EFFECT OF DAP, HUMIC ACID AND MICRONUTRIENT MIXTURE FOLIAR APPLICATION ON YIELD AND QUALITY CHARACTERS OF GROUNDNUT (ARACHIS HYPOGAEA L.) VAR. TMV 7 IN SANDY LOAM SOIL

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Abstract

A field experiment was conducted to study the effect of DAP, Humic acid and micronutrient mixture foliar application on yield and quality characters of groundnut var. TMV 7 in sandy loam soil. Groundnut plants were given foliar application viz., T₁–Control, T₂–DAP 2.0%, T₃–Humic acid 0.3%, T₄–Micronutrient mixture 0.3%, T₅–DAP 2.0% + Humic acid 0.3%, T₆–DAP 2.0% + Micronutrient mixture 0.3%, T₇–Humic acid 0.3% + Micronutrient mixture 0.3%, T₈–DAP 2.0% + Humic acid 0.3% + Micronutrient mixture 0.3% along with control T₀. The results concluded that DAP, humic acid and micronutrient mixture foliar application records higher values for yield and quality characters viz., number of pods plant⁻¹, 100 kernel weight (test weight), shelling percentage, pod yield, haulm yield, kernel yield, oil content, oil yield and protein content over control.

Keywords: Groundnut (var. TMV 7), Number of pods plant⁻¹, Pod yield, Haulm yield, Oil content, Protein content

Introduction

Groundnut is the major oilseed crop of India. The groundnut kernel has dual advantage of being important as a source of edible oil as well as protein. It is native of Brazil (Aparna et al., 2018). Nearly 75% of the groundnut is being cultivated in a low to moderate rainfall zone (Thulasiram et al., 2018). Groundnut seeds are good source of vitamin E, calcium, phosphorus, magnesium, zinc, iron, riboflavin, thiamine and potassium. Oil extracted from the kernel is used for culinary purpose (Poonia et al., 2018). The groundnut productivity was low due to improper nutrient management practices, low rainfall and low amount of nutrients in soil. Therefore foliar application helps in minimizing these constraints. Foliar application of nutrients constitutes one of the important milestones in the progress of agricultural production. Fertilizer applied to the soil at the time of sowing is not fully available to the plants as the crop approaches maturity (Meena et al., 2017). The effectiveness of foliar applied nutrients is determined by the type of formulation and the time of application. Yield increase to an extent of 5-10 per cent (Sonawane et al., 2010) can be achieved by using the right product at the right time. Humic acids increase the water infiltration and water holding capacity of the soil, increase plant root growth and metabolism and help plants deal with environmental stresses. The main benefit of humic acids in a liquid foliar application is that the plant will be able to uptake and utilize the nutrients in the solution many times more effectively than without the humates. Micronutrients are known to play many complex roles in plant development and health. Micronutrients promote the strong, steady growth of crops that produce higher yields and increase harvest quality and maximizing a plant’s genetic potential. Micronutrient needs vary with the type of soil, crop planted and available nutrient source.

Materials and Methods

A field experiment was conducted to study the effect of DAP, humic acid and micronutrient mixture foliar application on yield and quality characters of groundnut var. TMV 7. The experiment was conducted in a randomized block design (RBD) with the following eight treatments and replicated three times.

T₀ – Control
T₁ – DAP 2.0%
T₂ – Humic acid 0.3%
T₃ – Micronutrient mixture 0.3%
T₄ – DAP 2.0% + Humic acid 0.3%
T₅ – DAP 2.0% + Micronutrient mixture 0.3%
T₆ – Humic acid 0.3% + Micronutrient mixture 0.3%
T₇ – DAP 2.0% + Humic acid 0.3% + Micronutrient mixture 0.3%

Recommended package of practices have been followed and nutrients applied to the crops at crop growth period. Five plants in each sample plant was counted and the mean was expressed as number of pods plant⁻¹. Mean test weight of 100 grains per plot was recorded at 14 per cent moisture content and expressed in grams. The shelling percentage was calculated as per the formula given below.

\[
\text{Shelling percentage} = \left( \frac{\text{Weight of kernel}}{\text{Weight of pod}} \right) \times 100
\]

Fresh pods from each treatment plot were sun-dried for four days, weighed and expressed in kg ha⁻¹. The dry haulm yield from each plot at harvest was recorded after separating the pods and complete sun drying for a period of one week and haulm yield was worked out in kg ha⁻¹. The kernel yield was calculated as per the formula given below.

\[
\text{Kernel yield (kg ha}^{-1}) = \left( \frac{\text{Pod yield (kg ha}^{-1})\times \text{Shelling %}}{100} \right)
\]

The oil content of the kernel was estimated using diethyl ether as extractant by soxhlet’s apparatus and expressed in percent (Gupta and Varshaney, 1989). Oil yield was calculated as per the formula given below.
Oil yield (kg ha\(^{-1}\)) = \frac{Oil content (%) \times Kernel yield (kg ha\(^{-1}\))}{100}

Nitrogen content of kernel was estimated as per the procedure outlined in micro Kjeldahl method and the crude protein content of kernel was calculated by multiplying the percent nitrogen content of kernel with 6.25 (Piper, 1966). The data collection was analysed statistically which was given by Gomez and Gomez (1984).

**Results**

The effect of DAP, humic acid and micronutrient mixture foliar application has significantly influenced the yield and quality characters and the results are furnished below.

**Number of pods/plant\(^{-1}\), 100 kernel weight and shelling percentage**

At harvest stage, the number of pods plant\(^{-1}\) was significantly increased with the foliar application of HA. There was a significant increase in number of pods plant\(^{-1}\) with the combined application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%. The control recorded the minimum number of pods plant\(^{-1}\). The maximum number of pods plant\(^{-1}\) was recorded in the treatment T\(_8\), which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (23.00) succeeded by the treatments T\(_6\), T\(_7\), T\(_8\) on par with T\(_1\), T\(_2\), T\(_3\), T\(_4\), T\(_5\), T\(_6\), T\(_7\), T\(_8\) recorded 21.95, 20.95, 19.98, 19.86, 18.81 and 17.66 respectively. The minimum number of pods plant\(^{-1}\) recorded in control, T\(_1\) (16.30). The foliar application of humic acid along with DAP and micronutrients did not show any significant difference on 100 kernel weight and shelling percentage. However, the highest 100 kernel weight was noticed in the treatment T\(_8\) (DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%) recorded 72.80 g, this was followed by T\(_6\) > T\(_7\) > T\(_8\) > T\(_9\) > T\(_10\) and the lowest 100 kernel weight was (68.30 g) recorded in Control (T\(_1\)). The maximum shelling percentage was noticed in the treatment T\(_8\) (DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%) recorded 72.20%, this was followed by the treatment T\(_1\) (DAP @ 2.0% + HA @ 0.3%) recorded 71.79% and the minimum shelling percentage was noticed in control (69.60%).

**Pod, haulm and kernel yield**

Pod, haulm and kernel yield were significantly influenced with the foliar application of HA along with DAP and Mm. There was a significant increase in pod, haulm and kernel yield with the combined application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%. The control recorded the lowest yield. The treatment, T\(_8\) which received the combined foliar spray of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% twice at FS and PFS, registered the highest pod yield (2126 kg ha\(^{-1}\)) followed by T\(_8\) (1962 kg ha\(^{-1}\)) > T\(_7\) (1807 kg ha\(^{-1}\)) > T\(_1\) (1656 kg ha\(^{-1}\)) > T\(_2\) (1638 kg ha\(^{-1}\)) > T\(_3\) (1474 kg ha\(^{-1}\)) > T\(_4\) (1296 kg ha\(^{-1}\)) and the lowest pod yield was noticed in the treatment T\(_1\) (1085 kg ha\(^{-1}\)). The highest haulm yield was found in the treatment T\(_8\), which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (3425 kg ha\(^{-1}\)) which was subsequently followed by T\(_8\) (3161 kg ha\(^{-1}\)), T\(_7\) (2912 kg ha\(^{-1}\)), T\(_3\) (2667 kg ha\(^{-1}\)), T\(_5\) (2639 kg ha\(^{-1}\)), T\(_6\) (2375 kg ha\(^{-1}\)) and T\(_4\) (2088 kg ha\(^{-1}\)). The lowest haulm yield was recorded in the treatment T\(_1\) (1748 kg ha\(^{-1}\)). Among the various treatments, T\(_8\) which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% noticed highest kernel yield (1534 kg ha\(^{-1}\)) next to this, T\(_3\) (1408 kg ha\(^{-1}\)), followed by T\(_4\) (1290 kg ha\(^{-1}\)), T\(_5\) (1176 kg ha\(^{-1}\)), T\(_6\) (1162 kg ha\(^{-1}\)), T\(_2\) (1046 kg ha\(^{-1}\)), T\(_1\) (908 kg ha\(^{-1}\)) and the lowest kernel yield (755 kg ha\(^{-1}\)) was recorded in the treatment T\(_1\) (control).

**Oil content, oil yield and protein content**

There was no significant effect of the treatments on oil and protein content of groundnut, foliar application of humic acid along with DAP and micronutrients did not show any significant difference on oil content and protein content. However, the highest oil content was noticed in the treatment T\(_8\) (DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%) recorded 48.30%, subsequently followed by T\(_7\) > T\(_6\) > T\(_5\) > T\(_4\) > T\(_3\) > T\(_2\) > T\(_1\) and the lowest oil content was (45.90%) recorded in Control (T\(_1\)). Among the various treatments, T\(_8\) which received combined foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% twice at flowering and peg formation stage, registered highest oil yield (740.92 kg ha\(^{-1}\)), followed by the treatments T\(_3\) (DAP @ 2.0% + HA @ 0.3%) recorded 674.71 kg ha\(^{-1}\), T\(_2\) (HA @ 0.3% + Mm @ 0.3%) noticed 613.65 kg ha\(^{-1}\), T\(_3\) (HA @ 0.3%) registered 555.30 kg ha\(^{-1}\), T\(_6\) (DAP @ 2.0% + Mm @ 0.3%) recorded 548.23 kg ha\(^{-1}\), T\(_2\) (DAP @ 2.0%) recorded 486.72 kg ha\(^{-1}\) and T\(_1\) (Mm @ 0.3%) which recorded 421.22 kg ha\(^{-1}\) of oil yield and the lowest oil yield was 346.54 kg ha\(^{-1}\), recorded in the treatment T\(_1\) (control). The highest protein content was noticed in the treatment T\(_1\) (DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%) recorded 22.48%, this was followed by the treatment T\(_3\) (DAP @ 2.0% + HA @ 0.3%) recorded 22.06% and the lowest protein content was noticed in T\(_1\) (19.80%).

**Discussion**

The impact of the DAP, humic acid and micronutrient mixture foliar application on yield and quality characters of groundnut was discussed here as follows.

**Number of pods plant\(^{-1}\), 100 kernel weight and shelling percentage**

Application of HA @ 0.3% significantly increased the yield attributes and yield of groundnut. This increase in number of pods plant\(^{-1}\) and 100 kernel weight could be explained on the fact that the application of recommended dose of mineral fertilizers and humic acid foliar spray increased the uptake of nutrients by plants and consequently increased growth rate. The beneficial interaction effects of those fertilizers could be attributed to the enhancing of easily nutrients release into soil solution and to encourage their penetration through plant roots, as well as to develop photosynthesis. These results corroborate the findings of Rajpar et al. (2011) in mustard, El-Hak et al. (2014) in flax. Foliar application of humic acid significantly increased the shelling percentage. It has been speculated that an increase in shelling percentage of groundnut might be due to that humic substances might have various biochemical effects either at cell wall, membrane level at in the cytoplasm which inturn result into enhanced photosynthesis. These results corroborate the findings of Rajpar et al. (2011) in mustard, El-Hak et al. (2012) in pea and Bakry et al. (2014) in flax. Application of DAP @ 2.0% had positive increase in yield attributes of groundnut. This
could be attributed to increased translocation of photosynthates from leaves and stem to developing pods resulted in matured pods and bolder seeds. It was also evident from the data on leaf area duration that these fertilizer feedings treatments maintains leaf area for longer duration resulting in extended period of photosynthates translocation to developing seeds and hence recorded bolder seeds. Similar differences with respect to yield components were also reported earlier by Subrahmanyan et al. (2000) and Chandrasekaran (2004). The increased yield attributes with the foliar feeding of micronutrients @ 0.3% was due to the fact that, improvement in photosynthesis and carbohydrate metabolism resulting into greater formation of photosynthetic and metabolites in source and later on translocated in the newly formed sinks which ultimately increased the yield parameters. These results are in agreement with the findings of Shivakumar and Kumutha (2003).

**Pod, haulm and kernel yield**

The pod haulm, yield were increased by 49% each and kernel yield by 56% with the foliar application of HA along with Mm and DAP over control. Foliar application of HA had a tremendous effect on yield of groundnut. The increase in pod, haulm and kernel yield was attributed to that, HA amplified permeability of cell membrane and thereby facilitated the enhance of potassium into the cell which amplified permeability of cell membrane and thereby facilitated the enhance of potassium into the cell which accordingly raises the pressure inside the cell and cell division. On the other hand, increasing energy inside the cells would lead to chlorophyll production and photosynthesis rate increase. Then, the growth process is accelerated nitrogen absorption into the cells is intensified nitrate production is increased and finally the production is improved (Giasuddin et al., 2007). Moraditochinae (2012) in his experiment on peanut, obtained similar grain yield results in the presence of hemic acid. DAP has a compelling effect on yield of groundnut crop. Foliar feeding of DAP @ 2.0% had significantly increased the pod, haulm and kernel yield. The pod yield is an end product, which obviously depends upon the total dry matter production at different stages of crop growth and its partitioning into reproductive parts for higher production. The improvement in the DMP may be due to the assimilation of nutrients supplied through the foliar application meeting the required nutrients demand of the crop during flowering period of groundnut. Foliar application resulted in greater absorption, assimilation and translocation of nutrients for increased photosynthesis. Increased production of dry matter and its efficient translocation to the economic parts ultimately reflected on the final yield. The role of foliar application of nutrients on physiology of crop plants is well established. Therefore, better availability and uptake of nutrients could be assigned as the proper reason for significant increase in dry matter production and its accumulation with foliar spray treatments (Shivakumar Malladada, 2005; Dalei et al., 2014). The yield increase of groundnut due to micronutrients application is attributed to that, activation of various enzymes and increased basic metabolic rate in plants, facilitated the synthesis of nucleic acids and hormones, which inturn enhanced the yield due to greater availability of nutrients and photosynthates. These results are in agreement with those of Helpyati (2001) and Sumangala (2003).

**Quality characters**

It is more vivid that addition of HA improved quality parameters viz., oil content, oil yield and protein content of groundnut crop. The oil yield increased by 53% with the combined foliar application of DAP + HA + Mm over control. The combine application of HA and Mm showed significant effect on quality parameters of groundnut. This increase can be attributed to chelate property of elements such as Na, K, Mg, Ca, Zn, Fe, Cu and other elements which compensates nutrient deficiency and as a result promotes quality and production (Verlinden et al., 2009). Many researchers have claimed the oil and protein content increase in the presence of hemic acid and micronutrients. Hemic acid increased the protein content by improving the absorption of macro and micronutrients (Eneji et al., 2013; Bahrani, 2015). Foliar application of DAP had significantly increased the quality parameters of groundnut. This might be due to the increased availability and use of phosphorus, it was a major constituent of fatty acids, higher accumulation of phosphorus might have resulted in higher kernel oil content. The results of present investigation are in conformity with the findings of Krishnappa et al. (1994).

**Conclusion**

The present study concludes that impact of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% foliar application was the best treatment by observing the highest yield and quality characters of groundnut. This increase was due to the improvement in photosynthesis and carbohydrate metabolism, micronutrients application is attributed to that, activation of various enzymes and increased basic metabolic rate and higher accumulation of phosphorus. Hence, the foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% recommended for higher yield and quality characters in groundnut crop.

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pods plant$^4$</th>
<th>100 Kernel weight (g)</th>
<th>Shelling percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T$_1$ – Control</td>
<td>16.30</td>
<td>68.30</td>
<td>69.60</td>
</tr>
<tr>
<td>T$_2$ – DAP @ 2.0%</td>
<td>18.81</td>
<td>69.98</td>
<td>70.57</td>
</tr>
<tr>
<td>T$_3$ – HA @ 0.3%</td>
<td>19.98</td>
<td>70.77</td>
<td>71.03</td>
</tr>
<tr>
<td>T$_4$ – Mm @ 0.3%</td>
<td>17.66</td>
<td>69.21</td>
<td>70.13</td>
</tr>
<tr>
<td>T$_5$ – DAP @ 2.0% + HA @ 0.3%</td>
<td>21.95</td>
<td>72.09</td>
<td>71.79</td>
</tr>
<tr>
<td>T$_6$ – DAP @ 2.0% + Mm @ 0.3%</td>
<td>19.86</td>
<td>70.69</td>
<td>70.98</td>
</tr>
<tr>
<td>T$_7$ – HA @ 0.3% + Mm @ 0.3%</td>
<td>20.95</td>
<td>71.42</td>
<td>71.41</td>
</tr>
<tr>
<td>T$_8$ – DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%</td>
<td>23.00</td>
<td>72.80</td>
<td>72.20</td>
</tr>
<tr>
<td>SED</td>
<td>0.34</td>
<td>0.23</td>
<td>0.13</td>
</tr>
<tr>
<td>CD (0.05)</td>
<td>0.72</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

HA – Humic acid; Mm – Micronutrient mixture

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Table 2: Effect of DAP, humic acid and micronutrient mixture foliar application on pod, haulm and kernel yield of groundnut var. TMV 7

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Pod yield (kg ha(^{-1}))</th>
<th>Haulm yield (kg ha(^{-1}))</th>
<th>Kernel yield (kg ha(^{-1}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁ – Control</td>
<td>1085</td>
<td>1748</td>
<td>755</td>
</tr>
<tr>
<td>T₂ – DAP @ 2.0%</td>
<td>1474</td>
<td>2375</td>
<td>1040</td>
</tr>
<tr>
<td>T₃ – HA @ 0.3%</td>
<td>1656</td>
<td>2667</td>
<td>1176</td>
</tr>
<tr>
<td>T₄ – Mm @ 0.3%</td>
<td>1296</td>
<td>2088</td>
<td>908</td>
</tr>
<tr>
<td>T₅ – DAP @ 2.0% + HA @ 0.3%</td>
<td>1962</td>
<td>3161</td>
<td>1408</td>
</tr>
<tr>
<td>T₆ – DAP @ 2.0% + Mm @ 0.3%</td>
<td>1638</td>
<td>2639</td>
<td>1162</td>
</tr>
<tr>
<td>T₇ – HA @ 0.3% + Mm @ 0.3%</td>
<td>1807</td>
<td>2912</td>
<td>1290</td>
</tr>
<tr>
<td>T₈ – DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%</td>
<td>2126</td>
<td>3425</td>
<td>1534</td>
</tr>
</tbody>
</table>

SED 53.11 85.56 39.74

CD (0.05) 111.54 179.68 83.46

HA – Humic acid; Mm – Micronutrient mixture

Table 3: Effect of DAP, humic acid and micronutrient mixture foliar application on oil content, oil yield and protein content of groundnut var. TMV 7

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Oil content (%)</th>
<th>Oil yield (kg ha(^{-1}))</th>
<th>Protein content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁ – Control</td>
<td>45.90</td>
<td>346.54</td>
<td>19.80</td>
</tr>
<tr>
<td>T₂ – DAP @ 2.0%</td>
<td>46.80</td>
<td>486.72</td>
<td>20.80</td>
</tr>
<tr>
<td>T₃ – HA @ 0.3%</td>
<td>47.22</td>
<td>555.30</td>
<td>21.27</td>
</tr>
<tr>
<td>T₄ – Mm @ 0.3%</td>
<td>46.39</td>
<td>421.22</td>
<td>20.34</td>
</tr>
<tr>
<td>T₅ – DAP @ 2.0% + HA @ 0.3%</td>
<td>47.92</td>
<td>674.71</td>
<td>22.06</td>
</tr>
<tr>
<td>T₆ – DAP @ 2.0% + Mm @ 0.3%</td>
<td>47.18</td>
<td>548.23</td>
<td>21.22</td>
</tr>
<tr>
<td>T₇ – HA @ 0.3% + Mm @ 0.3%</td>
<td>47.57</td>
<td>613.65</td>
<td>21.66</td>
</tr>
<tr>
<td>T₈ – DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%</td>
<td>48.30</td>
<td>740.90</td>
<td>22.48</td>
</tr>
</tbody>
</table>

SED 0.12 20.12 0.14

CD (0.05) NS 42.25 NS

HA – Humic acid; Mm – Micronutrient mixture

References


