS and 13.37 g and 11.94 g at harvest) during *rabi* and summer season, which was on par with application of RDF 1.93 and 1.71 g at 25 DAS and 13.14 and 11.65 g at harvest during *rabi* and summer seasons.

Table 3: Effect of organic manures and inorganics on fresh weight of leaves per plant (g) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	19.68	16.75	18.21	117.53	90.07	103.80	17.62	11.84	14.67	19.86	19.12	19.49
T_2 : Vermicompost (100%)	12.86	11.35	12.11	72.78	59.62	66.20	13.04	7.63	10.34	16.49	15.07	15.78
T_3 : FYM (100%)	11.07	8.31	9.69	57.10	48.26	52.68	11.78	7.37	9.70	14.84	8.39	11.61
T_4 : Poultry manure (100%)	13.85	12.32	13.09	76.27	67.73	72.00	13.60	9.83	11.71	17.21	15.58	16.40
T_5 : Bhumilabha (100%)	13.24	8.89	11.07	65.40	52.58	58.99	12.25	7.61	9.93	16.32	14.49	15.41
T_6 : Vermicompost (50%) + FYM (50%)	17.58	14.82	16.20	83.19	76.43	79.81	13.93	10.50	12.22	18.12	16.77	17.45
T_7 : FYM (50%) + Poultry manure (50%)	18.07	15.55	16.81	97.44	83.69	90.57	17.50	10.93	14.28	18.39	17.84	18.12
T_8 : Poultry manure (50%) + Vermicompost (50%)	20.50	17.20	18.85	120.82	93.26	107.04	17.97	15.56	16.76	21.51	20.63	21.07
Mean	**15.86**	**13.15**	**14.50**	**86.32**	**71.46**	**78.89**	**14.71**	**10.16**	**12.45**	**16.97**	**14.03**	**15.50**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety	0.10	0.30	0.25	0.76	0.29	0.87	0.30	0.89
Treatments	0.20	0.61	0.51	0.52	0.59	1.75	0.60	1.78
T x V	0.29	NS	0.72	2.15	0.83	NS	0.85	2.51

V_1 – Japanese white V_2 – Pusa chetki
NS – Non-significant DAS – Days after sowing

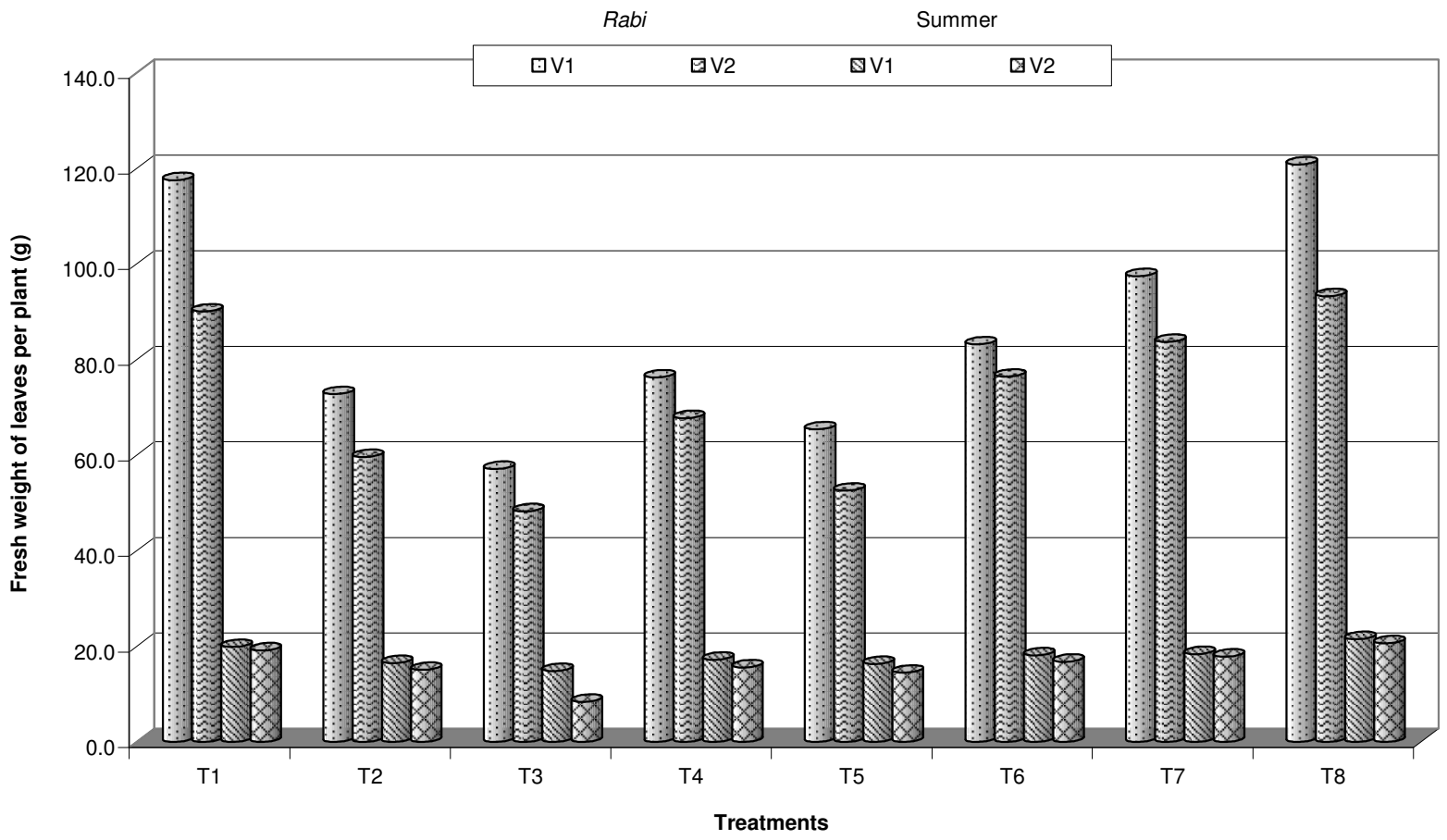


Fig. 4: Effect of organic manures and inorganics on fresh weight of leaves per plant (g) in radish varieties at harvest

Fig. 4: Effect of organic manures and inorganics on fresh weight of leaves per plant (g) in radish varieties at harvest

Table 4: Effect of organic manures and inorganics on fresh weight of root per plant (g) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	13.35	24.36	18.85	90.39	106.41	98.40	11.52	18.37	14.67	81.38	98.72	90.05
T_2 : Vermicompost (100%)	10.88	19.50	15.19	73.14	74.38	73.76	9.52	13.35	11.44	65.27	75.53	70.40
T_3 : FYM (100%)	7.85	14.52	11.19	63.66	69.33	66.50	7.11	12.41	9.76	59.32	63.80	61.56
T_4 : Poultry manure (100%)	10.91	20.29	15.60	75.67	83.29	79.48	9.54	13.80	11.67	68.59	76.35	72.47
T_5 : Bhumilabha (100%)	8.02	16.73	12.38	66.79	73.78	70.29	7.36	13.23	10.30	59.95	69.87	64.91
T_6 : Vermicompost (50%) + FYM (50%)	11.78	21.46	16.62	82.73	94.90	88.82	9.89	14.37	12.13	79.45	82.81	81.13
T_7 : FYM (50%) + Poultry manure (50%)	12.02	22.34	17.18	84.44	97.83	91.14	10.97	14.59	13.06	80.02	83.32	81.67
T_8 : Poultry manure (50%) + Vermicompost (50%)	13.69	25.00	19.35	90.69	107.46	99.07	11.88	18.68	15.28	83.46	99.77	91.62
Mean	**11.06**	**20.53**	**15.79**	**78.44**	**88.42**	**83.43**	**9.72**	**14.85**	**12.29**	**72.18**	**81.27**	**76.73**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety	0.35	1.03	0.48	1.43	0.17	0.52	0.69	2.07
Treatments	0.70	2.07	0.96	2.86	0.35	1.04	1.39	4.14
T x V	0.99	NS	1.63	4.05	0.49	NS	1.97	5.85

V_1 – Japanese white V_2 – Pusa chetki
NS – Non-significant DAS – Days after sowing

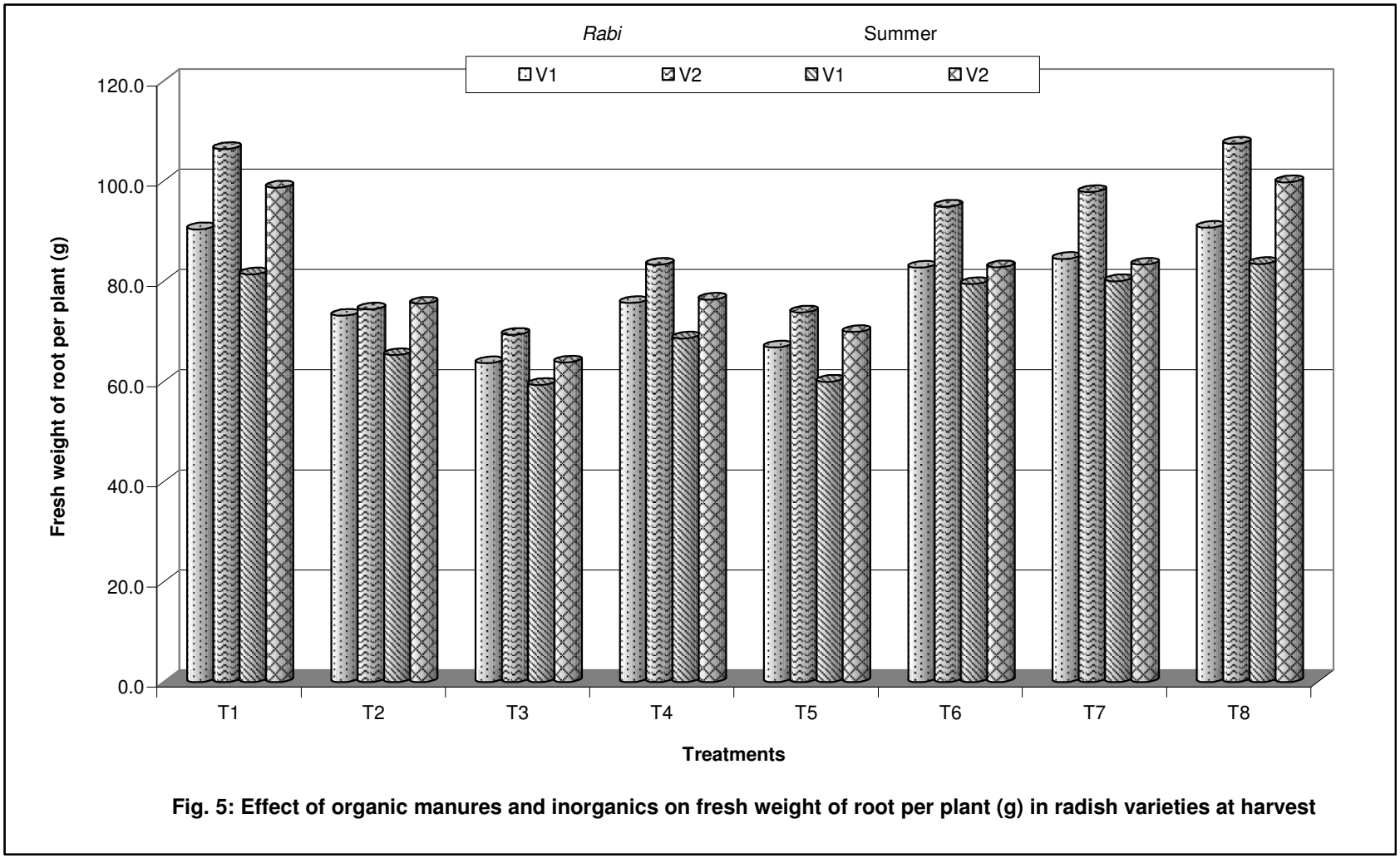


Fig. 5: Effect of organic manures and inorganics on fresh weight of root per plant (g) in radish varieties at harvest

Fig. 5: Effect of organic manures and inorganics on fresh weight of root per plant (g) in radish varieties at harvest

The interaction between varieties and treatments were found to be non-significant at 25 DAS during both seasons but at harvesting stage they were statistically significant. However, highest dry weight of leaves per plant recorded with application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) (16.45 and 15.07 g) in Japanese white (9.80 and 8.81 g) in Pusa chetki during *rabi* and summer seasons, which was on par with RDF (16.86 and 14.93 g) in variety Japanese white, which was followed by 9.41 and 8.37 g at harvest in variety Pusa chetki during both seasons. Significantly lowest was recorded at FYM @ 20 t per ha (100%) (8.42 and 6.84 g at harvest) in Japanese white (5.93 and 4.74 g at harvest) during *rabi* and summer seasons.

Dry weight of root per plant (g)

The data on dry weight of root per plant was significant between varieties tried in both seasons at both stages of crop growth (Table 6). However at harvest, the variety Pusa chetki recorded highest dry weight of roots per plant (14.75 and 11.03 g) during *rabi* and summer, respectively compared to Pusa chetki (11.40 and 9.19 g) during *rabi* and summer, respectively.

The dry weight of root per plant were found to be significant due to different sources of organics and their combinations in both seasons and at both stages of crop growth. Among the treatments, application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded significantly highest dry weight of roots (1.52 and 1.40 g at 25 DAS and 15.28 and 14.07 g at harvest) during *rabi* and summer season, which was on par with RDF except in *rabi* and summer at harvest (1.50 and 1.37 g at 25 DAS and 14.88 and 12.90 g at harvest) during both the seasons. Lowest was at FYM 20 t per ha (100%) (1.19 and 1.07 g at 25 DAS and 9.45 and 5.73 g at harvest) during *rabi* and summer season.

The interaction between varieties and treatments were found to be non-significant at 25 DAS during both the seasons but at harvest stage they were significant. However, highest dry weight of root per plant recorded with application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) (1.40 and 1.24 g at 25 DAS and 16.69 and 15.50 g at harvest) in Pusa chetki (1.64 and 1.56 g at 25 DAS and 13.86 g at harvest) in variety Japanese white, which was followed by RDF except at 25 DAS in *rabi* and at 25 DAS summer those were on par (1.38 and 1.21 g at 25 DAS and 16.37 g and 14.97 at harvest) in Pusa chetki (1.62 and 1.53 g at 25 DAS and 13.39 g and 10.83 g at harvest) during *rabi* and summer season.

Root length per plant (cm)

The data on root length per plant varied significantly tried in both the seasons. Significantly highest root length (16.13 and 13.89 cm) was recorded by the variety Japanese white than the variety Pusa chetki (15.23 and 12.97 cm at harvest) in *rabi* and summer season (Table 7).

The root length per plant influenced significantly due to application of organics and other combinations in both the seasons. Among the treatments, application of poultry manure 1.25 t per ha (50%) + vermicompost 1.75 t per ha (50%) recorded the highest root length (14.93 and 12.95 cm at 25 DAS and 17.57 and 14.85 cm at harvest) during *rabi* and summer season, which was followed by application of RDF (14.61 cm at 25 DAS and 17.29 a harvest) in *rabi* season and which were at par with application of RDF (12.88 cm at 25 DAs and 14.65 cm at harvest) during summer season. Significantly least root length (12.09 and 10.36 cm at 25 DAS and 11.85 and 11.49 cm at harvest) with application of FYM @ 20 t per ha (100%) during both seasons.

The interaction between varieties and treatments were found to be significant at both the stages during *rabi* and summer season as well. However, the treatment with application of poultry manure @ 1.25 t per ha (50%) + vermicompost 1.75 t per ha (50%) recorded the highest root length (15.19 and 13.19 cm at 25 DAS and 18.15 and 15.20 cm at harvest) in Japanese white (14.68 and 12.71 cm at 25 DAS and 16.99 and 14.49 cm at harvest) in Pusa chetki in *rabi* as well as in summer crop. This treatment was followed by RDF (14.89 and

Table 5: Effect of organic manures and inorganics on dry weight of leaves per plant (g) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	2.16	1.69	1.93	16.86	9.41	13.14	2.06	1.35	1.71	14.93	8.37	11.65
T_2 : Vermicompost (100%)	1.83	1.57	1.70	11.28	7.26	9.27	1.38	1.18	1.28	10.30	7.07	8.69
T_3 : FYM (100%)	1.60	1.37	1.48	8.42	5.93	7.17	1.32	1.09	1.21	6.84	4.74	5.79
T_4 : Poultry manure (100%)	1.91	1.62	1.77	12.42	7.84	10.13	1.41	1.22	1.32	10.76	7.42	9.09
T_5 : Bhumilabha (100%)	1.75	1.56	1.66	9.49	6.15	7.82	1.37	1.12	1.25	8.42	5.18	6.80
T_6 : Vermicompost (50%) + FYM (50%)	2.08	1.64	1.86	15.50	8.28	11.89	1.98	1.25	1.62	13.68	7.60	10.64
T_7 : FYM (50%) + Poultry manure (50%)	2.10	1.67	1.88	15.71	8.37	12.04	2.04	1.32	1.68	14.40	7.73	11.07
T_8 : Poultry manure (50%) + Vermicompost (50%)	2.29	1.75	2.02	16.95	9.80	13.37	2.07	1.38	1.73	15.07	8.81	11.94
Mean	**1.96**	**1.61**	**1.79**	**13.33**	**7.88**	**10.60**	**1.70**	**1.24**	**1.47**	**11.80**	**7.11**	**9.46**
Factors	SEm±		CD at 5%	SEm±		CD at 5%	SEm±		CD at 5%	SEm±		CD at 5%
Variety	0.02		0.07	0.03		0.09	0.03		0.09	0.18		0.54
Treatments	0.04		0.14	0.06		0.18	0.06		0.19	0.36		1.08
T x V	0.06		NS	0.08		0.26	0.09		NS	0.51		1.53

V_1 – Japanese white V_2 – Pusa chetki
NS – Non-significant DAS – Days after sowing

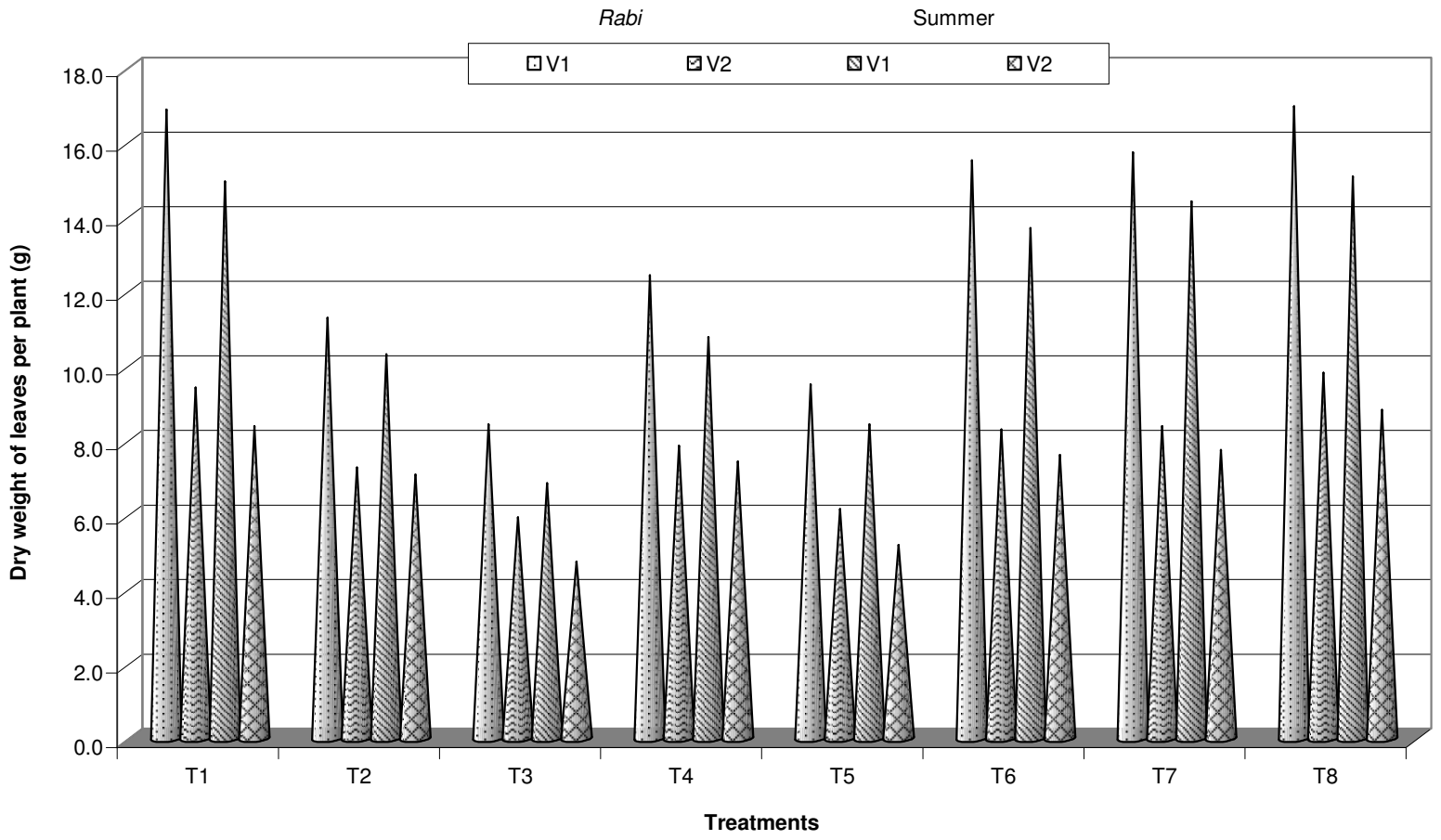


Fig. 6: Effect of organic manures and inorganics on dry weight of leaves per plant (g) in radish varieties at harvest

Fig. 6: Effect of organic manures and inorganics on dry weight of leaves per plant (g) in radish varieties at harvest

Table 6: Effect of organic manures and inorganics on dry weight of roots per plant (g) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	1.38	1.62	1.50	13.39	16.37	14.88	1.21	1.53	1.37	10.83	14.97	12.90
T_2 : Vermicompost (100%)	1.16	1.40	1.28	9.83	14.92	12.38	1.04	1.21	1.13	8.32	9.60	8.96
T_3 : FYM (100%)	1.08	1.31	1.19	8.67	10.22	9.45	1.02	1.12	1.07	6.60	4.85	5.73
T_4 : Poultry manure (100%)	1.19	1.43	1.31	10.39	15.15	12.77	1.05	1.23	1.14	8.71	10.50	9.60
T_5 : Bhumilabha (100%)	1.10	1.35	1.23	9.70	13.35	11.52	1.03	1.17	1.10	7.04	9.13	8.08
T_6 : Vermicompost (50%) + FYM (50%)	1.25	1.52	1.38	12.61	15.48	14.04	1.11	1.27	1.19	9.10	12.41	10.76
T_7 : FYM (50%) + Poultry manure (50%)	1.26	1.56	1.41	12.77	15.78	14.28	1.20	1.32	1.26	10.31	13.54	11.93
T_8 : Poultry manure (50%) + Vermicompost (50%)	1.40	1.64	1.52	13.86	16.69	15.28	1.24	1.56	1.40	12.63	15.50	14.07
Mean	**1.22**	**1.48**	**1.34**	**11.40**	**14.75**	**13.07**	**1.11**	**1.30**	**1.21**	**9.19**	**11.03**	**10.11**
Factors	SEm±		CD at 5%	SEm±		CD at 5%	SEm±		CD at 5%	SEm±		CD at 5%
Variety	0.005		0.013	0.02		0.08	0.01		0.04	0.14		0.43
Treatments	0.009		0.027	0.05		0.16	0.02		0.08	0.29		0.86
T x V	0.013		NS	0.07		0.23	0.04		NS	0.41		1.21

V_1 – Japanese white V_2 – Pusa chetki
NS – Non-significant DAS – Days after sowing

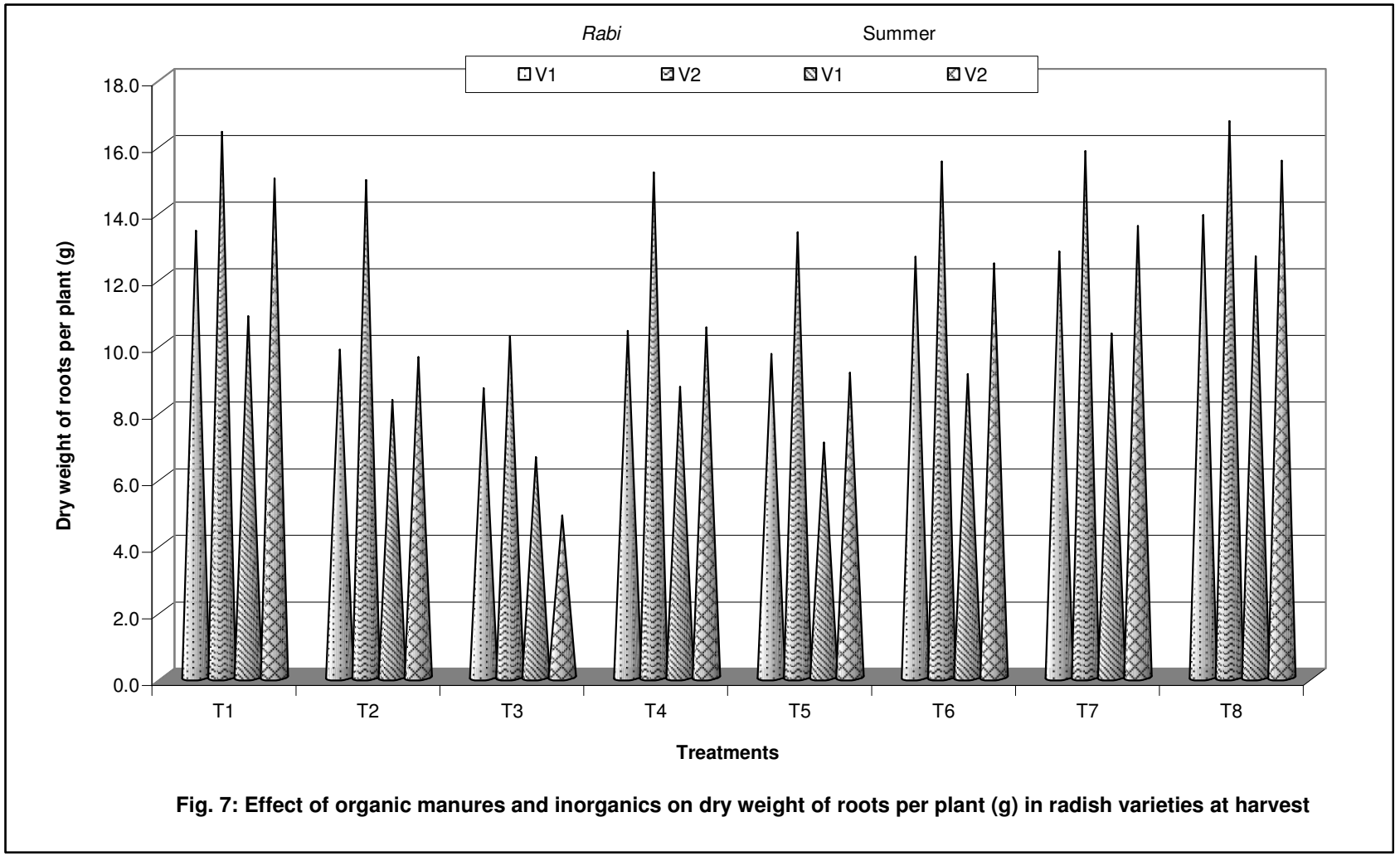


Fig. 7: Effect of organic manures and inorganics on dry weight of roots per plant (g) in radish varieties at harvest

Fig. 7: Effect of organic manures and inorganics on dry weight of roots per plant (g) in radish varieties at harvest

Table 7: Effect of organic manures and inorganics on root length per plant (cm) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	14.89	14.32	14.61	17.87	16.70	17.29	13.13	12.63	12.88	15.00	14.30	14.65
T_2 : Vermicompost (100%)	13.87	11.92	13.12	16.21	14.76	15.49	11.90	10.86	11.38	13.67	12.19	12.93
T_3 : FYM (100%)	13.50	10.68	12.09	12.14	11.56	11.85	11.58	9.14	10.36	11.27	11.71	11.49
T_4 : Poultry manure (100%)	14.31	12.43	13.15	16.70	15.33	16.01	12.47	11.56	12.01	14.30	12.29	13.30
T_5 : Bhumilabha (100%)	13.83	11.27	12.55	12.52	14.31	13.42	11.96	9.75	10.86	12.17	11.88	12.02
T_6 : Vermicompost (50%) + FYM (50%)	14.40	13.50	13.95	17.61	15.87	16.74	12.88	12.05	12.47	14.73	12.83	13.78
T_7 : FYM (50%) + Poultry manure (50%)	14.88	13.90	14.39	17.84	16.31	17.07	12.99	12.09	12.54	14.75	14.03	14.39
T_8 : Poultry manure (50%) + Vermicompost (50%)	15.19	14.68	14.93	18.15	16.99	17.57	13.19	12.71	12.95	15.20	14.49	14.85
Mean	**14.63**	**12.84**	**13.60**	**16.13**	**15.23**	**15.68**	**12.51**	**11.35**	**11.93**	**13.89**	**12.97**	**13.43**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety	0.04	0.11	0.05	0.16	0.08	0.24	0.07	0.21
Treatments	0.08	0.23	0.11	0.32	0.16	0.48	0.14	0.43
T x V	0.11	0.33	0.15	0.46	0.23	0.69	0.20	0.60

V_1 – Japanese white
V_2 – Pusa chetki
NS – Non-significant
DAS – Days after sowing

Table 8: Effect of organic manures and inorganics on root diameter per plant (cm) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	1.60	1.90	1.69	2.05	2.56	2.30	1.36	1.65	1.50	2.17	2.13	2.15
T_2 : Vermicompost (100%)	1.29	1.50	1.39	1.77	2.15	1.96	1.20	1.37	1.28	1.28	1.85	1.57
T_3 : FYM (100%)	1.14	1.46	1.30	1.48	1.65	1.57	1.12	1.26	1.19	1.09	1.22	1.16
T_4 : Poultry manure (100%)	1.40	1.51	1.45	1.88	2.27	2.07	1.21	1.40	1.30	1.29	1.94	1.61
T_5 : Bhumilabha (100%)	1.18	1.49	1.34	1.72	1.98	1.85	1.18	1.32	1.25	1.15	1.34	1.25
T_6 : Vermicompost (50%) + FYM (50%)	1.42	1.64	1.53	1.89	2.36	2.12	1.28	1.54	1.41	1.63	2.02	1.83
T_7 : FYM (50%) + Poultry manure (50%)	1.48	1.77	1.68	2.02	2.51	2.26	1.31	1.58	1.45	1.87	2.09	1.98
T_8 : Poultry manure (50%) + Vermicompost (50%)	1.61	2.01	1.81	2.09	2.70	2.40	1.51	1.73	1.62	2.19	2.19	2.19
Mean	**1.39**	**1.66**	**1.52**	**1.86**	**2.27**	**2.07**	**1.27**	**1.48**	**1.37**	**1.58**	**1.85**	**1.72**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety	0.01	0.03	0.09	0.27	0.01	0.03	0.04	0.12
Treatments	0.02	0.06	0.01	0.05	0.02	0.06	0.08	0.25
T x V	0.03	0.09	0.02	0.07	0.03	0.09	0.12	0.35

V_1 – Japanese white V_2 – Pusa chetki
NS – Non-significant DAS – Days after sowing

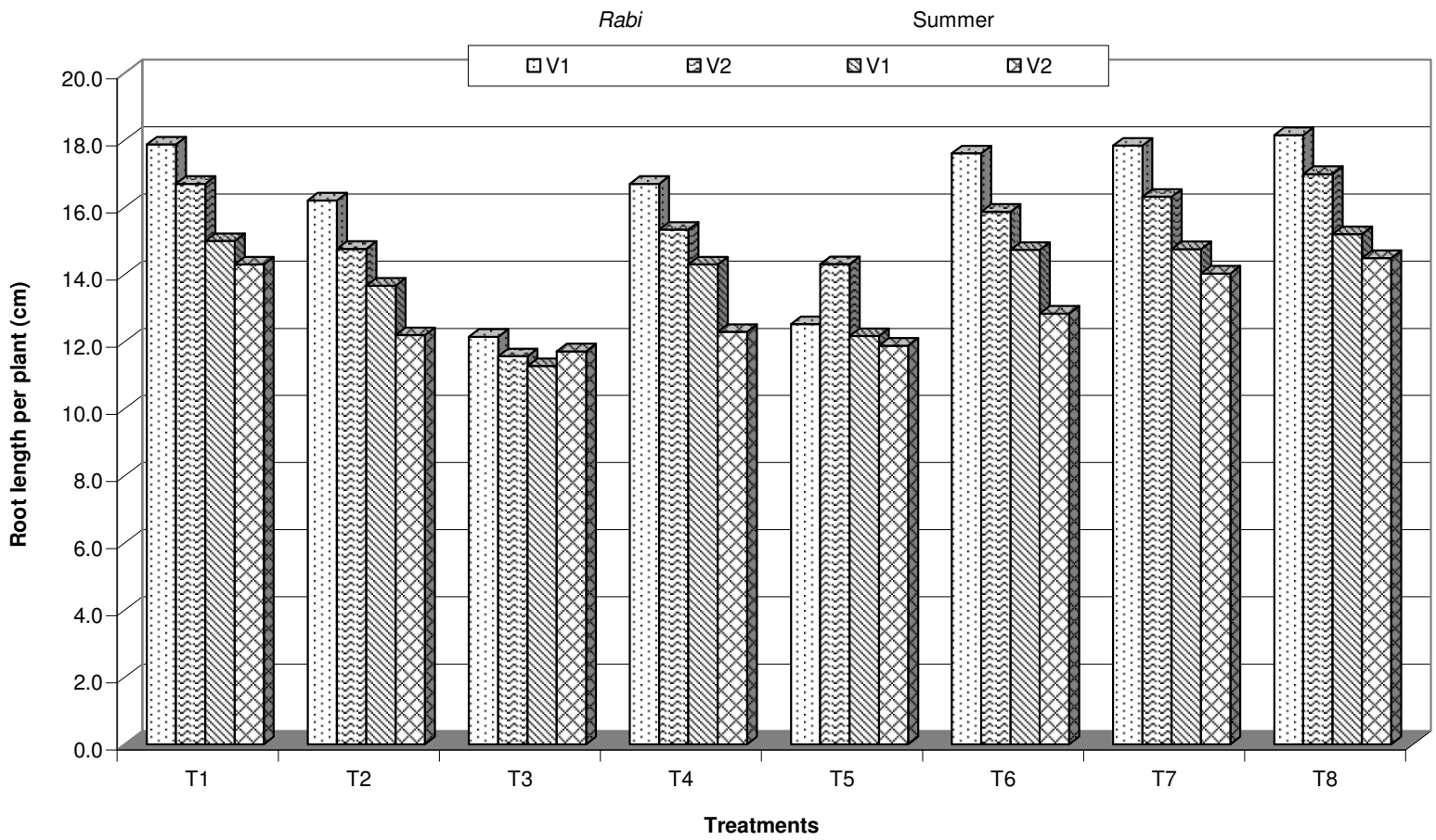
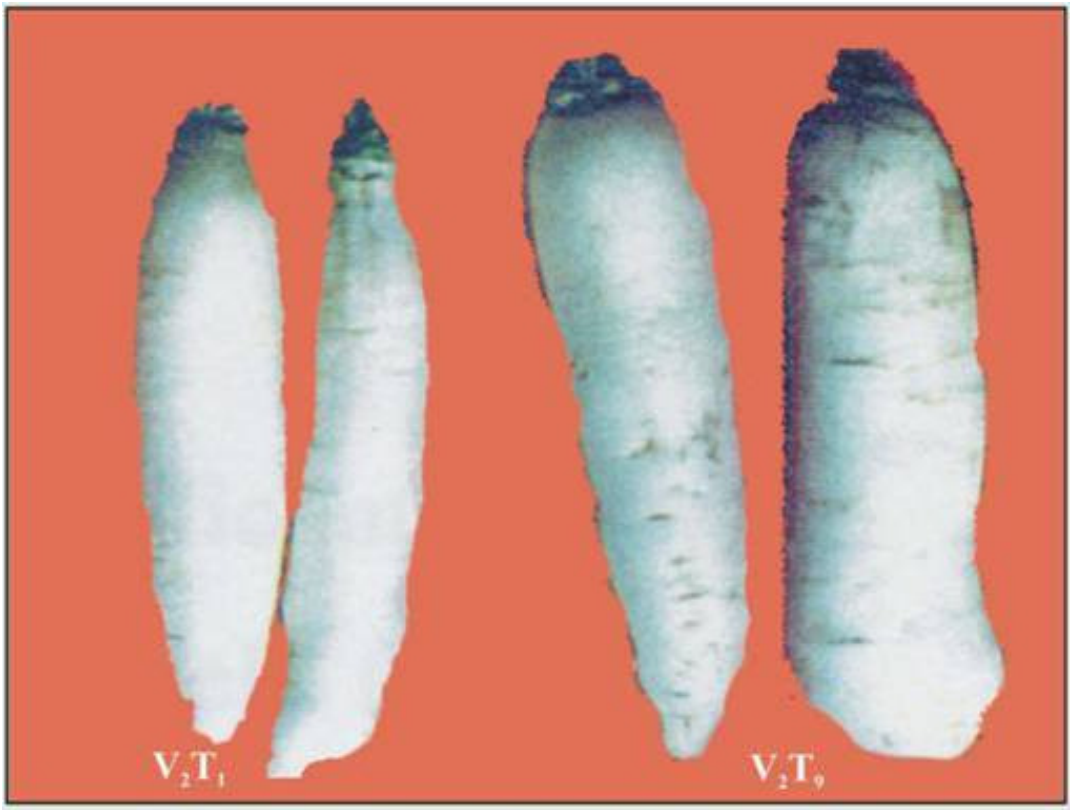


Fig. 8: Effect of organic manures and inorganics on root length per plant (cm) in radish varieties at harvest

Fig. 8: Effect of organic manures and inorganics on root length per plant (cm) in radish varieties at harvest

A. cv. Japanese White



B. cv. Pusa Chetki

Plate 2. Effect of treatments on different cultivars

17.87 cm and 14.32 cm and 16.70 cm) in *rabi* season at both stages in variety Japanese white and Pusa chetki, respectively. Some treatment which were at par (13.13 cm at 25 and 18.08 cm at harvest) in Japanese white (12.63 cm at 25 DAS and 14.30 cm at harvest) in Pusa chetki during summer season.

Root diameter per plant (cm)

The data on root diameter per plant varied significantly between the varieties tried in both the seasons. Pusa chetki recorded significantly the highest root diameter (2.27 and 1.85 cm) than Japanese white 1.86 and 1.58 cm) during *rabi* and summer seasons (Table 8).

The root diameter differed significantly due to application of organics and their combinations in both the seasons. Among treatments, application of poultry manure 1.25 t per ha (50% + vermicompost 1.75 t per ha (50%) recorded the highest root diameter (1.81 and 1.62 cm at 25 DAS and 2.40 and 2.19 cm at harvest) during *rabi* and summer season, which was followed by RDF (1.69 and 1.50 cm at 25 DAS and 2.30 and 2.15 cm at harvest) during both the seasons. Significantly lowest root diameter recorded at FYM @ 20 t per ha (100%) (1.30 and 1.19 cm at 25 DAS and 1.57 and 1.16 cm at harvest) during *rabi* and summer season.

Interaction between varieties and treatments on root diameter differed significantly during *rabi* and summer seasons. However, the treatment with application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded highest root diameter (2.01 and 1.73 cm at 25 DAS and 2.70 and 2.19 cm at harvest) in variety Pusa chetki (1.61 and 1.51 cm at 25 DAS and 2.09 and 2.19 cm at harvest) in Japanese white during both the seasons, which was followed by RDF except in Japanese white during *rabi* and at harvest both varieties during summer they were on par (1.90 and 1.65 cm at 25 DAS and 2.56 and 2.13 cm at harvest) in Pusa chetki (1.60 and 1.36 cm at 25 DAS and 2.05 and 2.17 cm at harvest) during both the seasons.

Total fresh weight per plant (g)

The data on total fresh weight per plant was significant between varieties in both the seasons at both stages of crop growth (Table 9). However at harvest, the variety Japanese white recorded highest total fresh weight per plant (164.85 and 91.85 g) during *rabi* and summer, respectively compared to Pusa chetki (162.98 and 88.30 g) during *rabi* and summer, respectively.

The total fresh weight per plant were found to be significant due to different sources of organics and their combinations in both seasons and at both stages of crop growth. Among the treatments, application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded significantly higher total fresh weight per plant (34.91 and 33.32 g at 25 DAS and 202.29 and 108.06 g at harvest) during *rabi* and summer season, which was on par with RDF (33.62 and 30.20 g at 25 DAs, 200.44 and 106.37 g at harvest) during both seasons.

The interaction between varieties and treatments were found to be non-significant at 25 DAS during both seasons but at harvest, they were found to be significant. However, highest total fresh weight per plant recorded with application of poultry manure @ 1.25 t per ha (50%) + vermicompost 1.75 t per ha (50%) (211.47 and 115.52 g) in Japanese white (193.12 and 100.59 g) in Pusa chetki at harvest with similar treatment during *rabi* and summer season, which was at par with RDF (207.92 and 113.54 g) in Japanese white (192.96 and 99.02 g) and Pusa chetki at harvest during both the seasons. The lowest was recorded at FYM @ 20 t per ha (100%) (120.77 and 69.52 g) in Japanese white (119.73 and 71.78 g) in Pusa chetki at harvest during *rabi* and summer season.

Table 8: Effect of organic manures and inorganics on root diameter per plant (cm) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	1.60	1.90	1.69	2.05	2.56	2.30	1.36	1.65	1.50	2.17	2.13	2.15
T_2 : Vermicompost (100%)	1.29	1.50	1.39	1.77	2.15	1.96	1.20	1.37	1.28	1.28	1.85	1.57
T_3 : FYM (100%)	1.14	1.46	1.30	1.48	1.65	1.57	1.12	1.26	1.19	1.09	1.22	1.16
T_4 : Poultry manure (100%)	1.40	1.51	1.45	1.88	2.27	2.07	1.21	1.40	1.30	1.29	1.94	1.61
T_5 : Bhumilabha (100%)	1.18	1.49	1.34	1.72	1.98	1.85	1.18	1.32	1.25	1.15	1.34	1.25
T_6 : Vermicompost (50%) + FYM (50%)	1.42	1.64	1.53	1.89	2.36	2.12	1.28	1.54	1.41	1.63	2.02	1.83
T_7 : FYM (50%) + Poultry manure (50%)	1.48	1.77	1.68	2.02	2.51	2.26	1.31	1.58	1.45	1.87	2.09	1.98
T_8 : Poultry manure (50%) + Vermicompost (50%)	1.61	2.01	1.81	2.09	2.70	2.40	1.51	1.73	1.62	2.19	2.19	2.19
Mean	**1.39**	**1.66**	**1.52**	**1.86**	**2.27**	**2.07**	**1.27**	**1.48**	**1.37**	**1.58**	**1.85**	**1.72**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety	0.01	0.03	0.09	0.27	0.01	0.03	0.04	0.12
Treatments	0.02	0.06	0.01	0.05	0.02	0.06	0.08	0.25
T x V	0.03	0.09	0.02	0.07	0.03	0.09	0.12	0.35

V_1 – Japanese white V_2 – Pusa chetki
NS – Non-significant DAS – Days after sowing

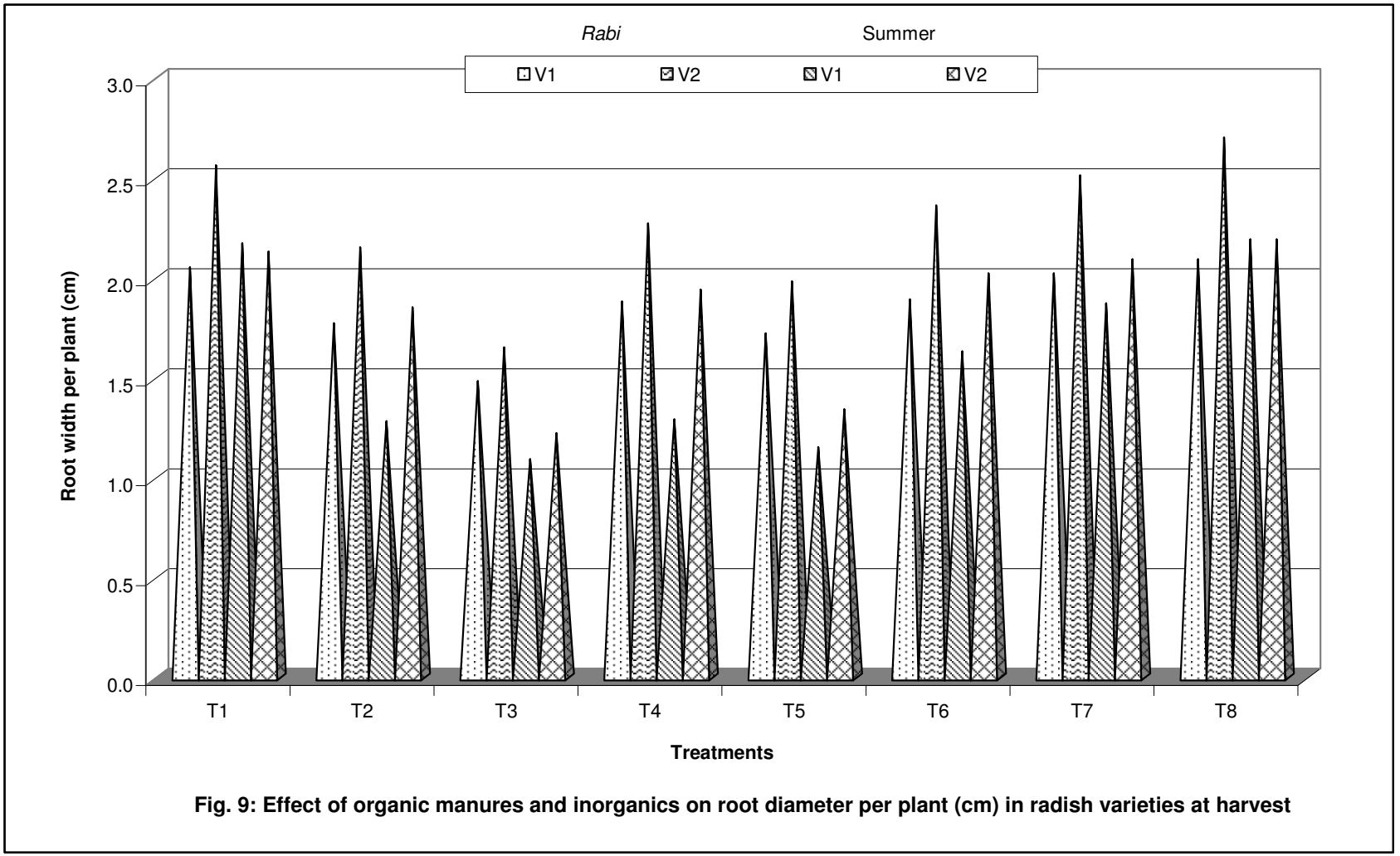


Fig. 9: Effect of organic manures and inorganics on root diameter per plant (cm) in radish varieties at harvest

Fig. 9: Effect of organic manures and inorganics on root diameter per plant (cm) in radish varieties at harvest

Table 9: Effect of organic manures and inorganics on total fresh weight per plant (g) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	32.42	34.81	33.62	207.92	192.96	200.44	29.82	30.58	30.20	113.54	99.20	106.37
T_2 : Vermicompost (100%)	23.51	24.92	24.22	145.92	145.58	145.75	23.77	23.78	23.77	84.10	79.64	81.87
T_3 : FYM (100%)	17.68	14.95	16.32	120.77	119.73	120.25	19.63	22.15	20.89	69.52	71.78	70.65
T_4 : Poultry manure (100%)	23.68	28.87	26.27	151.95	164.60	158.27	24.41	26.38	25.39	86.70	88.36	87.53
T_5 : Bhumilabha (100%)	21.70	23.08	22.39	132.19	134.11	133.15	20.14	22.96	21.55	78.03	72.80	75.41
T_6 : Vermicompost (50%) + FYM (50%)	26.23	30.29	29.35	165.92	176.70	171.31	25.02	27.63	26.33	91.61	96.85	94.23
T_7 : FYM (50%) + Poultry manure (50%)	29.82	32.46	30.06	182.67	177.08	179.88	29.41	28.06	28.74	95.80	97.19	96.50
T_8 : Poultry manure (50%) + Vermicompost (50%)	34.94	34.88	34.91	211.47	193.12	202.29	31.39	35.26	33.32	115.52	100.59	108.06
Mean	**26.25**	**28.03**	**27.14**	**164.85**	**162.98**	**163.92**	**25.45**	**27.10**	**26.27**	**91.85**	**88.30**	**90.08**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety	0.35	1.06	0.49	1.45	0.38	1.12	0.84	2.50
Treatments	0.71	2.12	0.98	2.91	0.76	2.25	1.69	5.00
T x V	1.01	NS	1.39	4.12	1.07	NS	2.39	7.08

V_1 – Japanese white V_2 – Pusa chetki
NS – Non-significant DAS – Days after sowing

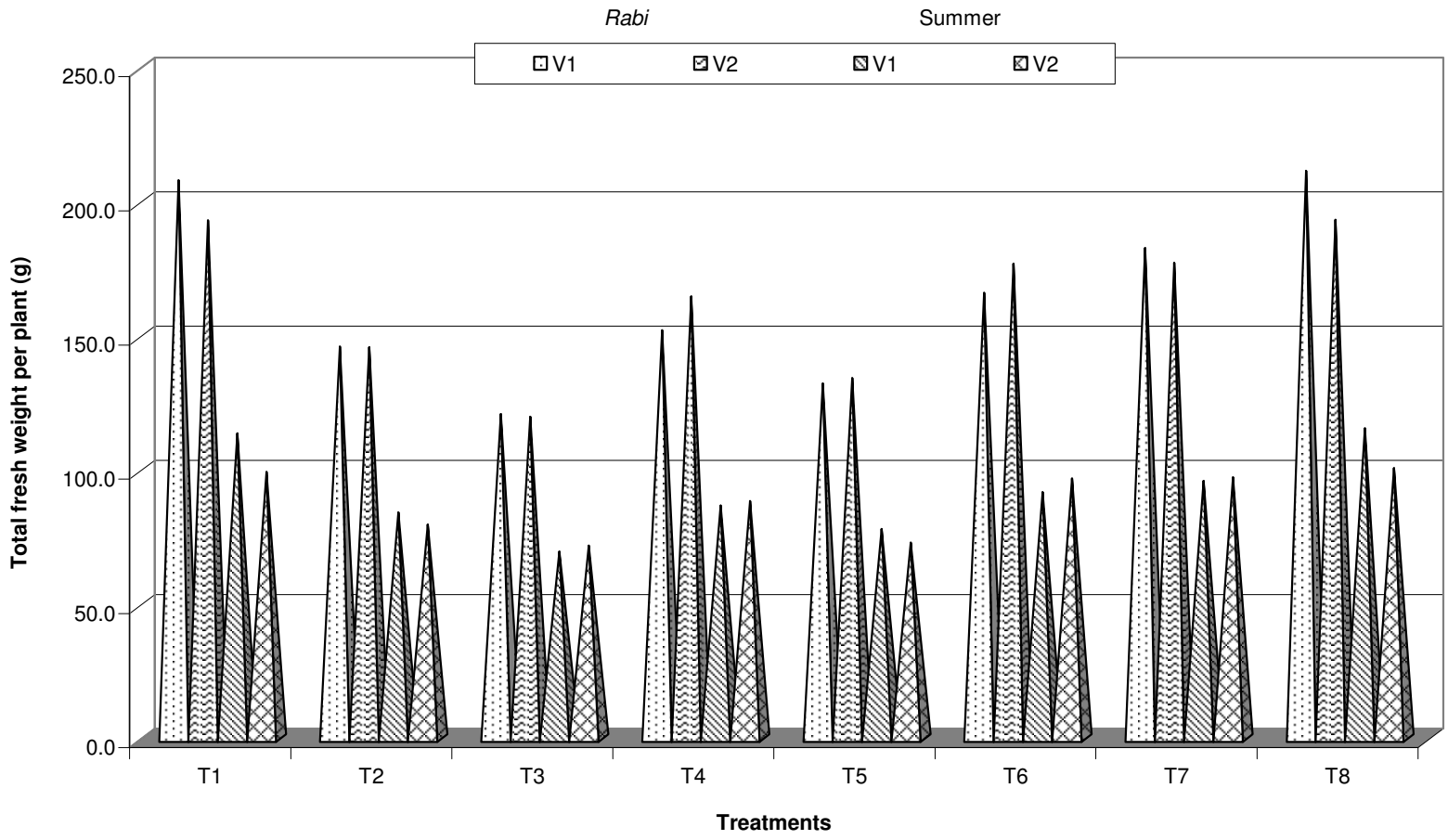


Fig. 10: Effect of organic manures and inorganics on total fresh weight per plant (g) in radish varieties at harvest

Fig. 10: Effect of organic manures and inorganics on total fresh weight per plant (g) in radish varieties at harvest

Table 10: Effect of organic manures and inorganics on total dry weight per plant (g) in radish varieties

Treatments	*Rabi*						Summer					
	25 DAS			At harvest			25 DAS			At harvest		
	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	3.44	3.20	3.32	27.98	21.43	24.52	3.13	2.80	2.97	25.97	20.64	23.31
T_2 : Vermicompost (100%)	2.37	2.61	2.48	22.83	15.47	19.15	2.34	2.32	2.33	21.48	13.67	17.58
T_3 : FYM (100%)	2.05	2.16	2.12	10.42	13.07	11.75	2.17	2.18	2.17	9.69	11.11	10.40
T_4 : Poultry manure (100%)	2.64	2.62	2.63	24.23	15.69	19.96	2.46	2.35	2.41	21.94	14.13	18.04
T_5 : Bhumilabha (100%)	2.34	2.49	2.41	18.04	15.20	16.62	2.21	2.29	2.25	16.35	13.50	14.93
T_6 : Vermicompost (50%) + FYM (50%)	3.13	2.73	2.93	23.17	17.81	20.86	2.94	2.36	2.65	23.44	17.86	20.65
T_7 : FYM (50%) + Poultry manure (50%)	3.37	2.85	3.11	27.90	21.07	24.30	3.09	2.39	2.74	23.85	18.56	21.20
T_8 : Poultry manure (50%) + Vermicompost (50%)	3.52	3.22	3.37	34.31	23.15	28.73	3.15	2.88	3.02	26.71	21.44	24.08
Mean	**2.86**	**2.74**	**2.81**	**23.61**	**17.86**	**20.74**	**2.69**	**2.45**	**2.57**	**21.18**	**16.36**	**18.77**

Factors	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%	SEm±	CD at 5%
Variety	0.03	0.09	0.14	0.43	0.03	0.09	0.22	0.67
Treatments	0.06	0.19	0.29	0.87	0.06	0.19	0.45	1.35
T x V	0.09	NS	0.41	1.23	0.09	NS	0.64	1.91

V_1 – Japanese white V_2 – Pusa chetki
NS – Non-significant DAS – Days after sowing

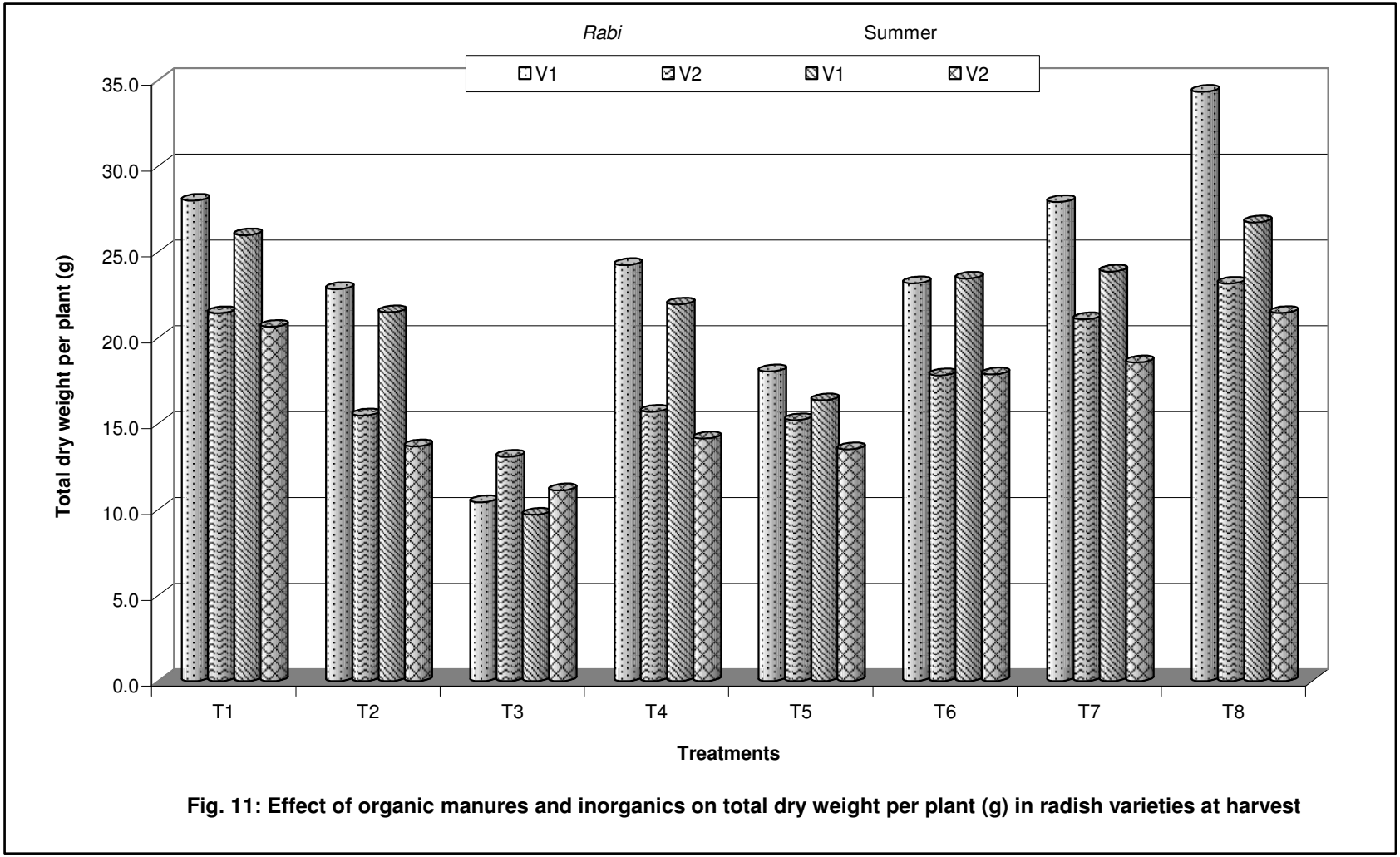


Fig. 11: Effect of organic manures and inorganics on total dry weight per plant (g) in radish varieties at harvest

Fig. 11: Effect of organic manures and inorganics on total dry weight per plant (g) in radish varieties at harvest

Table 11: Effect of organic manures and inorganics on yield (t/ha) in radish varieties

Treatments	*Rabi*			Summer		
	V_1	V_2	Mean	V_1	V_2	Mean
T_1 : RDF (100%)	30.13	35.47	32.80	27.13	32.91	30.02
T_2 : Vermicompost (100%)	24.38	24.79	24.59	21.76	25.18	23.47
T_3 : FYM (100%)	21.22	23.11	22.17	19.77	21.27	20.63
T_4 : Poultry manure (100%)	25.22	27.76	26.49	22.86	25.45	24.16
T_5 : Bhumilabha (100%)	22.26	24.59	23.43	19.98	23.29	21.53
T_6 : Vermicompost (50%) + FYM (50%)	27.58	31.63	29.61	26.48	27.60	27.04
T_7 : FYM (50%) + Poultry manure (50%)	28.15	32.61	30.38	26.67	27.77	27.80
T_8 : Poultry manure (50%) + Vermicompost (50%)	30.23	35.82	33.02	27.82	33.26	30.54
Mean	**26.15**	**29.47**	**27.81**	**24.06**	**27.09**	**25.58**

Factors	SEm±	CD at 5%	SEm±	CD at 5%
Variety	0.16	0.47	0.23	0.69
Treatments	0.32	0.95	0.46	1.38
T x V	0.45	1.35	0.65	1.95

V_1 – Japanese white V_2 – Pusa chetki

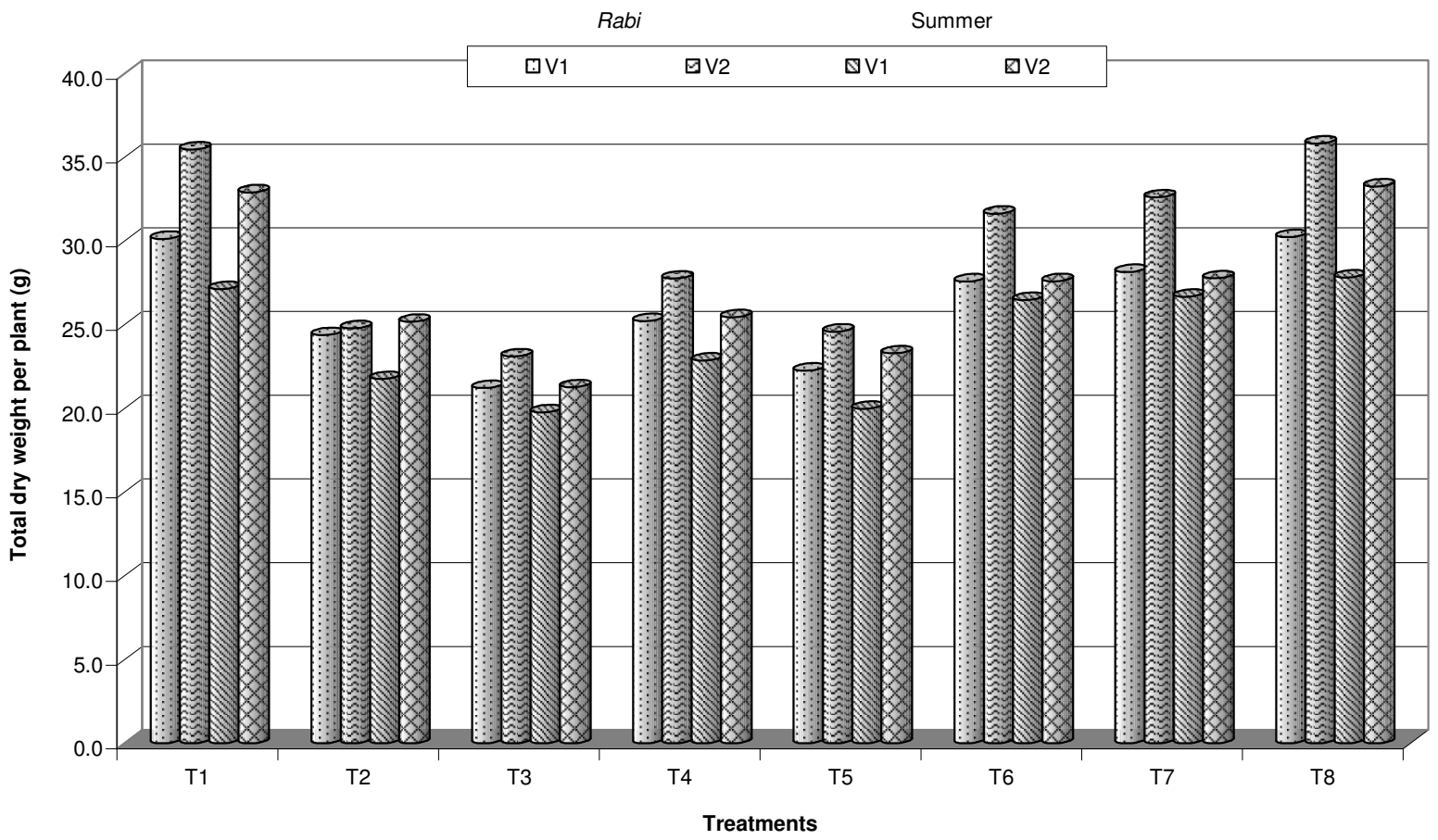


Fig. 12: Effect of organic manures and inorganics on yield (t/ha) in radish varieties

Fig. 12: Effect of organic manures and inorganics on yield (t/ha) in radish varieties

Total dry weight per plant (g)

The data on total dry weight per plant was significant between varieties tried in both the seasons at both stages of crop growth (Table 10). However at harvest, the variety Japanese white recorded highest total dry weight (23.61 and 21.18 g) during *rabi* and summer, respectively compared to Pusa chetki (17.86 and 16.36 g) during both *rabi* and summer, respectively.

The total dry weight per plant were found to be significant due to different sources of organics and their combinations in both seasons and at both the stages of crop growth. Among the treatments, application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded significantly highest total dry weight per plant (3.37 and 3.15 g at 25 DAS and 28.73 and 24.08 g at harvest) during *rabi* and summer season, which was on par with RDF (3.32 and 3.13 g at 25 DAS and 24.30 and 23.31 g at harvest) during *rabi* and summer season. Lowest was recorded at FYM 20 t per ha (100%) (2.12 and 2.17 g at 25 DAs and 11.75 and 10.40 g at harvest) during *rabi* and summer season.

The interaction between varieties and treatments were found to be non-significant at 25 DAS during both the seasons but at harvest, they were found to be significant. However, highest total dry weight per plant recorded with application of poultry manure @ 1.25 t per ha (50%) + vermicompost 1.75 t per ha (50%) (34.31 g and 26.71 g) in Japanese white (23.15 and 21.44 g) in Pusa chetki at harvest during both the seasons, which was on par with RDF except at harvest during *rabi* season (3.44 and 3.13 g at 25 DAS and 27.17 and 25.97 g at harvest) in Japanese white (3.20 and 2.80 cm at 25 DAS and 21.43 and 20.64 g at harvest) in Pusa chetki during both the seasons.

Yield per ha (t/ha)

The data on the effect of different organic manures, varieties and their interactions on the yield per ha are furnished in Table 11.

Among the different organics, significantly highest yield (33.02 t/ha) was recorded in application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%), which was followed by RDF (32.80 t/ha) and the lowest (22.17 t/ha) was in FYM @ 20 t per ha (100%). The differences amongst them being significant.

Significantly highest yield (29.47 t/ha) was recorded in Pusa chetki (V_2) followed by Japanese white (V_1) (26.15 t/ha). The differences amongst them being significant. The same trend followed by summer season also.

5. DISCUSSION

The use of organic manures in soil not only increase the fertility and moisture holding capacity in soil, but also play an important role in soil water conservation by their binding and aggregation properties. Moreover, they are helpful in balancing nutrient availability to the growing plants and boost of production and quality of the crops.

Health problems, quality consciousness and degradation of natural resources in the environment have thrown new challenges. Due to these burning problems, organic farming is gaining lot of importance towards achieving sustainability in crop production. Use of organic manures is inherent in Indian farming system. However, after the advent of chemical fertilizers, the importance of organic manuring has received least attention among the farming community, leading to increased toxicity in soil and far produce.

Several attempts have been made in part to increase the yield potential of root crops, but they are concerned with use of chemical fertilizers. Unfortunately, not only the productivity potential is low but the quality is also deteriorating. Hence, it is time to think not only of increasing the production potential but also to improve the quality by applying advancement in scientific production to meet the increasing demand and boost up the export earnings.

In any crop production programme, the main factor to be considered for better returns is to lower the cost of production without compromising on the yield of the crop. This can be accomplished through selection of a variety suitable for the region and by reducing application of inorganic fertilizers. In this direction an attempt was made to see the performance of radish varieties with organic manures under Dharwad condition. The results obtained are discussed hereunder.

5.1 Growth parameters

In this investigation, two varieties of radish viz., Japanese white and Pusa chetki were tried. Among the growth parameters studied, the variety Japanese white recorded significantly highest number of leaves and leaf area though recorded higher values, the differences were not statistically significant. The results are in conformity with the findings of Lingaiah *et al.* (1992) in respect of number of leaves and leaf area.

The results obtained in this study clearly indicate that radish respond well to organics and their combinations. In general, the treatment with poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) significantly greater number of leaves and leaf area followed by RDF during both seasons similar trend was observed. The increase in number of leaves may be due to the vital macro and micronutrient availability with vermicompost (Giraddi, 1993), Thannunathan *et al.* (1997) reported that application of vermicompost appears to be very effective amendment in onion. The increased number of leaves and leaf area in Bhunmyalaki (*Phyllanthus amarus* Schum) with the application of poultry manures and along with biofertilizers were recorded by Chezhiyan *et al.* (2005).

The interaction effect of variety and organic manures recorded significantly higher values for number of leaves and leaf area, though recorded higher values, the differences were not significant. The treatment with poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) involving the variety Japanese white recorded higher values for growth parameters followed by RDF application in same variety. The variety Japanese white respond well to different treatments when compared to Pusa chetki.

5.2 Yield parameters

Among the varieties, Japanese white recorded significantly higher fresh weight of leaves, dry weight of leaves, total fresh weight, total dry weight of whole plant and higher root length while Pusa chetki recorded significantly high fresh weight of root, high dry weight of root and root diameter. These results are in consonance with the findings of many workers (Pujari *et al.*, 1977; Rajgopal *et al.*, 1979; Lingaiah *et al.*, 1992 and Parthasarathy, 1998).

The treatment with poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded significantly greater values for higher fresh weight of leaves, dry weight of leaves, total dry weight and root length followed by RDF application. The results are in confirmity with the findings of Babalad (2005) in respect of dry weight and total dry matter recorded highest by applying poultry manure and other green manures in chilli. Hiranmai *et al.* (2003) in respect to fresh weight and dry weight of plants was higher in vermicompost and NPK in chilli. The increase in fresh weight of leaves, roots and whole plant may be due to higher level of nitrogen from inorganic and biofertilizers. The nitrogen will also be synthesized into amino acids which are built into complex proteins and help in promoting the luxurious growth of crop (Muthuswamy and Muthukrishnan, 1971). In carrot (Sendur *et al*., 1998) indicated that the application of RDF along with vermicompost and biofertilizers recorded higher growth and dry matter accumulation (Rao *et al*., 2001) in respect of root dry weight in groundnut indicated that application of poultry manure increased root dry weight in groundnut. Thanunathan *et al.* (1997) in respect to root length indicate that vermicompost coir pith increased root length of onion. This might be due to favourable physical conditions of soil and availability of plant nutrients in sufficient quantities.

Yadav *et al.* (2003) in respect with root volume or root diameter, the following workers indicated that application of vermicompost along with other organic manures, increase the root volume or width in chilli. Decrease in bulk density and increase in porosity and water holding capacity of the soil due to organic manures might have contributed in increasing the root volume of the plants. The increase in bulb diameter and length may be attributed to solubilization of plant nutrients by addition of vermicompost, FYM leading to increase uptake of NPK (Subbaiah *et al*., 1982). The results are in agreement with the findings of Renuka and Ravishankar (1998) and Giraddi (1993) in onion.

The results obtained in this study clearly indicate that radish varieties respond well to application of organic manures. In general, the treatment with poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) had significantly greater values for root diameter, root yield and dry matter production of roots. Leaves and whole plant involving variety Pusa chetki. However, the variety Japanese white recorded significantly higher values for root length, fresh weight and dry weight of leaves during both seasons, which is closely followed by RDF. The increase in root length and root diameter may be due to inherent characteristic of the variety. A variety may respond well to nitrogen fertilizers from various sources and different medias (Chauhan and Nanawathi, 1971).

5.3 Practical application of the results

Among the varieties tried in the experiment, the highest root yield (35.82 and 33.26 t/ha) was recorded in the variety Pusa chetki compared to Japanese white during both *rabi* and summer seasons. Among the organic manures treatment, treatment with poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded the highest economic yield during *rabi* and summer season, respectively.

Though, application of 100 per cent recommended dose of fertilizers without application of organic manures were on par with each other regarding enhancement of plant growth and yield of radish, application of organic manures was found to be best.

5.4 Future line of work

In continuation of the present investigation, the following future line of work are suggested for further research.

1. Effect of organic manures in combination with nitrogenous fertilizer on the quality of radish.

2. There is an urgent need to screen large number of organics, green manures, biofertiliers and other locally available organics on different radish genotypes which have profound influence on yield and quality.

3. It is necessary to identify suitable organics and biofertilizers for improving physiological and biochemical parameters in radish.
4. There is a need for different radish varieties for the suitability under organic production.

6. SUMMARY AND CONCLUSIONS

A field experiment was conducted at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *rabi* and summer season of 2006-07 on growth and yield of radish. The experiment consisted of treatments and two varieties (Japanese white and Pusa chetki) laid out in factorial randomized complete block design with three replications. The salient findings of the investigation are summarized hereunder.

1. The varieties differed significantly in the number of leaves per plant at 25 DAS and harvest. Japanese white (V1) recorded highest number of leaves (3.48 and 3.18) compared to Pusa chetki (V2) (3.26 and 2.88) during *rabi* and summer season. Among the interaction application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded highest number of leaves (3.83 and 3.52) per plant at harvest during *rabi* and summer season, respectively.

2. The leaf area per plant at 25 DAS and at harvest was significantly increased. Significantly higher leaf area per plant (331.50 and 33.08 cm^2) at harvest during *rabi* and summer season, respectively. The varieties differed significantly in leaf area. Japanese white (V1) recorded highest leaf area per plant (308.93 and 339.46 cm^2) during both seasons. In the interaction effect application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) recorded highest leaf area (380.00 and 413.95 cm^2) at harvest during *rabi* and summer season, respectively.

3. Fresh weight of leaves per plant was significantly influenced by organics and varieties. Highest fresh weight of leaves (86.32 g) was recorded in application with poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) in variety Japanese white at harvest during *rabi* season.

4. Fresh weight of root per plant was significantly influenced by organic levels and varieties at harvest. Highest fresh weight of roots (88.42 and 81.27 g) was recorded in poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) with Pusa chetki during *rabi* and summer season, respectively.

5. Dry weight of leaves and roots per plant was significantly influenced by organic levels at harvest. Highest dry weight of leaves per plant (13.33 and 11.80 g) was recorded in poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) with Japanese white (V1) during *rabi* and summer season, respectively. Highest dry weight of root (14.75 and 11.03 g) was recorded in poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) with Pusa chetki (V2) during *rabi* and summer season, respectively.

6. Total fresh weight and total dry weight was significantly influenced by organic levels and varieties at harvest. Highest total fresh weight of plant (164.85 and 91.85 g) was in poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) with Japanese white during *rabi* and summer season, respectively. Highest total dry weight per plant (23.61 and 21.18 g) in Japanese white with same treatments during *rabi* and summer season, respectively.

7. Root length and root diameter significantly influenced by organics and varieties at harvest. Highest root length (16.13 and 13.89 cm) was recorded with poultry manure @ 1.25 t per ha (50%) + vermcompost @ 1.75 t per ha (50%) in Japanesw white. Highest root diameter (2.27 and 1.85 cm) was recorded with similar treatment in Pusa chetki during *rabi* and summer season, respectively.

8. The yield was differed significantly highest yield was recorded with application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) (33.02 and 30.54 t/ha) during *rabi* and summer season and in varieties Pusa chetki (V2) recorded the highest yield (35.82 and 33.26 t/ha) during *rabi* and summer season, respectively.

Conclusions

Based on the above results, it is concluded that application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) followed by RDF was found more beneficial and significantly improved morpho-physiological trials, growth parameters, yield and yield components in radish. However, the variety Pusa chetki was found to be best, suitable for both *rabi* and summer season when concern to yield and yield components.

REFERENCES

Abbey, L., 2000, Effect of poultry manure and post-production application of fungicide on the shelf life of onion cv. Bawku Red. *Crop Res*., Hissar, **20**(1) : 87-92.

Anonymous, 1995, *Statistical Data on Horticultural Crops in Karnataka State*, Govt. of Karnataka, Department of Horticulture, Lalbaugh, Bangalore – 560 004, p. 13.

Arora, P. N., 1971, Effect of nitrogen, potash and seed size on radish. *Ind. J. Agron*., **16**(4) : 526-527.

Babalad, H. B., 2005, *Network Project on Organic Farming – Annual Report 2004-05*, Adhoc Project, PDCSR.

Bhaktavathsalam, R. and Geetha, T., 2004, Macronutrient analysis of vermicompost and their effects on the growth of radish plant. *Environ. and Ecol.,* **22**(4) : 941-947.

Bhat, K. L., 1996, Effect of different levels of nitrogen and phosphorus on yield of different cultivars of radish. *Crop Res*., **11**(2) : 204-206.

Bhuma, M., 2001, Studies on the impact of humic acid on sustenance of soil fertility and productivity of greengram (VBNGG-2). *M. Sc. (Agri.) Thesis*, Tamil Nadu Agric. Univ., Coimbatore (India).

Bijaysingh, U., Yadvindersingh, Sadana, S. and Meelu, O. P., 1988, Effect of green manure, wheat straw and organic manure on DTPA extractable Fe, Mn, Zn and Cu in a calcareous sandy loam soil at field capacity and under water logged conditions. *J. Ind. Soc. of Soil Sci*., **40**(1) : 114-118.

Chandramohan, S., 2002, Organic farming in cotton + blackgram intercropping system. *M. Sc. (Agri.) Thesis*, Tamil Nadu Agric. Univ., Coimbatore (India).

Chatterjee, B. N., Singh, K. I., Pal, A. and Mait, S., 1979, Organic manure as a substitute for chemical fertilizers for high yielding rice varieties. *Ind. J. Agric. Sci.,* **49**(3) : 188-192.

Chauhan, K. S. and Nanawathi, N. K., 1971, Effect of nitrogen, phosphorus and potassium on yield of radish. *Ind. J. Agron*., **16**(1) : 138-140.

Chavan, P. J., Syed, I., Rudraksha, G. B., Malewar, G. V. and Baig, M. I., 1997, Effect of various nitrogen levels through FYM and urea on yield, uptake of nutrients and ascorbic acid content in choilli (*Capsicum annuum* L.). *J. Indian Soc. Soil Sci*., **4**(4) : 833-835.

Chezhiyan, N., Saraswathy, S. and Vasumathi, 2003, Studies on organic manure and biofertilizers on plant density on growth, yield and alkaloid content of bhumyamalaki (*Phyllarthus amarus* Schum and Thonn). *South Indian Hort*., **51** : 96-101.

Choudhary, B. R. and Sirohi, P. S., 1975, Pusa chetki, an early maturing profitable radish. *Indian Hort*., **20**(3) : 15-16.

Choudhary, B. R., Fageria, M. S. and Dhaka, R. S., 2002, Role of growth hormones in chillies – A review. *Agric. Rev*., **23**(2) : 145-148.

Coogan, R. C., Wills, R. B. H. and Nguven, V. Q., 2001, Pungency levels of white radish (*Raphanus sativus* L.) growth in different seasons in Australia. *Food Chem.,* **72**(3) : 1-3.

Costellanos, S. J. Z. and Pratt, P. F., 1981, Mineralization of manure, nitrogen correlation with laboratory indices. *Soil Science Society of America*, **45** : 254-357.

Damke, M. M., Kawarkhe, V. J. and Patil, C. V., 1988, Effect of phosphorus and potassium on growth and yield of chilli. *Punjab Agric. Univ. J. Res.*, **12** : 110-114.

Deotale, A. B., Belorkar, P. V., Badvaik, N. G., Patil, S. R. and Rathod, J. R., 1994, Performance of some radish (*Raphanus sativus* L.) cultivars under Nagpur condition. *J. Soil and Crops*, **4**(2) : 120-121.

Dixit, J., Singh, R. P. and Gour, G. S., 1980, A note on varietal performance of radish crops (*Raphanus sativus* L.). *Haryana J. Hort. Sci.,* **9**(1-2) : 98-100.

Dwivedi, Y. C., naidu, A. K., Sengupta, S. K. and Sharma, R. S., 1995, Effect of inter and intra row spacing and levels of nitrogen and phosphorus on the yield of radish (*Raphanus sativus* L.). *Veg. Sci.*, **22**(1) : 13-15.

Espiritu, B. M., Palacappc, M. G., Camtera, J. J. L. and WIlavar, L., 1995, Studies on chemical and microbiological parameters for organic fertilizers as basis for quality standards : *Terminal Report* (November, 1994 to May, 1995), College Leguna, Philippines.

Geetha, K., Raju, A. S., Rao, P. S. and Reddy, M. S., 2000, Effect of individual and combined application of FYM and potash fertilizers on yield and potash nutrition of onion in Alfisol. *J. Res.,* ANGRAU, 29(4) : 34-39.

Gill, S. S., Gill, B. S., Brar, S. P. S. And Balwinder Singh, 1995, Nitrogen and phosphorus requirement of radish seed crop. *Seed Res.*, **23**(1) : 47-49.

Giraddi, R. A., 1993, Vermiculture and role in agriculture. In : *Proc. Course on the Officers of the State Department of Agriculture, Karnataka*, 18-20 October 1993 by the Department of Agricultural Microbiology, Univ. Agric. Sci. Dharwad, pp. 50-54.

Govindaswamy, R., Chochran, M. J., Miller, D. M. and Norman, R. J., 1994, Economics of trade between urea, nitrogen and poultry litter for rice production. *J. Agric. and Appl. Econ.*, **26**(2) : 552-564.

Grewal, J. S. and Trehan, S. P., 1984, Comparative efficiency of phosphorus, potassium and farmyard manure and their combinations for potato in acidic hill soil. *J. Indian. Soc. Soil Sci.*, **32** : 438-486.

Gupta, R. P., Sharma, V. P., Singh, D. K. and Srivastava, K. J., 1999, Effect of organic manures and inorganic fertilizers on growth, yield and quality of onion variety Agrifound Dark Red. *News lett. Nation. Hort. Res. and Dev. Found.*, **19**(2/3) : 7-11.

Haq, F. and Khan, M. S., 1972, Effect of different doses of nitrogen in the form of ammonium sulphate and phosphorus in superphosphate on the yield of fresh rot and seed yield of radish (Japanese white). *J. Agric. Res.*, Pakistan, **10**(4) : 285-288.

Hayworth, F., Cleawer, T. J. and Bran, J. M., 1966, The effect of different manurial treatments on the yield and mineral composition of early potato. *J. Hort. Sci.*, **41**(3) : 225-241.

Hiranmai Yadav and Vijayakumari, B., 2003, Influence of vermicompost with organic and inorganic manures on biometric and yield parameters of chilli (*Capsicum annuum* L. var. Plri). *Crop Res.,* **25**(2) : 236-243.

Jadhao, B. J., Kulwal, L. V. and Mahakal, K. G., 1999, Effect of nitrogen, phosphorus and potassium on growth and seed yield of radish (*Raphanus sativus* L.). *Vegetable Sci.*, **26**(1) : 95-96.

Jaiswal, J. P., Subedi, P. P. and Gurung, H. M., 1996, Fertilizer trials on radish and mulching trial on carrot at outreach research sites for off-season production. *Working Paper*, Lumle Regional Agricultural Research Centre, 1996 (96/13), p. 24.

Joshi, P. C. and Patil, N. S., 1992, Note on effect of plant density, nitrogen and phosphorus on the yield of radish. *Indian J. Hort.*, **49**(3) : 265-266.

Kale, R. N., Bano, K. and Satyavati, G. P., 1991, Influence of vermicompost application on growth and yield of cereals, vegetables and ornamental plants. *Final Rep. of KSCST Project N 67-04/vermin/34B,* p. 3478.

Kropisz, A., 1992, Influence of fertilization wit compost on yield of vegetables and their content of mineral elements. *Ann. Worsaw Agric. Univ.*, **16** : 9-13.

Kumar, J. C., Sooch, B. S. And Kharuna, D. S., 1995, Evaluation of radish cultivars for yield and its parameters during the spring season. *The Punjab Veg. Grower*, **30** : 62-63.

Lee, S. K. and Leong, P. C., 1981, Plant density and fertilizer dose on the Chinese radish (*Raphanus sativus* L.). *Singapore J. Primary Industries*, **9**(2) : 63-73.

Lingaiah, H. B., Uthaiah, B. C., Gowda, N. A. J. and Herle, P. S., 1992, Evaluation of radish cultivars in the coastal region of Karnatakla. *J. Agric. Sci.*, **5**(2) : 132-134.

Li-Xianttong, He-Fuchun, Li-Changhaln and Yuan-Hongxin, 2005, A new radish cultivar – Quifeng 2. *Acta Horticulture-Sinica*, **32**(6) : 1166.

Luxxati, A., Bressy, G. and Campanello, N. S., 1975, Influence of organic manures on carrot. *Annali Fac. Sci. Agr. Univ. Torino*, **10** : 199-218.

Madhu, M., Seshachalam, N., Nalawadmath, S. K., Nimje, P. M., 1997, Effect of organic and inorganic fertilizers on yield of crops and physico-chemical properties of soil in high hills of Nilgiris (India). *Indian J. Soil Conservation*, **25**(3) : 241-245.

Majkowska Gadomska, J. and Wierzbicka, B., 2005, Effect of growing cycle on the yield and nutritive value of radish roots. *Sodininkyste-ir-Darzininkyste*, **24**(3) : 221-226.

Mishra, H. P., 1987, Effect of NPK on growth, seed yield and quality of radish cv. Pusa Reshmi grown in the calcareous soils of North Bihar. *Indian J. Horti.*, **47** : 69-73.

Mol, C. and Stolk, J. H., 1979, Radish cultivars for spring culture. *Groenten-en-Fruit*, **34**(35) : 36-37.

Muthuswamy, S. and Muthukrishnan, C. R., 1971, Some growth response of radish (*Raphanus sativus* L.) to different nutrients. *South Indian Hort.*, **19** : 9-16.

Nautiyal, M. C., Prasad, A. and Lal, H., 1977, Studies on varietal performance of radish. *Plant Sci.,* **6** : 106-107.

Panse, V. G. and Sukhatme, P. U., 1978, *Statistical Methods for Agricultural Workers*, Indian Council of Agriculture Research, New Delhi.

Parthasarathi, 1998, Response of radish (*Raphanus sativus* L.) varieties to varying levels of fertility. M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Bangalore (India).

Patil, M. P., 1995, Integrated nutrient management in commercial vegetables. *M. Sc. (Agri.) Thesis*, Uni. Agric. Sci. Darwad (India).

Pimpini, F., Giardini, L., Borin, M., Gianquinto, G., 1992, Effect of poultry manure and mineral fertilizers on the quality of crops. *J. Agric. Sci.*, **118**(2) : 215-221.

Pujari, M. M., Jain, B. P. and Mishra, G. M., 1977, Investigations on morphological features and yield potential of promising radish (*Raphanus sativus* L.) cultivars. *Haryana J. Hort. Sci.*, **6**(1-2) : 85-89.

Rao, S. S. and Shaktawat, M. S., 2001, Effect of organic manure, phosphorus and gypsum on growth, yield and quality of groundnut (*Arachis hypogaea* L.). *Indian J. Pl. Physiol.*, **6**(3) : 306-311.

Reddy, K. C. and Reddy, K. M., 2005, Differential levels of vermicompost and nitrogen on growth and yield in onion (*Allium cepa* L.) – radish (*Paphanus sativus* L.) cropping system. *J. Res.,* ANGRAU, **33**(1) : 11-17.

Renuka, B. and Ravishankar, C., 2001, Effect of organic manures on growth and yield of tomato. *South Indian Hort*., **49** : 216-219.

Rojagopal, A. P., Rengaswamy, P. and Ashok Mehta, V., 1979, Varietal evaluation in radish. *South Indian Hort*., **27** : 75-78.

Roy, R. N. and Seth, J., 1970, Comparative efficacy of soil and foliar application of nitrogen, phosphorus and potassium with regard to growth and yield of radish. *Indian J. Agron*., **15**(3) : 236-238.

Rumpel, J., 1998, Effect of long-term organic, mineral and combined organic mineral fertilization on yield of onion (*Allium cepa* L.) grown from seeds. *Biuletyn Warzywniczy*, **48** : 5-15.

Sendur, K. S., Natarajan, S. and Thamburaj, S., 1998, Effect of organics and inorganic fertilizers on growth, yield and quality of tomato. *South Indian Hortic*., **46**(3-4) : 203-205.

Shafeek, M. R., Faten, S. A. and Aisha, H. A., 2003, Effect of organic manure and sulphur application on the productivity of Japanese radish plant. *Ann. Agric. Sci., Cario*, **48**(2) : 717-727.

Shanmugasundaram, R. and Savithri, P., 2004, Effect of nitrogen levels organic and amendments on nitrogen nutrition of carrot. *Agric. Sci. Digest*, **24** : 5-8.

Sharma, A. K., 2000, Effect of nitrogen and phosphorus and seed yield in radish (*Raphanus sativus* L.). *Agric. Sci. Digest*, **20** : 46-49.

Sharma, A. R. and Mitra, B. N., 1989, Direct and residual effect of organic materials and phosphorus fertilizers in rice-based cropping system. *Indian J. Agric*., **36** : 299-303.

Sharma, R. C., Grewal, J. S. and Mukhtarsingh, 1979, The value of farmyard manure as a source of P and K in potato. *J. Ind. Soc. Soil Sci*., **27**(2) : 161-166.

Sharma, R. C., Sharma, A.K. and Sharma, H. C., 1980, Effect of farmyard manure on distribution of photosynthates and efficiency of nitrogen utilization by potato. *J. Ind. Potato Assoc*., **7** (3): 125-139.

Sharma, S. K. and Kanaujia, S. P., 1992, Influence of transplanting dates of stickling and nitrogen levels on seed production of radish (*Raphanus sativus* L.). *Seed Res*., **20** : 92-95.

Sharma, V. K., Chandel, K. S., Kalia, P. and Pathania, N. K., 2002, Performance of different cultivars of radish (*Raphanus sativus* L.) under the midhill conditions of Himachal Pradesh. *Himachal J. Agric. Res*., **28**(1/2) : 26-29.

Shashidhara, G. B., 2000, Integrated nutrient management for chilli (*Capsicum annuum* L.) in Alfisols of Northern Transitional Zone of Karnataka. *M. Sc. (Agri.) Thesis*, Uni. Agric. Sci. Dharwad (India).

Shridhar, 1998, Evaluation of radish cultivars in South Andaman. *Prog. Horti*., **30**(3/4) : 217-220.

Singh, A. P., Singh, M. K., Singh, J. P. and Singh, S. B., 1990, Effect of nitrogen and spacing on seed production of radish. *Veg. Sci*., **17** : 210-212.

Sirohi, P. S., Sharma, S. C. and Choudary, B., 1992, One more to tropical group of radish varieties “Pusa Desi”. *Indian J. Hort*., **36**(4) : 34-35.

Sittirungsun, T., Dohi, H., Ueno, R., Shiga, Y., Nakamura, R., Horia, H. And Kamada, K., 2001, Influence of farmyard manure on the yield and quality in pac-choi and Japanese radish. *Bull. of Hokkaido Prefectural Agric. Exp. Stat.,* **80** : 11-20.

Sriramachandrasekharan, M. V., Ramanathan, G. and Ravichandran, M., 1996, Effect of organic manures on the availability of nutrients in rice rhizosphere soil. *Oryza*, **33** : 126-131.

Srivastava, O. P., 1998, Integrated nutrient management for sustained fertility of soil. *Ind. J. Agric. Chem*., **31**(1) : 1-12.

Stockdale, E. A., Lampkin, N. H., Hovi, M., Keatinge, R., Lemnartsson, F. K. M., Maconald, D. W., Padel, S., Tattersali, F. H., Walfe, M. S. and Watson, C. A., 2001, Agronomic and environmental implications of organic farming systems. *Adv. Agro*., **70** : 260-306.

Subbaiah, B. B. and Asija, G. L., 1956, A rapid producer for the estimation of available nitrogen in soils. *Current Sci*., **25** : 259-260.

Sundarraj, N., Nagaraju, S., Venkataramu, S. and Jaganath, M. K., 1972, Design and analysis of field experiment, Univ. Agric. Sci. Bangalore.

Sundharaiya, K., Ponnuswamy, V. and Vemurgan, S., 2003, Effect of FYM, sulphur and different nitrogen sources on herbage and seed yield of sweet basil. *South Indian Hort*., **51** : 93-95.

Supriya Langthasa and Barah, P., 2000, Varietal performance of radish under hill conditions of Assam. *Indian J. of Hill Farm.,* **13**(1/2) : 85-86.

Suresh, V. V., 2000, Effect of nitrogen and potassium on yield and quality parameters of Byadgi chilli (*Capsicum annuum* L.). *M. Sc. (Agri.) Thesis*, Uni. Agric. Sci. Dharwad (India).

Surlekov, P. and Pankov, V., 1989, The effect of fertilization on capsicum productivity and soil agro – chemical and biological properties in monoculture. *Pochvozanie-i-Agrokhimiya*, **24**: 17– 23.

Sweeten, J. M., 1980, Waste treatment : state of the art livestock waste : A renewable. In : *Proc. of 4th Int. Symp. on Livestock Wastes,* ASAE, St. Joseph, M. J., pp. 334-338.

Thanunathan, K., Natarajan, S., Senthilkumar, R. and Arulmurugan, K., 1997, Effect of different sources of organic amendments on growth and yield of onion in mine spoil. *Madras Agric. J*., **84**(7): 382-384.

Tomar, V. K., Bhatnagar, R. K. and Palta, R. K., 1998, Effect of vermicompost on production of brinjal and carrot. *Bharatiya Krishi Anusandhan Patrika*, **13**(3-4) : 153-156.

Vadiraj, B. A., Krishnakumar, M., Jayakumaran and Naidu, R., 1992, Studies on vermicompost and its effect on cardamom nursery seedlings. In : *Proc. of IV Nation. Symp. on Soil Biol. and Ecol.,* pp. 53-57.

Vadiraj, B. A., Siddagangaiah and Narayana, P., 1998, Effect of vermicompost on the growth and yield of turmeric. *South Indian Hort*., **46**(3-4) : 176-179.

Vinay Singh and Singh, R. K., 1995, Response of onion (Allium cepa L.) to N, P, Zn and FYM. *Ann. of Agric. Res*., **16**(1) : 79-81.

Vong, Q., Nguyen, Rod, C, Coogan, R. B. H. and Wills, 2001, Effect of planting time on growth and quality of Japanese radish (*Raphanus sativus* L.) grown on the central coast of New South Wales Australia. *Food. Chem*., **72**(1) : 1-3.

Warade, S. D., Desale, S. B. and Shinde, K. G., 1996, Effect of organic, inorganic and biofertilizers on yield of onion bulbs cv. B 780. *J. Maharashtra Agric. Univ.*, **20**(3) : 467-468.

Yadav, H. and Vijayakumari, B., 2003, Influence of vermicompost with organic and inorganic manures on biometric and yield parameters of chilli (*Capsicum annuum* L.). *Crop Res.*, Hissar, **25**(2) : 236-243.

Yanwang, K., Yamamoto and Yakushido, K., 2002, Changes in nitrate N content in different soil layers after the application of livestock waste compost pellets in a sweet corn field. *Soil Sci. Pl. Nuti.,* **48**(2) : 165-170.

Yousef, M. and Shafi, M., 1969, Evaluation of some quick maturing exotic varieties of radish (*Raphanus sativus* L.). *West Pakistan J. Agric. Res.*, **7**(4) : 83-93.

Zhou-Dongmei, Hao-Xiuzhen, Wang-Yuhun, Dong-Yuan Hua and Cang-Long, 2005, Copper and Zn uptake by radish and pakchoi as affected by application of livestock and poultry manures. *Chamosphere*, **59**(2) : 167-175.

Appendix I. Physical and chemical properties of the soil from the experimental site

Particular	Value obtained	Method adopted
A. physical properties		
Clay (%)	32.70	International pipette method (Piper, 1966)
Silt (%)	9.50	,,
Fine sand (%)	31.24	,,
Coarse sand (%)	26.56	,,
B.Chemical properties		
Total N (kg/ha)	264.52	Modified Kjeldahl's method(Jackson, 1967)
Available P_2O_5(kg/ha)	16.50	Olsen' method (Jackson, 1967)
Available K_2O(kg/ha)	245.35	Flame photometer (Jackson, 1967)
Soil pH	6.70	pH meter (Jackson, 1967)

Appendix II: Monthly meteorological data for the experimental year (2006-07) and the mean of past 56 years (1950-2005) of Main Agricultural Research Station, University of Agricultural Sciences, Dharwad

Month	Rainfall (mm)		Temperature (^{0}C)				Relative humidity (%)	
	2006-07	1950-2005	Mean maximum		Mean minimum		2006-07	1950-2005
			2006-07	1950-2005	2006-07	1950-2005		
April	1.5	49.34	37.1	37.36	20.3	19.85	49	76
May	166.8	79.53	35.1	33.71	20.9	21.40	61	66
June	212.4	110.59	29.5	28.87	20.6	21.49	78	81
July	176.1	150.86	26.6	29.13	20.4	21.01	87	87
August	115.2	96.85	26.3	27.00	19.6	20.30	85	86
September	91.4	103.85	29.2	28.56	19.2	19.91	77	82
October	38.6	129.42	30.0	30.08	19.1	18.42	67	76
November	55.4	32.21	29.2	30.17	18.1	15.86	70	68
December	-	5.41	29.1	29.38	12.8	12.52	61	63
January	-	0.07	30.4	29.61	14.0	14.63	52	63
February	-	1.11	31.9	32.53	15.7	16.43	62	51
March	12.8	0.23	35.3	36.43	19.7	19.56	45	56
Total	**870.2**	**759.47**						

Appendix III: Prices of inputs and outputs

Sl. No.	Particulars	Price (Rs.)
I	**INPUTS**	
1.	**Chemical fertilizers**	
a.	Urea	5.00/kg
b.	DAP / SSP	8.95/kg
c.	MOP	4.30/kg
2.	**Organic manures**	
a.	Farmyard manure	250.00/t
b.	Vermicompost	3000.00/t
c.	Poultry manure	1800.00/ t
d.	Bhumilabha	4000.00/t
3.	**Plant protection measures**	
a.	Fenvalerate	500.00/lit
4.	**Wages**	
a.	Men	50.00/day
b.	Women	35.00/day
c.	Bullock pair	20.00/day
d.	Tractor	250.00/hr
5.	**Irrigation**	**20.00/hr**
II	**OUTPUT**	
	Radish roots	1500.00/tonne

Appendix IV: Cost of cultivation of radish crop during *rabi* season as influenced by organic manures and inorganics

Treatments	Total yield (t/ha)		Cost of cultivation (Rs./ha)		Gross income (Rs./ha)		Net income (Rs./ha)		Cost:benefit ratio	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1 : RDF (100%)	30.13	35.47	10144	10144	45195	53205	35051	43061	3.45	4.24
T_2 : Vermicompost (100%)	24.38	24.79	17900	17900	36570	37185	18670	19285	1.04	1.07
T_3 : FYM (100%)	21.22	23.11	13400	13400	31830	34665	18430	21265	1.37	1.58
T_4 : Poultry manure (100%)	25.22	27.76	12150	12150	378370	41640	25687	29490	2.11	2.42
T_5 : Bhumilabha (100%)	22.26	24.59	17720	17720	33390	36885	15970	19165	0.88	1.08
T_6 : Vermicompost (50%) + FYM (50%)	27.58	31.63	16150	16150	41370	47443	25220	31293	1.56	1.93
T_7 : FYM (50%) + Poultry manure (50%)	28.15	32.61	12775	12775	42225	48915	29450	36140	2.30	2.82
T_8 : Poultry manure (50%) + Vermicompost (50%)	30.23	35.82	15525	15525	45345	53730	29820	38205	1.92	2.46

V_1 – Japanese white V_2 – Pusa chetki

Appendix V: Cost of cultivation of radish crop during summer season as influenced by organic manures and inorganics

Treatments	Total yield (t/ha)		Cost of cultivation (Rs./ha)		Gross income (Rs./ha)		Net income (Rs./ha)		Cost:benefit ratio	
	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2	V_1	V_2
T_1 : RDF (100%)	27.13	32.91	10144	10144	40695	49365	30551	39221	3.01	3.86
T_2 : Vermicompost (100%)	21.76	25.18	17900	17900	32640	37770	14740	19870	0.82	1.11
T_3 : FYM (100%)	19.77	21.27	13400	13400	29655	31905	16255	18505	1.21	1.38
T_4 : Poultry manure (100%)	22.86	25.45	12150	12150	34290	36675	22140	24525	1.82	2.01
T_5 : Bhumilabha (100%)	19.98	23.29	17720	17720	29970	34935	12250	17215	0.70	0.98
T_6 : Vermicompost (50%) + FYM (50%)	26.48	27.60	16150	16150	39720	41400	23570	25250	1.45	1.56
T_7 : FYM (50%) + Poultry manure (50%)	26.67	27.77	12775	12775	40005	41655	27230	28880	2.13	2.26
T_8 : Poultry manure (50%) + Vermicompost (50%)	27.82	33.26	15525	15525	41730	49890	26205	34365	1.68	2.21

V_1 – Japanese white V_2 – Pusa chetki

Appendix VI: Contents in organic manures

Manures	Per cent			Parts per million (ppm)			
	Nitrogen	Phosphorus	Potassium	Copper	Iron	Manganese	Zinc
Farmyard manure	0.50	0.20	0.50	0.5	37.0	112.0	23.0
Vermicompost	1.10	0.80	1.00	0.9	41.0	144.0	126.0
Poultry manure	2.00	1.60	2.30	1.0	52.0	151.0	121.0
Bhumilabha	3.22	1.39	2.88				

ORGANIC STUDIES IN RADISH (*Raphanus sativus* L.) VARIETIES

DHANANJAYA 2007 Dr. SATISH S. PATIL
Chairman

ABSTRACT

A field experiment was conducted at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *rabi* and summer season of 2006-07 on growth and yield of radish. The experiment consisted of eight treatments and two varieties (Japanese white and Pusa chetki) laid out in factorial randomized complete block design with three replications.

The yield was differed significantly highest yield was recorded with application of poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) (33.02 and 30.54 t/ha) during *rabi* and summer season and in varieties Pusa chetki (V_2) recorded the highest yield (35.82 and 33.26 t/ha) during *rabi* and summer season, respectively.

Fresh weight of root per plant was significantly influenced by organic levels and varieties at harvest. Highest fresh weight of roots (88.42 and 81.27 g) was recorded in poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) with Pusa chetki during *rabi* and summer season, respectively.

Root length and root diameter significantly influenced by organics and varieties at harvest. Highest root length (16.13 and 13.89 cm) was recorded with poultry manure @ 1.25 t per ha (50%) + vermicompost @ 1.75 t per ha (50%) in Japanese white. Highest root diameter (2.27 and 1.85 cm) was recorded with similar treatments in Pusa chetki during *rabi* and summer season, respectively.