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Soil and foliar application of humic acid on productivity of groundnut (*Arachis hypogea* L.)

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Abstract
A field experiment was conducted at the Agricultural Research Station, Nipani, University of Agricultural Sciences, Dharwad during *kharif* 2018 to study the effect of soil and foliar application of humic acid (HA) on productivity of groundnut. Combined application of 30 kg HA ha^{-1} to soil as basal followed by foliar spray of 2 per cent HA at 45 days after sowing (DAS) along with recommended dose of fertilizers (RDF) recorded significantly higher plant height (21.06 cm), number of branches per plant (8.53), total dry matter production per plant (29.67 g) at harvest, number of pods per plant (21.1), pod weight per plant (19.9 g), pod (2802 kg ha^{-1}), haulm (3924 kg ha^{-1}) and kernel yield (1971 kg ha^{-1}) as compared to RDF alone (21.06 cm, 8.53, 29.67 g, 15.3, 13.6 g, 2319 kg ha^{-1}, 3273 kg ha^{-1} and 1536 kg ha^{-1}, respectively).

Keywords: Farm yard manure, groundnut, humic acid, productivity

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the essential oilseed crop of sub- tropical and tropical regions of the world which belongs to the family leguminoceae. It is commonly known as peanut, poor man’s almond and also called as king of oil seeds. Groundnut seeds are valued for both its oil and protein content as it contains about 40-45 per cent oil and 25 per cent protein. Groundnut plays a major role in bridging the vegetable oil gap in the country. In India, the reasons for low groundnut yields are the use of low yielding varieties, cultivation of the crop on marginal lands under rainfed conditions, occurrence of drought due to vagaries of monsoon, poor soil fertility, higher incidence of diseases and pests and lack of adequate nutrition. Among many factors, maintenance of organic matter in satisfactory level is one of the constraints. Among organic manures, farm yard manure is one of the major sources of manure in ancient times. However, limited availability of manures and slow release of plant nutrients from the manures are important constraints in their use as source of nutrients. Recently use of organic manures reduced due to non-availability in adequate quantities and high cost factor involved. So, it is necessary to go for organic end products like humic substances for better soil condition, higher input use efficiency and enhanced productivity of crops. Humic acid is other option of organic manure or organic matter.

Organic matter becomes a vital part in both crop production and to maintain soil fertility but meeting this one is difficult in present agriculture. Hence, the answer is humus, which is well decomposed organic matter derived from microbial action. Schnitzer (2000) [9] reported that the term total humic substances (humic acid + fulvic acid + humin) are also synonymous with soil organic matter. Humic acid application along with recommended dose of fertilizers and organic manures plays a greater role in plant biochemical and physiological activities and soil fertility, consequently resulting in better growth and yield of crops (Kalaichelvi *et al.*, 2006) [5]. Humic acids in small amount act as specific sensitizing agents, increasing the permeability of cell membrane and resulting in an increased uptake of nutrients by the plants in large amounts and are a source of available iron. Humic acid typically contains heterocyclic compounds with carboxylic, phenolic, alcoholic and carbonyl fractions extracted out from lignite with high molecular weight. Humic acid extracted from various resources such as lignite, peat, coal, farm yard manure, coir pith *etc.*, besides natural persistence in the soil.

Humic acid applications represent sustainable solution for the integration of agricultural systems into new eco-friendly strategies for future farming.

They are possibly the most versatile natural substances ever known (Ulukan, 2008) [14]. It is a promising natural resource to be used as an alternative for fertilizers to increase crop productivity. Humic acid might benefit plant growth by improving nutrient uptake and hormonal effects. Some studies have documented yield increases in vegetables, root crops, flowers and cereals by humic substances (Nikbakht *et al.*, 2008) [6]. In this way, addition of humic acid directly into the soil and foliar spray to crop is one of the most economical and rapid way in order to solve organic manures problem in agriculture.

Material and Methods

The field experiment was conducted at Agricultural Research Station, Nipani, located in the Northern Transition Zone (Zone-8) of Karnataka, during *kharif* 2018. The experiment was laid out with thirteen treatments, replicated thrice in a randomized complete block design. The treatment combinations include recommended dose of fertilizers alone (T_1) and it is common for all treatment, FYM at 7.5 t ha^{-1} (T_2), soil application of HA @ 20 kg ha^{-1} (T_3), soil application HA @ 30 kg ha^{-1} (T_4), foliar spray of HA at 1 per cent (T_5), foliar spray of HA at 1.5 per cent (T_6), foliar spray of HA at 2 per cent (T_7), $T_3 + T_5$ (T_8), $T_3 + T_6$ (T_9), $T_3 + T_7$ (T_{10}), $T_4 + T_5$ (T_{11}), $T_4 + T_6$ (T_{12}) and $T_4 + T_7$ (T_{13}) were laid out in plots of 3.0 m x 4.0 m with 3 replications in randomized block design. The soil of the experimental field was black clayey type with neutral in pH (7.61), medium in available nitrogen (331.2 kg N ha^{-1}) and medium in available phosphorus (32.7 kg P_2O_5 ha^{-1}) with high in available potassium (453.2 kg K_2O ha^{-1}), medium in organic matter content (0.54 %) and normal in salt content (0.55 dS m^{-1}). Healthy and bold seeds of TAG-24 variety selected for sowing. Seeds were weighed separately for each plot at the rate of 125 kg ha^{-1} with spacing of 30 × 10 cm. Recommended fertilizer dose of 18: 46: 25 kg NPK ha^{-1} through DAP and MOP for all treatment. Farm yard manure (FYM) was applied to treatment (T_2) 15 days before sowing @ 7.5 t ha^{-1}. Humic acid source used in experiment was Mangala Gold and marketed by Mangalore Chemicals & Fertilizers LTD. Humic acid granules at 20 and 30 kg ha^{-1} were applied at sowing as a basal application. Crop was sprayed with humic acid @ 1, 1.5 and 2 per cent at peg initiation stage (45 DAS). The observations were taken in randomly selected and tagged five plants in each plot. Crop was harvested at maturity, immediately after uprooting, plants were sun dried for 2 days under field condition. Then the pods were separated from plants manually and dried under the sun till they attain satisfactory drying. Growth parameters like plant height, number of branches and total dry matter production per plant observation taken at harvest. The pod yield and haulm yield per plot were recorded. Statistical analysis of data was done as per the methodology suggested by Gomez and Gomez (1984) [3].

Results and Discussion

Significantly higher number of pods per plant (21.1), pod weight per plant (19.9 g), pod yield (2802 kg ha^{-1}), haulm yield (3924 kg ha^{-1}) and kernel yield (1971 kg ha^{-1}) were recorded with soil application of humic acid @ 30 kg ha^{-1} plus foliar spray of 2 per cent humic acid at 45 DAS with RDF (T_{13}) which was followed by soil application of 30 kg humic acid ha^{-1} + foliar spray of 1.5 per cent humic acid at 45 DAS + RDF (T_{12}), soil application of 30 kg humic acid ha^{-1} + humic acid foliar spray at 1 per cent at 45 DAS + RDF (T_{11}), soil application of 20 kg humic acid ha^{-1} + humic acid foliar spray at 2 per cent at 45 DAS + RDF (T_{10}), soil application of 20 kg humic acid ha^{-1} + humic acid foliar spray at 2 per cent at 45 DAS + RDF (T_9) and soil application of 20 kg humic acid ha^{-1} + foliar spray of 2 per cent humic acid at 45 DAS + RDF (T_8). Least number of pods per plant (15.3), pod weight per plant (13.6 g), pod yield (2319 kg ha^{-1}), haulm yield (3273 kg ha^{-1}) and kernel yield (1536 kg ha^{-1}) were was observed in treatment receiving RDF alone (T_1) and data presented in Table 1. Presence of higher amount of carboxylic and phenolic hydroxyl groups and lesser aromatic nature of humic acid might have increased the nutrient absorption, translocation and increase in physiological processes thus resulting in better growth and development of crop. Humic acid act as growth regulators and enhance stress tolerance in plants. The enhancement in pod and haulm yield in these treatments was to extent of 20.1 and 20.0 per cent respectively over control. These results are in agreement with those of Selim *et al.* (2012) [10] who reported that increasing humic acid application rates up to 120 kg ha^{-1} enhanced the plant growth and tuber production in potato. Similarly, Savita (2018) [8] reported that 29.76 and 24.89 per cent yield improvement in soybean, respectively, in sandy loam due to soil application of humic substances at 5 kg ha^{-1} + foliar spray of humic substances extracted from vermicompost (0.2 %) at 40 DAS (1741 kg ha^{-1}). Significantly higher number of pods per plant (21.07), pod weight per plant (19.94 g) and numerically the highest 100 kernel weight (36 g) was recorded respectively for the treatments with soil application of humic acid at 30 kg ha^{-1} + foliar spray of 2 per cent humic acid at 45 DAS. Similarly, Waqas *et al.* (2014) [15] obtained higher pods per plant, test weight and grain yield per plant with soil application of humic acid in mung bean and Tuba Arjumend *et al.* (2015) [13] in wheat. Increase in yield parameters may be attributed to efficient translocation of photosynthates and appropriate nutrient accessibility (Harshad Thakur, 2013) [4]. RDF + FYM treated plot recorded considerably reduced output because FYM is bulky in nature and takes a long time to release nutrients. Similar findings were observed by Harshad Thakur (2013) [4] who reported that application of RDF + FYM at 5 t ha^{-1} recorded significantly lower dry matter yield, seed yield and stalk yield of sunflower over of RDF + 12.5 kg ha^{-1} of humic acid as soil application. Humic acid is comparatively slower oxidisable in nature might have released the nutrients slowly oxidisable up to seed filling stage thereby enhancing kernel weight on account of better mobilization of nutrients to seeds. Thenmozhi *et al.* (2004) [12] also reported significant effect of humic acid on yield of groundnut. Similar result was also recorded by Talavia (2005) [11] in groundnut. Dandge *et al.* (2016) [1] also reported significant effect of humic acid on yield of soybean.

Significantly higher plant height (21.06 cm), number of branches per plant (8.53) and total dry matter production (29.67 g) at harvest were recorded in treatment receiving soil application of 30 kg ha^{-1} humic acid plus foliar spray of 2 per cent humic acid at 45 DAS (T_{13}) over RDF (T_1) and data presented in Table 2. The improvement in growth characteristics of groundnut in response to humic acid application was due to the presence of growth promoting substances like Indole acetic acid (IAA), gibberellins and auxins in its structure which are directly involved in cell respiration, oxidative phosphorylation, photosynthesis, protein synthesis and various enzymatic reactions. The pre-requirement for greater returns in any crop is a greater accumulation of total dry matter and its partitioning into different components of the plant coupled with the maximum translocation of photosynthates to sink. Total dry matter partitioning in individual plant parts may depends on various environmental factors influencing growth like interception of photo synthetically active radiation, relative humidity, CO_2 concentration and soil moisture availability. Significantly the least total dry matter production (23.78 g plant^{-1} at harvest) was obtained with T_1 (RDF alone). The plots which received humic only through foliar spray was found inferior to soil application. However, the plots received humic acid for both soil as well foliar was found better than those received either from soil or from foliar alone. The extent of increase in total dry matter was 28.67 per cent at 60 DAS and at harvest, respectively over control. Higher total dry matter in the treatments which received humic acid both through soil and foliage might be due to balanced availability of macro and micro nutrients at all stages by preventing their fixation and precipitation, there by improved nutrient use efficiency and better availability of nutrients in soil. This was in line with the findings of Sangeetha and Singaram (2007) [7]. According to Gayathri (2016) [2] application of humic acid at 90 kg ha^{-1} with NPK showed significantly higher growth parameters in capsicum as compared to treatment which received NPK + FYM.

Conclusions

Findings of the present investigation revealed that the combined application of humic acid (soil and foliar) found better as compared to either soil application or foliar spray. Soil application of humic acid at 30 kg ha^{-1} along with foliar spray of 2 per cent humic acid at 45 DAS in presence of RDF enhanced the yield parameters of groundnut.

Table 1: Yield parameters of groundnut as influenced by soil and foliar application of humic acid at different levels

Tr. No.	Treatment details	Number of pods per plant	Pod weight per plant (g)	Yield (kg ha^{-1})		
				Pod	Haulm	Kernel
T_1	Recommended dose of fertilizers* (RDF)	15.3	13.6	2319	3273	1536
T_2	Farm yard manure at 7.5 t ha^{-1}	18.5	16.8	2661	3669	1825
T_3	SA of humic acid @ 20 kg ha^{-1}	17.9	16.1	2577	3614	1768
T_4	SA of humic acid @ 30 kg ha^{-1}	18.4	16.6	2646	3642	1820
T_5	FS of humic acid @ 1%	16.8	14.6	2423	3393	1630
T_6	FS of humic acid @ 1.5%	17.1	14.9	2476	3445	1682
T_7	FS of humic acid @ 2%	17.4	15.1	2502	3499	1711
T_8	$T_3 + T_5$	18.9	17.4	2672	3691	1848
T_9	$T_3 + T_6$	19.2	17.8	2682	3717	1863
T_{10}	$T_3 + T_7$	19.8	18.4	2710	3769	1890
T_{11}	$T_4 + T_5$	20.0	18.8	2761	3806	1935
T_{12}	$T_4 + T_6$	20.5	19.3	2780	3886	1951
T_{13}	$T_4 + T_7$	21.1	19.9	2802	3924	1971
	S.Em.±	0.82	0.90	46.8	80.0	42.1
	CD at 5%	2.40	2.62	136.6	233.4	123.0

*RDF applied to all treatments
SA: Soil application of humic acid as basal at the time of sowing
FS: Foliar spray of humic acid at 45 DAS (Pegging stage)

Table 2: Growth parameters of groundnut at harvest as influenced by soil and foliar application of humic acid at different levels

Tr. No.	Treatment Details	Plant height (cm)	Number of branches per plant	Total dry matter production (g plant^{-1})
T_1	Recommended dose of fertilizers* (RDF)	16.68	6.80	23.78
T_2	Farm yard manure at 7.5 t ha^{-1}	18.69	7.80	27.07
T_3	SA of humic acid @ 20 kg ha^{-1}	17.72	7.47	26.22
T_4	SA of humic acid @ 30 kg ha^{-1}	18.11	7.80	26.67
T_5	FS of humic acid @ 1 %	17.02	7.00	24.56
T_6	FS of humic acid @ 1.5 %	17.91	7.20	24.96
T_7	FS of humic acid @ 2 %	18.34	7.27	25.56
T_8	$T_3 + T_5$	18.83	7.93	27.33
T_9	$T_3 + T_6$	19.44	8.07	27.67
T_{10}	$T_3 + T_7$	19.94	8.20	28.00
T_{11}	$T_4 + T_5$	20.11	8.33	28.22
T_{12}	$T_4 + T_6$	20.81	8.47	28.89
T_{13}	$T_4 + T_7$	21.06	8.53	29.67
	S.Em.±	0.88	0.37	0.97
	CD at 5%	2.56	1.07	2.83

*RDF applied to all treatments
SA: Soil application of humic acid as basal at the time of sowing
FS: Foliar spray of humic acid at 45 DAS (Pegging stage)

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