IMPACT OF INTEGRATED SOIL FERTILITY MANAGEMENT AND SOWING DATE ON GROWTH, YIELD AND DIGESTIVE ENZYMES IN RADISH

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خلاصہ

مطالعہ و تشخیص کے بعد یہ بات مشاہدہ میں آئی ہے کہ کامل وزرخیز مٹی کے اثرات مولی کی ایک خاص قسم (Early long white) میں دیکھا گیا ہے یہ تجربہ ربیع کے موسم میں 2020-21 میں پی اے آر سی/سارک ماڈل فارم پر کیا گیا۔ جس کا جائے وقوع 24.0 º سے 52.0 º شمالی طول اور 1467.0º طول البلد تھا۔ RCBD کے بیچ دو تاریخوں میں بوئے گئے یعنی پہلی اور پندرہ اکتوبر کی تاریخ میں تجرباتی مٹی کی فطرت وساخت موٹی اور میتلی تھی جس کی فطرت اساسی اور پی ایچ (9.74) اور نمکیاتی فطرت لیے ہوئے تھی۔ پہلے T1 کو 35 Kg کھاد میں NP100% اور NP T2,N 90 Kg P نامیاتی سیال کھاد مہیا کی گئی یہ بات مشاہدہ میں آئی کہ پندرہ اکتوبر کو بوئی ہوئی مولی کی پیداوار اور بڑھوتری زیادہ ہوئی اور اس کی نمایاں خصوصیات پودے کے قد و کاٹھ پودے کے پتوں اور پودے کے وزن میں نمایاں طور پر دیکھی گئی نیز اس کے علاوہ پودے کی جڑوں جڑوں کی موٹائی اور جڑوں کے وزن پر بھی اس کا اچھا اثر پڑا اس کے علاوہ ہضمی انزائم کی مقدار میں اضافہ کا سبب بھی بنا جس کی وجہ غیر نامیاتی کھاد NP تھی جو نامیاتی کھاد کے ساتھ استعمال کی گئی۔ نتیجہ یہ اخز ہوا کہ اس کھاد کے استعمال سے کیمیائی و فعلیاتی خصوصیات میں اضافہ ہوا بڑھوتری اور صحت سے وابستہ ہضمی خصوصیات کے حامل انزائم امائی لیز اور پروٹیز کی مقدار میں اضافہ ہوا مثبت ارتباط تمام انزائمز میں دیکھا گیا۔

Abstract

Study to assess the impact of integrated soil fertility management in Radish (*cv*. Early Long White) was conducted in Rabi Season 2020-21 at experimental field of Southern Zone Agricultural Research Center, Pakistan Agricultural Research Council University of Karachi (24.0 ^{o}N latitude and 67.0 ^{o}E longitude). Seed was sown with two sowing dates viz. 1st and 15th October. Soils of trial area were sandy in texture, alkaline in reaction (pH 9.74) and saline in nature with (EC dSm^{-1}>4.0). Treatment TI: 100% NP at 135Kg N; 90 Kg P, T2: NP: Organic liquid fertilizer (50:50 %) and T3: 100% organic liquid fertilizer (45ml) was applied accordingly. It was observed that radish sown on 15th October, growth and yield attributes viz: plant height (cm), leaves plant^{-1}, weight of leaves plant^{-1}, root length (cm), root girth (cm), root weight (g), plant biomass (g), and root yield (g) and digestive enzymes content shown to have significantly increased upon integration of inorganic fertilizer (NP) with organic liquid fertilizers. It is concluded that by improving soil physicochemical and biological properties, growth, yield, amylase and protease contents in radish may also be enhanced.
Key words: amylase, growth, integrated soil fertility, protease, radish, yield

Introduction

Radish (*Raphanussativus* L.) is grown upon an area of 25, 332 acres with yield of around 173806 tones (Jatoi *et al.*, 2011) in Pakistan. According to an estimated grower getting an average yield per hectare is 15.9 tons that is lesser when compared to other production catchments in developed countries. Major reason of this diminishing yield is improper utilization of agricultural practices and technology. Together with, nutritional imbalance during growing season also affects per unit yield of radish crop (Jilani *et al.*, 2010). As the percent organic matter content in soils of Pakistan is very low accompanied with intensive cropping exerted impact upon further depletion of essential nutrients (Ahmed *et al.*, 2004). Sustainable supply of nutrients depends upon additional source of nutrients. Chemical fertilizers application to enhance yield per unit of the area, is commonly applied for to obtain balanced nutrient supply during harvest season (Mishra and Dash, 2014). Owing to conventional practice of application of inorganic nutrient fertilizers, not only the input cost of grower is increased but the soil and water quality is deteriorated as well. Hence the approaches of other means to cater needs of plants during growing season, such as organic and integrated methodologies for sustainable supply of balanced nutrition, is gaining significance these days.

Integrated soil fertility management (ISFM) theme thus become popular as the combination of inorganic and organic fertilization to retain fertility and to enhance yield of cultivated field crops (Khalid *et al*., 2016). The theme is economically viable, comparatively cheap and contain potential to maintain soil fertility, productivity and sustainability. Farming community is getting good returns from its marketing due to improved quality particularly root vegetables such as radish. Radish is edible young tender and fusiform roots that is directly eaten as Salad. It is a rich source or of vitamin A, C and carrying medicinal value as several enzymes occurrence have strong catalytic impact on chemical reactions and properties (Azzopardi *et al*., 2016).

Enzymes are known as protein performing as catalyst in several biological processes and reactions without being utilized by their own. In almost all biochemical processes enzymes are vital component as a catalyst and can be denatured through different sources, hence are most active under mild conditions. Majority of enzymes show satisfactory performance at neutral pH at the body temperature. Enzymatic activity is very specific and correlated with the substrate and the class concerned substrate molecule. The specific response of the enzyme is due to active site within it that is complementary to the shape and polarity of the substrate as one type of substrate may fit-in only with the site. In higher plants significant contribution of enzymes as vital sources like an aid to diagnostic procedures in hospitals and laboratories across the globe is established (Guglielminetti *et al*., 1995). Amylase that is also termed as diastase is of physiological, commercial and historical significance in both plants and animals perform enzymatic starch hydrolysis, yielding monomeric carbohydrates and are found as malt extract converted into starch to sugars (Perata *et al*., 1992 and Sun *et al*., 1991) This is established that breakdown of starch in cereal seed is occurred due to α-amylase and not due to phosphorylases during the degradation of native starch granules (Beck and Ziegler, 1989). Complete hydrolysis of starch requires sufficient performance of α-amylase, β-amylase, a de-branching enzyme, and α-glycosidase (Peter and Stephanie, 1994). In this process carbon and the energy deposited within, breakdown of polymers into small as simi able sugars occur first before conversion into basic glucose. The enzymes proteases play vital role in plant metabolism and regulating progress and responsible of degradation of protein (Dilley, 1970). Major application of protease is of industrial and medicinal application (Beck and Ziegler, 1989). Several vital protease are isolated and characterized from microorganisms and the activity within some higher plants species is found as well (Garcia *et al.*, 1988)

Therefore, the present study was conducted to evaluate the impact of integrated use of chemical fertilizer (NP) along with liquid organic fertilizer upon growth, yield and some enzymatic activity in Radish.

Materials and Methods

The study of assessing impact of integrated soil fertility management in Radish (cv. Early Long White) was conducted in Rabi Season 2020-21 at experimental field of Southern Zone Agricultural Research Center, Pakistan Agricultural Research Council, University of Karachi (24.0 ^{o} N latitude and 67.0 ^{o} E longitude) Seed with two sowing dates (S1:1st October and S2: 15thOctober) was sown at 6 cm on both sides of the well-prepared ridges with 45cm width in a block measuring 90m^{2}on soils were sand in texture, alkaline in reaction (pH 9.74) and saline in nature with (EC dSm^{-1}>4.0) The treatment combination was applied in each trial plot at 135Kg Nha^{-1}; 90 Kg P ha^{-1} and organic liquid fertilizers at 5 L ha^{-1} viz: TI: 225grams NP (100% inorganic), T2: 112.5 NP (50% inorganic) + 22.5ml liquid fertilizer (50% Organic) and T3: 45 ml liquid fertilizer (100% Organic). Two split dozes of each treatment, first after 20 days and remaining after 65 days was applied. Ten (10) mature plants from each of trial plot were analyzed for growth and yield attributes viz: plant height (cm), leaves plant^{-1}, weight of leaves plant^{-1}, root length (cm), root girth (cm), root weight (g), plant biomass (g), and root yield (g). For Enzyme estimation, freshly uprooted radish samples were washed well followed by cutting into pieces and mashing with piston and mortar. The liquid extracted was filtered and with transparent soft cloth and further kept on centrifuge at 5500 RPM for 15 minutes to draw crude enzyme extract. After saturation at 30-50 percent through addition of Ammonium Sulpohate (NH_4SO_4) followed by gentle string the precipitate obtained was dissolved in distilled water and allowed to settle for 24 hours. In order to remove insoluble material and to obtain final crude enzyme solution, the precipitate was again centrifuged in a refrigerating equipment for 15 minutes at 5500 RPM. Enzyme amylase and the protease was investigated following method given by Bucheli. The collected data were subjected to statistical analysis of data was conducting obtain Comparison among treatments was derived in attributes by using software Statistica 8.1 ((Analytical Software, 2005).

Table-1: Correlation among parameters

Parameters	Plant height (cm)	Leaves Plant^{-1}	Leaves weight (g)	Root length (cm)	Root girth (g)	Plant biomass (g)	Root weight (g)	Root yield (tons ha^{-1})	Amylase content (unitml^{-1})	Protease content (unitml^{-1})
Plant height (cm)	1	.707**	.678**	.832**	.761**	.861**	.850**	..809**	.139	.161
Leaves plant^{-1}	.707	1	.751**	.870**	.947**	.861**	.877**	857**	.171	.103
Weight of leaves (g)	.678	.761**	1	.665**	.743**	.689**	.641**	.799**	.213	.019
Root length (cm)	.822	.870**	.665**	1	.856**	.787**	.838**	.730**	.641**	.485*
Root girth (g)	.761	.947**	.743**	.856**	1	.919**	.928**	.864**	.771**	.285
Plant biomass (g)	.861	.861**	.689**	.781**	.919**	1	.919**	.988**	.753**	.704*
Root weight (g)	.850	.887**	.644**	.808**	.929**	.988**	1	.947**	.761**	.644*
Root yield (tons ha^{-1})	.809	.807**	.799**	.730**	.864**	.988**	.947**	1	.675**	.533*
Amylase content (unitml^{-1})	.139	.171	.213	.641**	.771**	.753**	.761**	.675**	1	-0.1631
Protease content (unit ml^{-1})	.161	.103	.019	.599*	.285	.704*	.644*	.533*	-0.1631	1

** *correlation is significant at 0.01level (2-tailed)*

Result and discussion

Plant height (cm): Plant height is an indicator of vegetative growth directly influenced by field practices and management strategies. Influence of treatments; TI: 225grams NP (100% inorganic), T2: 112.5 NP (50% inorganic) + 22.5ml liquid fertilizer (50% Organic) and T3: 45 ml liquid fertilizer (100% Organic) and sowing dates (S1, S2) upon radish plant height is depicted in fig.1. It is revealed that upper surface plant height ranged from 53.9 – 64.0cm. Higher increase was recorded at S1 in both T1 and T3. This is derived that impact T2 (50% organic and 50% percent inorganic fertilizer) showed significant impact significant (p<0.05) on upper surface leaf height at planting dates S2 (15th October). Table-1 showed that plant height showed strong positive relationship (p<0.01) with leaves per plant, weight of leaves, root length, root girth, plant biomass, root weight and root yield of radish. The addition of organic fertilizer in combination to liquid fertilizer not only increase nutrients contents in soil but also mineralize these into available form through mobilization of microbial activity. Resultant, besides soil fertility and productivity is enhanced. The results are in agreement with those obtained by Kiran *et al*., (2016).

Leaves plant^{-1}: Fresh leaves growth is reflective of both vegetative and sound root growth that is dependent of fertilizer application and agronomic practices. Fig.2 reveled that count of leaves per plant ranged from 17.13 to 21.09. Increase in count was recorded at S2 in T1 and T3 whereas as compared to T1 and T3, T2 was found to be more effective in increasing no of leaves per plant. It was derived that vegetative growth and leaves in radish increased significantly (p<0.05) with the application of organic fertilizers along recommended inorganic doses at 50:50 ratio respectively, whereas difference in sowing dates (October 1st and 15th) shown non-significant (P>0.05) response. Table-1 showed that Leaves per plant showed strong positive relationship (p< 0.01) with plant height, weight of leaves, root length, root girth, plant biomass, root weight and root yield. Similar outcomes were as well obtained by Chapagain *et al*. (2010) and Kumar *et al*. (2017) who reported that an increase in number of leaves in radish was recorded under NPK along with organic manure fertilizer integration.

Leaf weightplant^{-1}(g): Leaf weight per plant is an indicator of judicious supply of plant nutrient and sound metabolic processes. Fig.3 showed that leaves weight per plant ranged from 95.74- 147.83g. Higher weight was recorded with S2 at all treatments (T1, T2, and T3). Statistical analysis showed that T2 was found to be significant (p<0.05) in increasing leaf weight per plant in Than T1 and T2. This was derived that application organic and inorganic at 50:50 ratio increased weight of fresh leaves plant benefiting plant growth as whole. Table-1 reflected strong positive relationship (p< 0.01) of weight of leaves with plant height, No. of leaves plant^{-1}, root length, root girth, plant biomass, root weight and root yield. Similar outcomes were found by Noor *et al*. (2007), Sharma *et al*. (2012) and Khalid *et al*. (2016) who reported that increase in leaves weight recorded was due to integration of organic and inorganic manures application.

Root length (cm): Length of plant roots and further distribution in branches are interactive processes in entire root development (Atkinson *et al*., 2014).Results in fig. 4 showed that increase in root length ranged from 31. 3 to 40.45cm. Higher root length was recorded with S2 at T1 and T3 where as at T2 same trend was recorded with S1. Magnitude of root length increase was derived at T2. This reflected that sowing of radish on 1st October along with application of organic and inorganic fertilizer at 50:50 ratio of recommendation exerted significant ($p<0.05$) impact on root length. Table-1 showed that root length showed strong positive relationship ($p<0.01$) with plant height, No. of leaves per plant, weight of leaves, root girth, plant biomass, root weight and root yield. Results are in agreement with Patel *et al*. (2016) who recorded significant increase in root length upon integration of inorganic fertilizers application in soils.

Root girth (cm): The changing attributes viz. elongation and branching build morphological variations of root lengths, numbers and girth diameters within rhyzo sphere (Gruber *et al*., 2013). In order to understand the root distribution system and architecture, root girth or root diameter is important trait of plant growth. Fig.5 showed that root girth of radish ranged from 7.61- 12.46cm. The girth was found higher at S2 in each treatment viz T1, T2 and T3 but magnitude of increase was recorded at T2. Statistical analysis showed that irrespective of sowing dates either on 1st or 15th October, organic and inorganic fertilizer combination at 50: 50 ratio significantly($p<0.05$) enhanced radish root girth. Table-1 revealed that root girth showed strong positive relationship ($p<0.01$) with plant height, No. of leaves per plant, weight of leaves, root length, plant biomass, root weight and root yield. Similar results were observed by Vithwel and Kanaujia (2013).

Plant biomass (g): Plant biomass is a parameter that is reflective of total crop yield directly influenced by attributes such as length, weight of leaves, root length, diameter and root weight plant per plant. Fig.6 showed that plant biomass ranged from 175.3-383.8g. Enhanced plant biomass of radish was recorded when seed was sown on 15th October (S2) in all treatments (T1, T2, and T3). Higher significant ($p<0.05$) increase in biomass was recorded when organic and inorganic fertilizer in combination at 50:50 are applied. Table-1 showed that plant biomass carried strong positive relationship ($p<0.01$) with plant height, No. of leaves per plant, weight of leaves, root length, root girth, root weight and root yield. Similar results were also obtained by Jaisankar (2018).

Root weight (g): The root is reflective of root growth and judicious supply of water nutrients and healthy plant growth.Fig.7 showed that root weight of radish ranged from 81.53 -243.9g. Compared to SI, increasing trend in weight of root was recorded in S2 at all treatments (T1,T2 and T3). The influence of application of organic and inorganic fertilizer with 50: 50 ratio respectively enhances root weight significantly *($p<0.05$)* when radish was sown on 15th October. Table-1 showed that root weight carried strong positive relationship ($p<0.01$) with plant height, No. of leaves per plant, weight of leaves, root length, root girth, plant biomass and root yield. Similar results were are obtained by Kamalakannan and Manivannan (2002).

Root yield (tons ha^{-1}): Yield of radish may be enhanced due to increase in root density and length in deep soil layers and upper surface vegetative growth. Radish yield depicted in Fig.8 showed that it ranged from 6.11 - 12.51 tons ha^{-1}. In all treatments (T1, T2 and T3) increased in yield was recorded with S2. This increase in yield with S2 upon SI was found to be significant ($p<0.05$) at each treatment. It was derived that addition of organic fertilizer along with inorganic at 50:50 ration enhanced radish yield which was sown on October 15th. Table-1 showed that root yield carried strong positive relationship *($p<0.01$)* other attribute such as plant height, No. of leaves per plant, weight of leaves, root length, root girth, plant biomass and root weight. Similar increase in root yield at integrated soil fertility management was recorded by Panwar *et al*., (2001).

Amylase (unitml^{-1}): Amylase that initially was termed as *distaste* is a constituent abundantly occur in radish as digestive enzyme have play significant role to hydrolyze the glycosidic bonds in starch molecules, converting complex carbohydrates into simple sugars (Azzopardi *et al*., 2016). Fig.9 indicated that overall count of alpha amylase irrespective of treatments (T1,T2 and T3) and sowing dates (S1 and S2) ranged between 1.64 to 2.63 unitml^{-1} in radish. Significant increase ($p<0.05$) in the count upon T2 was recorded whereas S1 and S2 remained insignificant ($p>0.05$) in all treatments. The trend of increasing count revealed that application of integration of fertilizers viz. organic and inorganic at 50:50 enhanced the amylase count at both sowing dates (1st and 15th October). Table-1 showed that amylase count carried strong positive relationship *($p<0.01$)* with other attribute such as root length, root girth, plant biomass and root weight. Similar results were also found by Perata *et al*. (1992).

Protease (unitml^{-1}): Protease is another enzyme that play a significant role in digestion of food through primary breakdown of proteins and polypeptides from animals and plants and for proline dipeptides from gluten and casein. Protease also termed as proteinase are catalytic enzyme hydrolyzing peptide bonds of proteins.

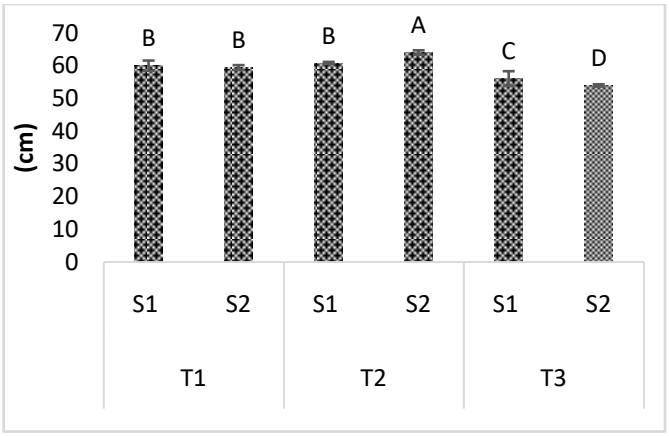

Fig.1: Plant height as effected by treatments (CV%= 1.80; SE=0.8680)

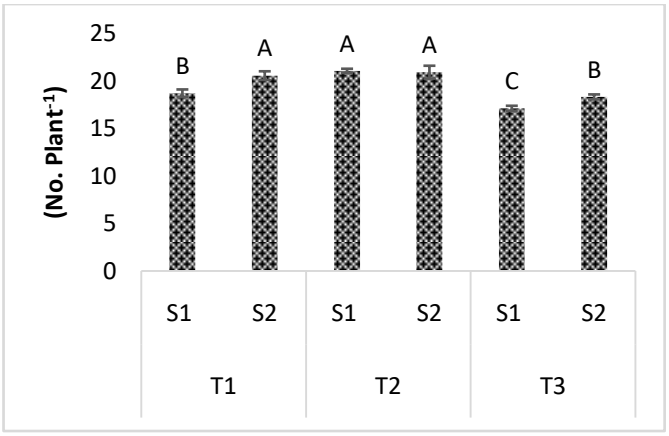

Fig. 2: No. of leaves as effected by treatments (CV%= 2.22; S.E= 03527)

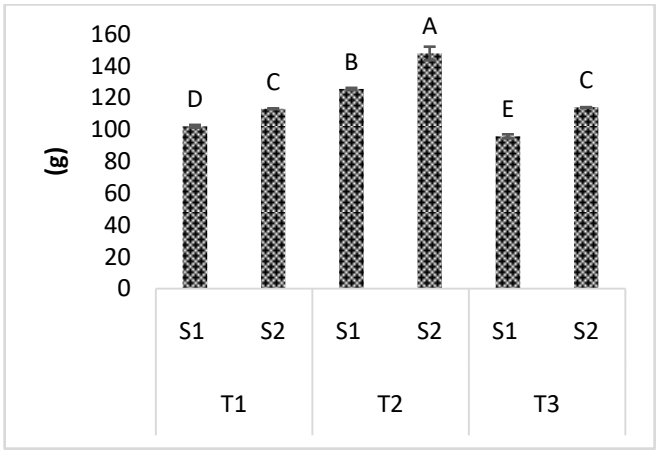

Fig.3: Leaf weight as effected by treatments (CV%= 1.45; S.E= 1.3782)

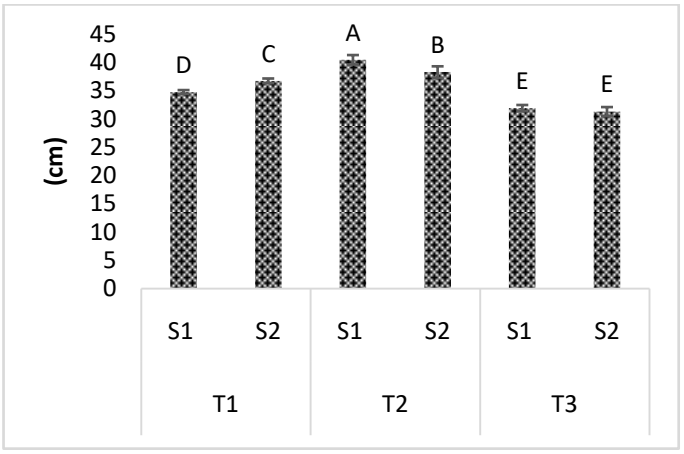

Fig.4: Root length as effected by treatments (CV%= 1.29 ; S.E= 03749)

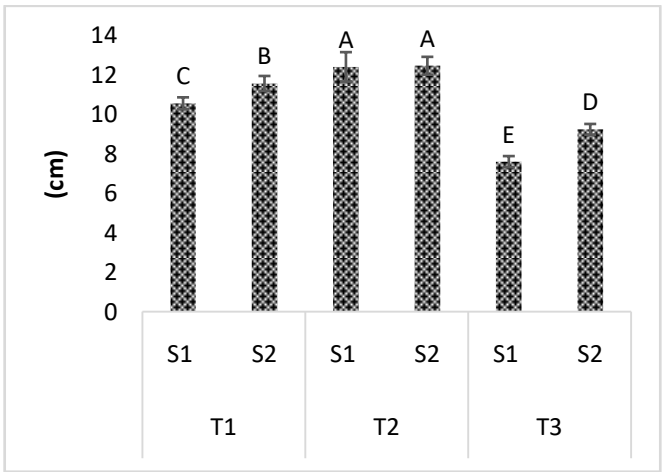

Fig.5: Root girth as effected by treatments (CV % = 3.13; S.E= 0.2713)

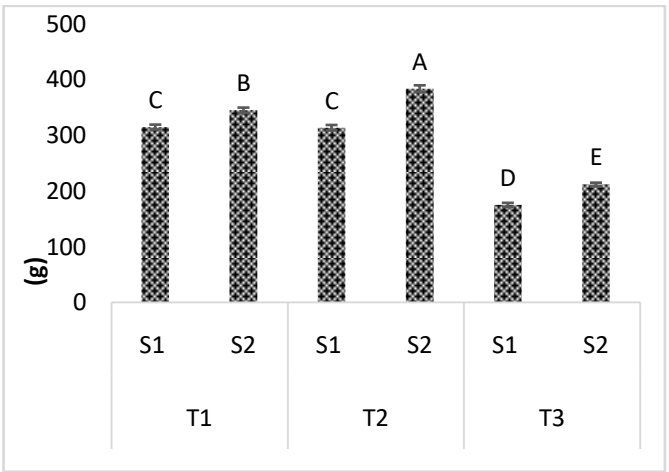

Fig.6: Plant biomass as effected by treatments (CV% =1.30 ; S.E= 3.0816)

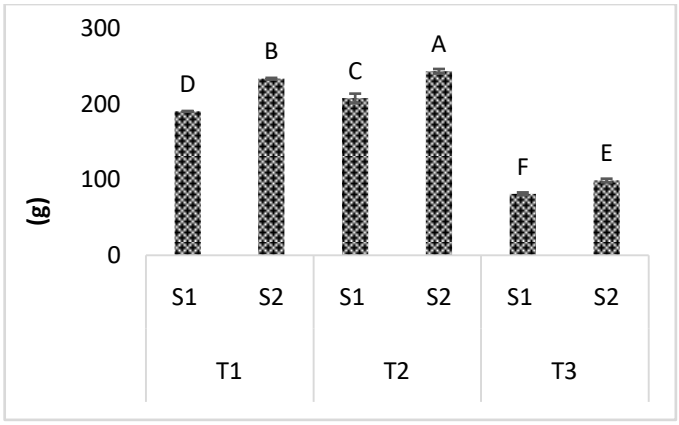

Fig.7: Root weight as effected by treatments (CV% =1.52 ; S.E=2.1885)

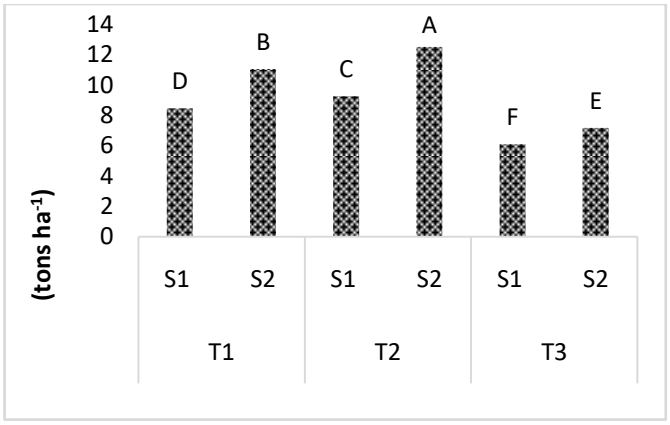

Fig.8: Root yield as effected by treatments (CV % = 0.61 ; S.E= 0.0455)

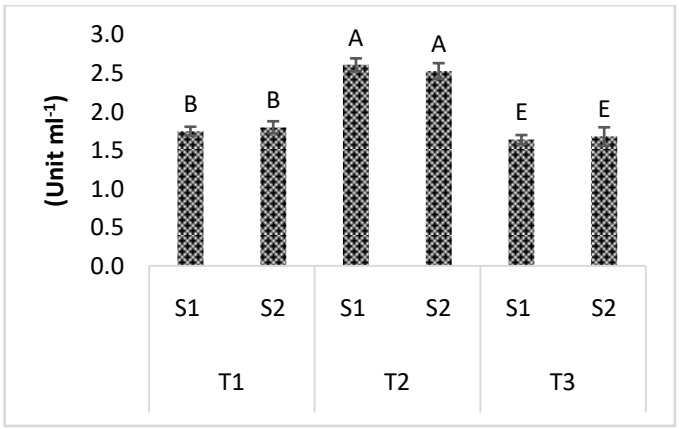

Fig. 9: Amylase as effected by treatments (CV% = 0.21 ; S.E 0.0173)

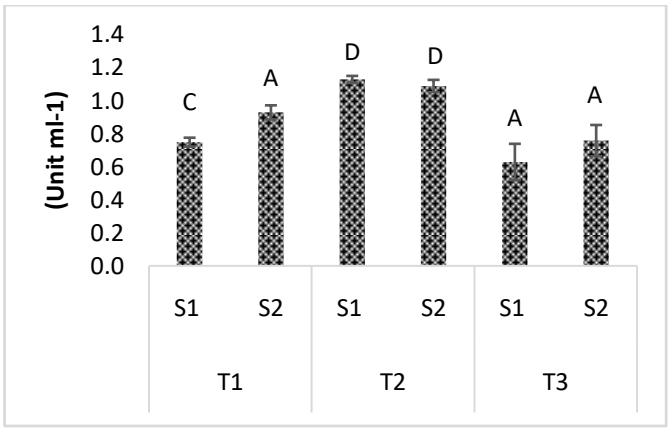

Fig.10: Protease as effected by treatments (CV% = 0.42 ; S.E=0.0329)

These enzymes occur in all organisms, engaged in several physiological reactions from simple digestion of food proteins to highly regulated cascades viz. Blood-clotting, complement system, apoptosis pathways, and invertebrate prophenol oxidase activity). Fig.10 revealed that protease count irrespective of treatments (T1, T2 and T3) and sowing dates (S1 and S2) in radish varied from 0.63 to 1.13. Compared to T1, Significant increase (p<0.05) of count of protease was found at T2 whereas sowing dates (S1 and S2) in T2 and T3 remained insignificant (p>0.05). The results indicated that radish sown on 1st and 15 October, application of organic matter in combination to recommend doses of inorganic with 50:50 ratio enhanced the protease count. Table-1 showed that root yield carried positively significant relationship (p<0.01) with root length, plant biomass, root weight and root yield whereas same was found negative with amylase contents that reflected that increase amylase enzyme contents have depressive impact upon protease. Results are in agreement with Gruber *et al*. (2013); Garica and Iajolo (1988).

Conclusion

It was concluded that liquid organic fertilizer applied with inorganic fertilizers improve soil physicochemical properties thereby enhancing growth, yield and digestive enzymes; amylase and protease in radish when sown in second to 3rd week of October. Therefore it is suggested that crop input cost on account of inorganic fertilizer purchase may be reduced if organic liquid fertilizer is integrated at ratio of 50:50%.

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