Radish (Raphanus sativus L.) a member of the family cruciferae is a popular vegetable in both tropical and temperate regions of the world. It is one of the most ancient vegetables. Certain remarks of Herodotus reveal that it was cultivated about 2700 B.C. 1. Radish is widely used as a root vegetable, tender leaves and shoots are also used as greens. Generally commercial radishes are approximately 5 cm in diameter and are either red or white. It is a cool season vegetable and a monthly mean temperature of 10-15°C favours its growth and development.

For an early and good crop stand, sandy to sandy loam soils are considered suitable for it. Its roots can be eaten raw as a salad or cooked as a vegetable. It has a cooling effect, prevents constipation, increases appetite, and its roots and leaves are very tasty when cooked together. It is recommended to the patients suffering from piles, liver trouble, enlarged spleen and jaundice. In the year 2013, area and production of radish in India was in about 170.30 Thousand hectares and 2410.78 Thousand metric Tonnes, respectively 2. The degradation in soil health in many intensively cultivated areas is manifested in terms of loss of soil organic matter, depletion of native soil fertility, particularly with respect to secondary micronutrients and stagnation or even decline in crop productivity. Depletion in soil fertility is due to imbalanced and unscientific use of fertilizer and is one of the major constraints in improving crop productivity 3. It has been widely accepted that organic farming alone could serve as a holistic approach towards achieving sustainable agriculture as it is nature based, environment friendly and ensures the conservation of resources for the future 4. Similarly, vermiwash 5 would have enzymes, secretions of earthworms which would stimulate the growth and yield of crops and even develop resistance in crops through foliar spray Zambare et al. 6. Some worker reported that vermiwash contains enzyme of proteases, amylases, ureases and phosphatase besides nitrogen fixing bacteria like Azotobacter sp. Agrobacterium sp. and Rhizobium sp. and some phosphate solubilizing bacteria which influences significantly the growth of plant.

MATERIALS AND METHODS

The present investigation was undertaken with the main objective of performance of different levels of vermiwash spray on growth and yield of radish cv. Local variety. The experiment was laid out in randomized completely block design (RBD) with five treatments and five replications. The experiment consists of five treatments involving application of water and vermiwash in the proportion of 1:1, 1:2, 1:3 and 1:4 and control were imposed and the foliar application was made by using knapsack sprayer in the evening hours twice at 15 and 30 days after sowing seeds. The data clearly revealed that the yield obtained with treatment T4 (100% RDF as fertigation and vermiwash foliar twice times spray 1:4 at 15 and 30 days after sowing seeds) was significantly higher than all other treatments in growth and yield attributes during experiment 1 (November sowing), experiment 2 (December sowing) and also pooled analysis study, such as root diameter (5.53, 5.20 and 5.37 cm), length (25.90, 23.79 and 24.85 cm), weight (90.90, 85.20 and 88.05 g), yield / plot (18.18, 17.04 and 17.61 kg), yield/ha (60.89, 56.79 and 58.69 t/ha) and marketable yield (45.45, 44.33 and 44.89 t/ha), respectively of radish cv. Local variety. Thus, it can be concluded that foliar spray of vermiwash (1:4) effective than control.
Table-1. Performance of different levels of vermiwash spray on leaf length leaf weight and total no. of leaves per plant of radish cv. Local variety

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Leaf length, (cm)</th>
<th>Single radish leaf weight, (g)</th>
<th>Total no. leaves per plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sowing time-2013-14</td>
<td>Pooled</td>
<td>Sowing time-2013-14</td>
</tr>
<tr>
<td></td>
<td>NOV</td>
<td>DEC</td>
<td>NOV</td>
</tr>
<tr>
<td>T1</td>
<td>36.00</td>
<td>35.96</td>
<td>35.98</td>
</tr>
<tr>
<td>T2</td>
<td>37.38</td>
<td>37.80</td>
<td>37.59</td>
</tr>
<tr>
<td>T3</td>
<td>41.26</td>
<td>40.68</td>
<td>40.97</td>
</tr>
<tr>
<td>T4</td>
<td>42.22</td>
<td>41.62</td>
<td>41.92</td>
</tr>
<tr>
<td>SEm (+)</td>
<td>0.62</td>
<td>0.75</td>
<td>0.49</td>
</tr>
<tr>
<td>CD @ 0.05</td>
<td>1.87</td>
<td>2.24</td>
<td>1.40</td>
</tr>
<tr>
<td>CV (%)</td>
<td>3.71</td>
<td>4.44</td>
<td>4.09</td>
</tr>
</tbody>
</table>

Table-2. Performance of different levels of vermiwash spray on root diameter, root length and single radish weight of radish cv. Local variety

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Root diameter, (cm)</th>
<th>Root length, (cm)</th>
<th>Single radish weight, (gm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sowing time-2013-14</td>
<td>Pooled</td>
<td>Sowing time-2013-14</td>
</tr>
<tr>
<td></td>
<td>NOV</td>
<td>DEC</td>
<td>NOV</td>
</tr>
<tr>
<td>T1</td>
<td>4.27</td>
<td>4.05</td>
<td>4.16</td>
</tr>
<tr>
<td>T2</td>
<td>4.84</td>
<td>4.44</td>
<td>4.64</td>
</tr>
<tr>
<td>T3</td>
<td>5.28</td>
<td>4.95</td>
<td>5.12</td>
</tr>
<tr>
<td>T4</td>
<td>5.53</td>
<td>5.20</td>
<td>5.37</td>
</tr>
<tr>
<td>T5</td>
<td>4.04</td>
<td>3.97</td>
<td>4.01</td>
</tr>
<tr>
<td>SEm (+)</td>
<td>0.17</td>
<td>0.21</td>
<td>0.14</td>
</tr>
<tr>
<td>CD @ 0.05</td>
<td>0.52</td>
<td>1.26</td>
<td>0.39</td>
</tr>
<tr>
<td>CV (%)</td>
<td>8.13</td>
<td>10.39</td>
<td>9.27</td>
</tr>
</tbody>
</table>

Studies on Performance of Different Levels of Vermiwash
Table-3. Performance of different levels of vermiwash spray on yield / plot, yield per ha and marketable yield of radish cv. local

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Yield/ plot, (Kg)</th>
<th>Yield per ha, (t/ha)</th>
<th>Marketable yield, (t/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sowing time-2013-14</td>
<td>NOV</td>
<td>DEC</td>
</tr>
<tr>
<td>T1</td>
<td></td>
<td>16.88</td>
<td>16.29</td>
</tr>
<tr>
<td>T2</td>
<td></td>
<td>17.21</td>
<td>16.62</td>
</tr>
<tr>
<td>T3</td>
<td></td>
<td>17.74</td>
<td>16.86</td>
</tr>
<tr>
<td>T4</td>
<td></td>
<td>18.18</td>
<td>17.04</td>
</tr>
<tr>
<td>T5</td>
<td></td>
<td>16.01</td>
<td>16.08</td>
</tr>
<tr>
<td>SEM (+)</td>
<td></td>
<td>0.43</td>
<td>0.38</td>
</tr>
<tr>
<td>CD @ 0.05</td>
<td></td>
<td>1.30</td>
<td>NS</td>
</tr>
<tr>
<td>CV (%)</td>
<td></td>
<td>5.64</td>
<td>5.07</td>
</tr>
</tbody>
</table>

Table 3: Performance of different levels of vermiwash spray on yield / plot, yield per ha and marketable yield of radish cv. local

Experiments consists of five treatments involving application of water and vermiwash in the proportion of 1:1, 1:2, 1:3 and 1:4 and control were imposed. The foliar application was made with knapsack sprayer in the evening hours twice at 15 and 30 days after sowing seeds.

An untreated check was also maintained, plot size was 3 x 1 m and each treatment as replicated five times. The recommended doses of 25 tones FYM, half dose 25 kg N, 50 kg P₂O₅ and 50 kg K₂O per hectare at the time of soil preparation and half 25 kg N top dressed in two equal splits at 12 and 23 days after sowing were imposed. Vermiwash was applied as per treatment at 15 and 30 days after seed sowing and thinning operation were carried out at 15 and 25 days after seed sowing and maintained proper plant population.

Vermiwash was used in four different dilutions viz., 1:1, 1:2, 1:3 and 1:4 by mixing with simple water, as foliar spray to evaluate its effect on growth and yield of radish cv. Local. Recommended dose of fertilizer along with water sprays was maintained as standard check (control). Two rounds of vermiwash sprays were taken up at 15 days interval commencing after sowing. Vermiwash was obtained by culturing earthworms on organic substrates (65 % pre-composted crop wastes and 35 % animal manure) in equipment specially fabricated as described by ASPEE, ARDF, Tansa Farm. Composting material such as, cow dung, waste leaf material were collected from nearby buffalos shed and was exposed to sun light for 5 to 10 day to remove the various harmful organism and noxious gases. The moisture level was maintained by sprinkling water and the earthworms to get acclimatized to the vermiwash unit conditions. Vermiwash was extracted from vermiwash collecting device. The apparatus made by effective cementing tank method in which worm bed is prepared. Concentrated sample of vermiwash collected after a period of 30 days. Vermiwash is a liquid that is collected after the passage of water thought a column of worm and is very useful as a foliar spray. It is a collection of excretory products and mucus secretion of earthworm along with micronutrient from the soil organic molecular. These are transported to the leaf, shoot and other parts of the plants in the natural ecosystem vermiwash.

**Statistical analysis:** The data obtained during both experimental studies were analyzed as per the statistical methods prescribed by 7. The standard error of mean was worked out and the critical difference (C.D.) in between two
RESULTS AND DISCUSSION

The performance of different levels of vermiwash spray on growth and yield of radish cv. Local variety in two different experiments and their pool study was shown in tables-1, 2 and 3 and fig 1 - 2.

Leaf length of radish was recorded by different levels of vermiwash (Table-1). The highest leaf length 42.22, 41.62 and 41.92 cm was found with T₄ (1:4 vermiwash) during experiment 1, experiment 2 and also pooled analytical study, respectively and similarly the lowest leaf length 30.80, 31.72 and 31.26 cm was observed in control treatment during experiment 1, experiment 2 and also pooled study, respectively.

Single radish leaf weight was observed maximum in treatment T₄ i.e., 16.30, 14.48 and 15.39 g during experiment 1, experiment 2 as well as pooled study respectively and lowest weight was observed in treatment T₅, i.e., 9.50, 8.97 and 9.24 g during experiment 1, experiment 2 and pooled study, respectively. The positive effect of vermiwash spray on crop growth was observed by 8-10 cm.

Total no. of leaves per plant showed significant difference between various treatments, while treatment T₄ recorded maximum no. of leaves with mean values 11.80, 11.57 and 11.68 during experiment 1, experiment 2 and pooled study, respectively. Minimum no. of leaves was recorded in treatment T₅ with mean values 7.40, 8.24 and 7.82 during experiment 1, experiment 2 and pooled study respectively.

Different levels of vermiwash showed significant variations in root diameter, length and weight (Table-2). Maximum root diameter (5.53, 5.20 and 5.37 cm), length (25.90, 23.79 and 24.85 cm) and weight (90.90, 85.20 and 88.05 g) was recorded in treatment T₄ (1:4 vermiwash) during experiment 1, experiment 2 and pooled study, respectively. Minimum root diameter (4.04, 3.97 and 4.01 cm), length (20.90, 19.90 and 20.40 cm) and weight (80.06, 80.38 and 80.22 gm) was recorded in T₅ control during experiment 1, experiment 2 and pooled study, respectively. Root length was maximum in plants involving vermiwash treatments. Root length increase indicates efficient absorption of water followed by transport and conduction.

The positive effect of vermiwash spray on root growth is in confirmation with 8-10”.

Effect of vermiwash spray yield parameters of radish cv. Local variety

The results of the experiment revealed that the radish cv. Local variety yield characters such as yield/plot, yield/ha and marketable yield were significantly influenced by foliar spray of vermiwash compared to control with no spray or water spray as shown in table-2. Among the vermiwash sprays, T₄ (1:4 i.e. dilution of water : vermiwash) recorded significantly higher values for yield / plot 18.18, 17.04 and 17.61 kg/plot during experiment 1, experiment 2 and pooled study, respectively. Lower values of yield / plot was noted in treatment control (T₅) with mean values 16.01, 16.08 and 16.04 during experiment 1, experiment 2 and pooled study, respectively.

Yield / ha and marketable yield of radish cv. Local variety showed significant variation between different treatments. Higher Yield / ha 60.59, 56.79 and 58.69 t/ha was recorded in treatment T₄ (1:4 i.e. dilution of water: vermiwash) during experiment 1, experiment 2 and pooled study, respectively. Lower values of yield / ha 53.37, 53.38 and 53.47 t / ha during experiment 1 (Nov), experiment 2 (Dec) and also pooled data, respectively was recorded in control treatment.

Maximum marketable yield of radish cv. Local variety was recorded in T₄ 45.45, 44.33 and 44.89 t/ha during experiment 1, experiment 2 and pooled study, respectively. While marketable yield radish cv. Local variety showed significant variation between treatments. Higher Yield / ha 40.03, 40.83 and 40.43 during experiment 1, experiment 2 and pooled study, respectively. Several reports revealed by 11 and application of vermiwash increased radish yield of 7.30% by 8 and dry chilli yield by 12.

13 studied the influence of foliar sprays of vermiwash yield increased due to might be the reason for increasing chlorophyll and nitrogen contents in the leaf.

From the forgoing discussion, it was clearly revealed that the yield obtained with treatment T₄ (100 % RDF as fertigation and vermiwash foliar twice times spray 1:4 at 15 and 30 days after sowing seeds) was significantly higher than all other treatments in growth and yield attributes during experiment 1, experiment 2 and pooled study, such as root diameter (5.53, 5.20, 5.37 cm), length (25.90, 23.79 and 24.85cm), weight (90.90, 85.20 and 88.05 g), yield / plot (18.18, 17.04 and 17.61 kg), yield / ha (60.59, 56.79 and 58.69 t/ha) and marketable yield (45.45, 44.33 and 44.89 t/ha) respectively, of radish cv.
Local variety. Thus it can be concluded that foliar spray of vermiwash (1:4) effective than control.

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REFERENCES