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EFFECT OF FOLIAR APPLICATION OF DAP, HUMIC ACID AND MICRONUTRIENTS ON GROWTH 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 foliar application of DAP, humic acid and micronutrients on growth characters of groundnut (*Arachis hypogaea* L.) var. TMV 7 in sandy loam soil. Groundnut plants were given foliar application *viz.,*T_1–Control,T_2–DAP 2.0%, T_3–Humic acid 0.3%,T_4–Micronutrient mixture 0.3%, T_5–DAP 2.0% + Humic acid 0.3%, T_6–DAP 2.0% + Micronutrient mixture 0.3%, T_7–Humic acid 0.3% + Micronutrient mixture 0.3%, T_8–DAP 2.0% + Humic acid 0.3% + Micronutrient mixture 0.3%. The results observed that foliar application of humic acid, DAP and micronutrient mixture recorded higher values for growth characters viz., plant height, number of leaves plant^{-1}, leaf area index, number of nodules plant^{-1}, chlorophyll content and dry matter production over control.

***Keywords*:** Foliar application, Humic acid, DAP, Micronutrient mixture, Growth characters, Groundnut, Sandy loam soil

Introduction

Groundnut (*Arachis hypogaea* L.), is the kingpin among the oilseed crops, popularly known as “Wonder nut”, “poor man’s cashew nut” and “King of oilseeds”. It occupies a predominant position in Indian oilseed economy and ranks first in area and production with respect to the total oil seeds production in the country. It is grown in 24.59 M ha worldwide with a total production of 40.47 million tonnes and productivity of 1640 kg ha^{-1}. The major groundnut producing countries in the world are China, India, Nigeria, USA and Myanmar. In India, it is grown in an area of 4.59 lakh hectares with annual production of 7.65 lakh tons during the year 2016-2017 (Anon, 2017). About 80% of the total area lies in the five states of India *viz.,* Gujarat, Andhra Pradesh, Tamil Nadu, Karnataka and Maharashtra, which together account for 84% of the total production. The ideal soil for groundnut is well drained, light coloured, loose, friable, sandy loam soils and well supplied with macronutrients, micronutrients and organic matter. The low groundnut productivity is attributed to several production constraints, which include poor and imbalanced nutrition and cultivation in sandy soils. Therefore, it is most essential to pay a great attention to the nutrition of groundnut to enhance its productivity. Among the agro-techniques in groundnut production, appropriate nutrient management practices appear to be more important in sandy loam soils situation because of low nutrient use efficiency. Selection of proper crop nutrition practice through both soil and foliar feeding is the need in present situation. Therefore foliar feeding practice of humic acid, micronutrients and DAP would be more useful in exhaustive crop like groundnut. Foliar spray enables plant to absorb the applied nutrients from the solution through their leaf surface and thus, may result in efficient use of fertilizer. Foliar nutrition is an effective method for correcting deficiencies and overcoming the soil’s inability to transfer nutrients to the plant. Availability of essential nutrients and trace minerals from the soil may be limited at times by root distribution, soil temperature, soil moisture, nutrient imbalances etc. foliar nutrition helps to maintain a nutrient balance within the plant, which may not occur with soil uptake (Meena *et al.,* 2007). Foliar feeding targets the growth stages where declining rates of photosynthesis occurs and enhances the root growth and nutrient absorption (Gunasekar *et al.,* 2018). Foliar spray stimulates an increase in chlorophyll production, cellular activity and respiration. It also triggers a plant response to increased water and nutrient uptake from the soil (Veeramani *et al.,* 2012). Humic acid application has definite input on protein synthesis and nucleic acid synthesis. The nutrients such as calcium, iron, potassium, and phosphorus are stored in humic acid molecules in a form readily available to plant, and are released when the plants require them. Humic substances have also a major contribution in soil fertility maintenance and plant nutrition (Bryan and Stark, 2003). Foliar application of micronutrients such as zinc (Zn), boron (B), iron (Fe), manganese (Mn), and molybdenum (Mo), play a significant role in plant development. Among the macronutrients, nitrogen is a major structural component of the plant cell. It plays an important role in plant metabolism and is involved in synthesis of proteins, amino acids and nucleic acids. Phosphorus is essential for the formation of protoplasm, cell division, development of meristematic tissues and also hastens nodule formation.

Materials and Methods

The field experiment was conducted to study the effect of humic acid, DAP and micronutrients on growth characters of groundnut var. TMV 7 at North Pichavaram, nearby Chidambaram, Cuddalore district, Tamilnadu during December 2016-March 2017. The experimental field is geographically located at 11°24N latitude and 79°41E longitude at an altitude of +5.79m above mean sea level and 6 km away from Bay of Bengal. The experimental soil was sandy loam in texture and taxonomically classified as *Typic ustifluvent*. The initial soil sample was collected from a depth of 0-15 cm, prior to layout of the experiment. The sample was air dried and passed through 2 mm sieve for analysis. The details of physico-chemical properties and nutrient status of the experimental soil are given in Table 1.The experiment was conducted in a randomized block design (RBD) with the following eight treatments.

Treatment details

T_1 – Control

T_2 – DAP 2.0%

T_3 – Humic acid 0.3%

T_4 – Micronutrient mixture 0.3%

T_5 – DAP 2.0% + Humic acid 0.3%

T_6 – DAP 2.0% + Micronutrient mixture 0.3%

T_7 – Humic acid 0.3% + Micronutrient mixture 0.3%

T_8 – DAP 2.0% + Humic acid 0.3% + Micronutrient mixture 0.3%

Each treatment was replicated three times. The field was pulverized well to obtain a good tilth and laid out as per the plan. Individual plots were prepared and leveled as per the plot size before taking up sowing operation. A uniform NPK doses of 25:50:75 kg ha^{-1} was applied to all the plots through urea, single super phosphate and muriate of potash. The treatments were given through foliar application as per the treatment schedule twice at flowering stage and peg formation stage. The seeds were hand dibbled at 5 cm depth by adopting a spacing of 30 × 10 cm and covered with soil. Plots were irrigated immediately after sowing and subsequent irrigation was given and when required by crop during crop growth period. Five plants were tagged in each plots used for taking biometric observations and five plants in three replication were allowed by grown up to maturity and harvested on 105 DAS and utilized for recording DMP. The data were statistically analyzed by following the procedure outlined by Gomez and Gomez (1984).

Results

The foliar application of humic acid along with DAP and micronutrients twice at flowering and peg formation stage, significantly influenced the growth characters *viz.,* plant height, number of leaves $plant^{-1}$, leaf area index, number of nodules $plant^{-1}$, chlorophyll content and dry matter production at different growth stages of groundnut crop.

Plant height

The plant height increased as crop growth progresses. The crop responded well for the foliar application of HA. There was a significant increase in plant height with the combined foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%. The control recorded the lowest value. At flowering stage (FS), the highest plant height (37.70 cm) was recorded in the treatment T_8,which received combined foliar application of DAP @2.0% + HA @0.3% + Mm @ 0.3%, twice at flowering and peg formation stages, followed by T_5 (DAP @ 2.0% + HA @ 0.3%), T_7 (HA @ 0.3% + Mm @ 0.3%), T_3 (HA @ 0.3%),T_6 (DAP @2.0% +Mm @ 0.3%), T_2 (DAP @ 2.0%) and T_4 (Mm @ 0.3%) recorded 36.27, 34.92, 33.59, 33.44, 32.01 and 30.45 cm respectively. The lowest plant height was recorded in the treatment T_1 (28.60 cm). However, the treatments T_3 and T_6 were on par. Among the various treatments, the highest plant height was registered in the treatment T_8, which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (48.70 cm) at peg formation stage (PFS) succeeded by the treatments T_5 (46.92 cm), T_7 (45.25 cm),T_3 (43.60 cm) on par with T_6 (43.41 cm), subsequent to this T_2 (41.63 cm) and T_4 (39.69 cm). The lowest plant height was noticed in the treatment T_1 (37.40 cm). At harvest stage (HS), the highest plant height (60.70 cm) was found in the treatment T_8, which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (twice at FS and PFS), followed by the treatments $T_5 > T_7 > T_3$ on par with $T_6 > T_2 > T_4$ recorded 59.18, 57.73, 56.32, 56.15, 54.63 and 52.97 cm respectively. The lowest plant height was recorded in the control (51.00 cm) (Table 2).

Number of leaves $plant^{-1}$

Foliar application of HA along with DAP and micronutrients to groundnut, significantly increased the number of leaves at different stages of crop growth. The maximum number of leaves $plant^{-1}$ at FS (23.50) was recorded in the treatment T_8, which received combined foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%, twice at FS and PFS followed by the treatments T_5 (DAP @ 2.0% + HA @ 0.3%), T_7 (HA @ 0.3% + Mm @ 0.3%), T_3 (HA @ 0.3%), T_6 (DAP @ 2.0% + Mm @ 0.3%), T_2 (DAP @ 2.0%) and T_4 (Mm @ 0.3%) recorded 23.17, 22.86, 22.55, 22.52, 22.19 and 21.83 respectively. The minimum number of leaves $plant^{-1}$ (21.40) was recorded in control, T_1. At PFS, the maximum number of leaves $plant^{-1}$ was recorded in the treatment T_8, which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (35.50), followed by the treatment T_5 (35.00), succeeded by T_7 (34.52), next to this T_3 (34.06), which was almost equal to T_6 (34.00), followed by T_2 (33.50) and T_4 (32.95). The minimum number of leaves $plant^{-1}$ was recorded in the treatment T_1 (32.30). As the crop growth progresses after peg formation stage there will be a decline in number of leaves $plant^{-1}$ at harvest stage, however, among the various treatments, the maximum number of leaves $plant^{-1}$ at harvest stage was registered in the treatment T_8, which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (29.20) twice at FS and PFS, succeeded by the treatments T_5, T_7, T_3, T_6, T_2 and T_4 recorded 28.73, 28.28, 27.85, 27.79, 27.32 and 26.81 respectively. The minimum number of leaves $plant^{-1}$ was noticed in the control plot (26.20) (Table 3).

Leaf area index (LAI)

A significant increase in leaf area index of groundnut was found with the foliar application of HA. There was a significant increase in leaf area index with the interaction effect of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%. Among the various treatments the treatment T_8. recorded the highest LAI at FS (1.44), PFS (3.25) and HS (2.99)which received the combined foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% twice at flowering stage and peg formation stage, this was followed by the treatment T_5, received DAP @ 2.0% + HA @ 0.3%, which recorded the LAI at FS (1.37), PFS (3.08) and HS (2.84), followed by the treatment T_7 (HA @ 0.3% + Mm @ 0.3%) recorded 1.31 at FS, 2.91 at PFS and 2.70 of LAI at HS, followed by T_3,which received HA @ 0.3%, recorded LAI of 1.25, 2.75 and 2.56 at FS, PFS and HS respectively, which was almost equal to T_6 (DAP @ 2.0% + Mm @ 0.3%), registered 1.24 at FS, 2.73 at PFS and 2.54 of LAI at HS, this was followed by the treatment T_2 (DAP @ 2.0%) recorded 1.17, 2.56 and 2.39 of LAI at FS, PFS and HS respectively, succeeded by the treatment T_4,which received Mm @ 0.3%, registered 1.10 at FS, 2.37 at PFS and 2.22 of LAI at HS. The control, T_1 recorded the minimum leaf area index at FS (1.01), PFS (2.15) and HS (2.03) (Table 4).

Number of nodules plant^{-1}

Foliar application of HA gradually increased the number of nodules plant^{-1} in groundnut. At FS, among the various treatments, the maximum number of nodules plant^{-1} was found in the treatment T_8, which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (28.50) twice at FS and PFS followed by $T_5 > T_7 > T_3$ on par with $T_6 > T_2 > T_4$ recorded 27.29, 26.15, 25.02, 24.89, 23.68 and 22.36 respectively. The minimum number of nodules plant^{-1} was recorded in control (20.80). The maximum number of nodules plant^{-1} at PFS was found in the treatment T_8, which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (55.40), succeeded by the treatments T_5 (DAP @ 2.0% + HA @ 0.3%), T_7 (HA @ 0.3% + Mm @ 0.3%), T_3 (HA @ 0.3%) on par with T_6 (DAP @ 2.0% + Mm @ 0.3%), T_2 (DAP @ 2.0%) and T_4 (Mm @ 0.3%) recorded 54.80, 54.24, 53.68, 53.62, 53.02 and 52.37 respectively. The minimum number of nodules plant^{-1} was recorded in the treatment T_1 (51.60). At harvest stage, the maximum number of nodules plant^{-1} was found in the treatment T_8, which received the combined foliar application of DAP @ 2.0% +HA @ 0.3% + Mm@ 0.3%(30.60) followed by T_5(29.30), T_7 (28.06), T_3 (26.85), T_6 (26.71), T_2 (25.41)and T_4 (23.98).The minimum number of nodules plant^{-1} was recorded in the treatment T_1 (22.30). However, the treatments T_3 and T_6 were found to be statistically on par (Table 5).

Chlorophyll content

The chlorophyll content increased as crop growth progresses. The crop responded well for the foliar application of HA. There was a significant increase chlorophyll content with the combined application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%. The highest chlorophyll content (1.46 mg g^{-1}) at flowering stage was recorded in the treatment T_8, which received combined foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% twice at FS and PFS, this was succeeded by T_5, T_7, T_3 equal to T_6 followed by T_2 and T_4 recorded 1.40, 1.34, 1.28, 1.28, 1.22 and 1.15 mg g^{-1} respectively. The lowest chlorophyll content was recorded in the treatment T_1 (1.07 mg g^{-1}). At peg formation stage, the highest chlorophyll content was recorded in the treatment T_8, which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (2.59 mg g^{-1}) followed T_5 (DAP @ 2.0% + HA @ 0.3%), T_7 (HA @ 0.3% + Mm @ 0.3%), T_3 (HA @ 0.3%), T_6 (DAP @ 2.0% + Mm @ 0.3%), T_2 (DAP @ 2.0%) and T_4 (Mm @ 0.3%) by recorded 2.38, 2.19, 2.00, 1.98, 1.77 and 1.55 mg g^{-1} respectively. The lowest chlorophyll content was recorded in the treatment T_1 (1.28 mg g^{-1}). However, the treatments T_3 and T_6 were statistically on par (Table 6).

Dry matter production

The DMP increased as crop growth progresses. The crop responded well for the foliar application of HA. There was a significant increase in DMP with the interaction effect of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%. The control recorded the lowest DMP. At FS, the highest DMP was recorded in the treatment T_8, which received the combined foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (2327 kg ha^{-1}) followed by $T_5 > T_7 > T_3$ on par with $T_6 > T_2 > T_4$ recorded 2101, 1887, 1678, 1653, 1427 and 1181 kg ha^{-1} respectively. The lowest DMP was recorded in the treatment T_1 (890 kg ha^{-1}). Among the various treatments, the highest DMP was recorded in the treatment T_8, which received DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% (3975 kg ha^{-1}) at PFS, followed by T_5 (3662 kg ha^{-1}), succeeded by T_7 (3367 kg ha^{-1}), next to this T_3 (3078 kg ha^{-1}), which is comparably equal to T_6 (3044 kg ha^{-1}), subsequently followed by T_2 (2732 kg ha^{-1}) and T_4 (2391 kg ha^{-1}). The lowest DMP was recorded in the treatment T_1 (1989 kg ha^{-1}). However, the treatments T_3 and T_6 were found to be on par. The highest DMP at harvest stage (5551 kg ha^{-1}) was registered in the treatment T_8, which received the foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% twice at flowering and peg formation stages, followed by T_5 (DAP @ 2.0% + HA @ 0.3%), T_7 (HA @ 0.3% + Mm @ 0.3%), T_3 (HA @ 0.3%) on par with T_6 (DAP @ 2.0% + Mm @ 0.3%), T_2 (DAP @ 2.0%) and T_4 (Mm @ 0.3%) recorded 5123, 4720, 4324, 4277, 3850 and 3384 kg ha^{-1} respectively. The lowest DMP was recorded in the treatment T_1 (2833 kg ha^{-1}) (Table 7 and Fig.1).

Discussion

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

Plant height, number of leaves plant^{-1} and LAI

The trend of increasing growth parameters such as plant height, number of leaves, and leaf area index with the foliar application of HA in groundnut was reported earlier by MacCarthy *et al.* (2001) and concluded that humates enhance nutrient uptake, improve soil structure and increase the yield and quality of various oil seed crops. Researchers also found that lower dose of humic acid equally effective to their higher levels in increasing plant growth and enhancing the nutrient uptake (Salt *et al.,* 2001). Humic acid influence plant growth both direct and indirect ways. Indirectly, it improves physical, chemical and biological conditions of soil, while directly, it increase chlorophyll content, accelerates plant respiration and hormonal growth responses, increases penetration in plant membranes, *etc*. These effects of humic acid operate singly or in integration. Humic sources extent their influence on foliar transport in number of ways. The foliar application enhances the absorption of nutrients by the leaf at site of application. The above findings are consonance with the findings of Chen and Solovitch (2003). The morphological character (plant height, no of leaves plant^{-1} and leaf area index) differ due to foliar application of fertilizer. The significant effect of foliar application of DAP was reported earlier by Hatwar *et al.* (2003) it is due to the fact that application of DAP resulted in greater mobilization of macronutrients. These findings are in good harmony with the reports of Manasa (2013). Foliar application of micronutrients have a significant influence on plant height, number of leaves plant^{-1} and leaf area index. Due to the application of B promoted the absorption of N by groundnut and these helped in increasing plant growth and development (Rezaul *et al.,* 2013) the results are in confirming with Jing *et al.* (1994).Due to the application of Zn, helps in activation of many enzymes and helps in utilization of nitrogen (Sharma and Jain, 2003). This was proved by this experiment i.e., foliar application of HA @ 0.3% + DAP @ 2.0% + Mm @ 0.3% results in maximum plant height, number of leaves plant^{-1} and LAI.

Number of nodules plant^{-1}

Humic acid has a positive effect on number of nodules. Nodule development appeared to be dependent on source-sink relationship. This is a function of growth habit of legume crop. Treatments which produced and maintained more active photosynthesis are able to nodules well due to availability of adequate photosynthetic product. HA application had a definite input on the protein synthesis and nucleic acid synthesis. The high cation exchange capacity of HA prevents nutrients from leaching. It absorbs the nutrients from chemical fertilizer and these exchanges of nutrients are slowly released to the plants. Foliar application of humic acid fastens the absorption of N and P through foliage and induces nodules formation and rhizobial activity (Metre *et al.,* 2013). The increased number of nodules plant^{-1} was attributed to greater availability phosphorus at nodule formation stage through foliar feeding of DAP. Similar results were found by Naveen Kumar (2012), Shinde *et al.* (2001) due to combined foliar spray of major nutrients. Application of micronutrients (Mo) increased number of nodules. It might be due to the fact that Mo is a constituent of enzyme nitrogenase which is essential for the process of symbiotic N_2 fixations. This unique role of Mo in enhancing nitrogen fixation might have increased the nitrogen availability to crop plants for efficient growth and development (Shankar *et al.,* 2017).

Chlorophyll content

Humic acid has a convincing effect on chlorophyll content. The increase in chlorophyll content with the foliar application of HA may be due to the rate of quenching of chlorophyll inflorescence, which was markedly increased in the plant leaves and the steady state value of quenching (Bakry *et al.,* 2014). These results are in agreement with those obtained by El-Hariri *et al.* (2004) and Bakry *et al.* (2013). The chlorophyll content increased due to the foliar application of DAP. The combined application of HA @ 0.3% + DAP @ 2.0% + Mm @ 0.3% produced higher chlorophyll content at PFS (2.59) which was 51% higher compared to control (1.28). This is due to foliar application of nitrogen through DAP produced higher chlorophyll content. Increased chlorophyll content in leaves was attributed to greater availability of nitrogen for the formation of chlorophyll, which inturn increased the rate of photosynthesis and resulted in greater production and accumulation of total dry matter. Similar observations were recorded by Thakare *et al.* (2006) and Naveen Kumar (2012). The foliar feeding of micronutrients had a compelling effect on chlorophyll content. The increase in chlorophyll content may be due to zinc and iron take part in chlorophyll synthesis and imparts dark green colour to the plants. Similar results were found by Babaein *et al.* (2011) in sunflower and Galavi *et al.* (2011) in safflower crop.

Dry matter production

There was a tremendous increase in DMP by 49% with the combined foliar application of HA @ 0.3% + DAP 2.0% + Mm @ 0.3% over control (Fig. 2). The results illustrated that groundnut plant treated with HA (@ 0.3%) recorded significant increase of dry weight of plant compared to control plants. These obtained results were in agreement with those obtained by Peymaninia *et al.* (2012) on wheat and Bakry *et al.* (2013) on flax crop. These obtained increase in response to humic acid due to that, HA is considered to increase the permeability of plant membranes and enhance the uptake of nutrients (Piccolo *et al.,* 1992). It could be concluded that this increase may be due to the role of humic acid in increasing endogenous hormone as IAA and the role of these hormones in stimulating cell division or cell enlargement and this inturn improve plant growth (Abdel Mawgoud *et al.,* 2007). Further more HA increased the porosity of soil and improve growth of root system which leads to increase the shoot system (Garcia *et al.,* 2008). The higher dry matter production at harvest stage was recorded with foliar spray of HA @ 0.3% + DAP @ 2.0% + Mm @ 0.3%, due to supply of all the three major nutrients through foliar application at critical stage. Further, it also enhances the photosynthetic activity leading to production and accumulation of more carbohydrates and auxins which favour retention of more flowers ultimately leading to more number of reproductive parts per plant. Similar observations were earlier noticed by Veerabhadrappa and Yeledhalli (2005). Micronutrients played a significant role in increasing of dry matter production. The increase in DMP might be due to the significant improvement in nodulation and N fixation with the Zn and B application. Zinc enhanced the plant growth through auxin production and activation of several enzyme systems as evidenced by Saxena and Chandel (1997) and Elayaraja and Singaravel (2012).

Conclusion

The present study concludes that foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% was established as the best treatment by recording the highest growth parameters of groundnut in sandy loam soil. This increase was due to the micronutrient mixture enhances the nitrogen fixation and activation of several enzyme systems. Hence, the combined foliar application of DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3% recommends for higher production of growth characters in groundnut crop.

Table 1 : Physico-chemical properties of the experimental soil

S. No.	Properties	Content
I	**Physical Properties**	
1.	Mechanical composition	
	Sand	60.2
	Silt (%)	28.4
	Clay (%)	11.3
	Textural class	Sandy loam
	Taxonomical class	*Typic ustifluvent*
2.	Bulk density (Mg m^{-3})	1.45
3.	Particle density (Mg m^{-3})	3.20
4.	Pore space (%)	42.28
5.	Water holding capacity (%)	31.45

S. No.	Properties	Content
II	**Physico-chemical properties**	
1.	PH	8.3
2.	Electrical conductivity (dS m^{-1})	1.02
3.	Cation exchange capacity (C mol (p+) kg^{-1})	14.10
III	**Chemical properties**	
1.	Organic carbon (%)	0.52
	Available macronutrients (kg ha^{-1})	
2.	N	168.20
3.	P_2O_5	12.10
4.	K_2O	193.42
IV	**Exchangeable cations (C mol (p+) kg^{-1})**	
1.	Ca	4.6
2.	Mg	2.4
V	**Available micronutrients (DTPA extractable (mg kg^{-1}))**	
1.	Zn	1.71
2.	Mn	17.94
3.	B	0.08

Table 2 : Effect of humic acid, DAP and micronutrients foliar spray on plant height (cm) of groundnut

Treatments	Plant height (cm)		
	FS	**PFS**	**HS**
T_1 – Control	28.60	37.40	51.00
T_2 – DAP @ 2.0%	32.01	41.63	54.63
T_3 – HA @ 0.3%	33.59	43.60	56.32
T_4 – Mm @ 0.3%	30.45	39.69	52.97
T_5 – DAP @ 2.0% + HA @ 0.3%	36.27	46.92	59.18
T_6 – DAP @ 2.0% + Mm @ 0.3%	33.44	43.41	56.15
T_7 – HA @ 0.3% + Mm @ 0.3%	34.92	45.25	57.73
T_8 – DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%	37.70	48.70	60.70
SED	**0.46**	**0.58**	**0.49**
CD (0.05)	**0.98**	**1.21**	**1.04**

HA – Humic acid; Mm – Micronutrient mixture

Table 3 : Effect of humic acid, DAP and micronutrients foliar spray on number of leaves $plant^{-1}$ of groundnut

Treatments	Number of leaves $plant^{-1}$		
	FS	**PFS**	**HS**
T_1 – Control	21.40	32.30	26.20
T_2 – DAP @ 2.0%	22.19	33.50	27.32
T_3 – HA @ 0.3%	22.55	34.06	27.85
T_4 – Mm @ 0.3%	21.83	32.95	26.81
T_5 – DAP @ 2.0% + HA @ 0.3%	23.17	35.00	28.73
T_6 – DAP @ 2.0% + Mm @ 0.3%	22.52	34.00	27.79
T_7 – HA @ 0.3% + Mm @ 0.3%	22.86	34.52	28.28
T_8 – DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%	23.50	35.50	29.20
SED	**0.11**	**0.16**	**0.15**
CD (0.05)	**0.23**	**0.34**	**0.32**

HA – Humic acid; Mm – Micronutrient mixture

Table 4 : Effect of humic acid, DAP and micronutrients foliar spray on leaf area index (LAI)of groundnut

Treatments	LAI		
	FS	**PFS**	**HS**
T_1 – Control	1.01	2.15	2.03
T_2 – DAP @ 2.0%	1.17	2.56	2.39
T_3 – HA @ 0.3%	1.25	2.75	2.56
T_4 – Mm @ 0.3%	1.10	2.37	2.22
T_5 – DAP @ 2.0% + HA @ 0.3%	1.37	3.08	2.84
T_6 – DAP @ 2.0% + Mm @ 0.3%	1.24	2.73	2.54
T_7 – HA @ 0.3% + Mm @ 0.3%	1.31	2.91	2.70
T_8 – DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%	1.44	3.25	2.99
SED	**0.02**	**0.06**	**0.05**
CD (0.05)	**0.05**	**0.12**	**0.10**

Table 5 : Effect of humic acid, DAP and micronutrients foliar spray on number of nodules plant^{-1} of groundnut

Treatments	Number of nodules plant^{-1}		
	FS	PFS	HS
T_1 – Control	20.80	51.60	22.30
T_2 – DAP @ 2.0%	23.68	53.02	25.41
T_3 – HA @ 0.3%	25.02	53.68	26.85
T_4 – Mm @ 0.3%	22.36	52.37	23.98
T_5 – DAP @ 2.0% + HA @ 0.3%	27.29	54.80	29.30
T_6 – DAP @ 2.0% + Mm @ 0.3%	24.89	53.62	26.71
T_7 – HA @ 0.3% + Mm @ 0.3%	26.15	54.24	28.06
T_8 – DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%	28.50	55.40	30.60
SED	**0.39**	**0.19**	**0.42**
CD (0.05)	**0.83**	**0.41**	**0.89**

HA – Humic acid; Mm – Micronutrient mixture

Table 6 : Effect of humic acid, DAP and micronutrients foliar spray on chlorophyll content (mg g^{-1}) of groundnut

Treatments	Chlorophyll content (mg g^{-1})	
	FS	PFS
T_1 – Control	1.07	1.28
T_2 – DAP @ 2.0%	1.22	1.77
T_3 – HA @ 0.3%	1.28	2.00
T_4 – Mm @ 0.3%	1.15	1.55
T_5 – DAP @ 2.0% + HA @ 0.3%	1.40	2.38
T_6 – DAP @ 2.0% + Mm @ 0.3%	1.28	1.98
T_7 – HA @ 0.3% + Mm @ 0.3%	1.34	2.19
T_8 – DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%	1.46	2.59
SED	**0.02**	**0.07**
CD (0.05)	**0.04**	**0.14**

HA – Humic acid; Mm – Micronutrient mixture

Table 7 : Effect of humic acid, DAP and micronutrients foliar spray on dry matter production (DMP) of groundnut

Treatments	DMP (kg ha^{-1})		
	FS	PFS	HS
T_1 – Control	890	1989	2833
T_2 – DAP @ 2.0%	1427	2732	3850
T_3 – HA @ 0.3%	1678	3078	4324
T_4 – Mm @ 0.3%	1181	2391	3384
T_5 – DAP @ 2.0% + HA @ 0.3%	2101	3662	5123
T_6 – DAP @ 2.0% + Mm @ 0.3%	1653	3044	4277
T_7 – HA @ 0.3% + Mm @ 0.3%	1887	3367	4720
T_8 – DAP @ 2.0% + HA @ 0.3% + Mm @ 0.3%	2327	3975	5551
SED	**73.32**	**101.33**	**138.67**
CD (0.05)	**153.96**	**212.79**	**291.21**

HA – Humic acid; Mm – Micronutrient mixture

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