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Physico-Chemical Properties And Microbial Count Of Soil After Harvest Of Sunflower (*Helianthus Annuus* L.) As Influenced By Humic Acid And Fulvic Acid.

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ABSTRACT
An experiment was conducted during kharif 2012 to find the effect of humic substances on growth, yield and quality of sunflower (DRSH- 1) at the college farm, college of agriculture, Rajendranagar, Hyderabad. The results indicated that nutrient uptake and chemical properties of soil were significantly influenced by different treatments. However, available nitrogen status was not altered by different treatments. Nutrient uptake (N, P and K) and post-harvest nutrient status (P and K) were higher under combined application of RDF (60: 60: 30 kg N, P_2O_5 and K_2O ha^{-1}) + soil application of humic acid granules @ 12.5 kg ha^{-1} while, the lowest nutrient status was associated with application of recommended dose of fertilizer alone.
Key words: *Chemical properties, humic acid, nutrient uptake and microbial load.*

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INTRODUCTION

Oilseeds play an important role in agricultural economy of India. Oilseeds are important next only to food grains in terms of area, production and value (Hegde 2012). The production of oilseeds in India is below the target levels. The shortage of edible oils has become a problem in India with increasing demographic pressure. During 2010-11, the country imported about 9.2 m t of vegetable oils costing around Rs. 38,000 crores (Hegde 2012). Sunflower can play a key role in meeting out the shortage of edible oils in the country. The major factors attributing to less productivity of sunflower in India are that the crop is grown on marginal lands with low organic matter and poor fertility under rainfed conditions and inadequate application of major nutrients like nitrogen. As soils under rainfed condition are low in organic carbon status, there is a need to enhance application of organic matter for improving productivity. Prolonged use of chemical fertilizers alone in intensive cropping systems leads to unfavorable soil nutrient status, harmful effects on soil physico-chemical and biological properties and thus defies the concept of sustainable crop production.

Natural organic substances such as humic and fulvic acids play an essential role in ensuring soil fertility and plant nutrition. Addition of such molecules either to the soil or through foliar spray along with adequate amount of conventional fertilizers improves the efficiency of applied fertilizers apart from promoting the conversion of unavailable form of nutrients to available forms. The organic compounds prepared from humic and fulvic substances have chelating, plant growth stimulating effects and positive effect on the growth of various groups of microorganisms. The presence of humic acids was found to increase the content and total amount of nitrogen in plant. Keeping the above points in view, the present investigation was initiated.

MATERIALS AND METHODS:

An experiment was conducted during *Kharif* season 2012 at the college farm, college of agriculture, Rajendranagar, Hyderabad. The soil of the experimental site was sandy loam in texture, neutral in reaction (pH 7.3), low in organic carbon (0.41%), medium in available phosphorus (25.9 kg ha^{-1}) and available potassium (240.3 kg ha^{-1}) and low in available nitrogen (244.6 kg ha^{-1}).

The experiment was laid out in randomized block design consisting of seven treatments and replicated thrice. The treatment details are T_1 - RDF (Recommended dose of fertilizer through inorganics 60: 60: 30 kg N, P_2O_5 and K_2O ha^{-1}), T_2 - RDF + FYM @ 5 t ha^{-1}, T_3 - RDF + 12.5 kg ha^{-1} humic acid granules (soil application as basal), T_4 - RDF + foliar spray of humic acid @ 0.5 %, T_5 – RDF + foliar spray of humic acid @ 1.0 %, T_6 – RDF + foliar spray of fulvic acid @ 0.5 %, T_7 - RDF + foliar spray of fulvic acid @ 1.0 %. Foliar spray of humic and fulvic acid was done at button and flowering stages respectively.
Sunflower hybrid (DRSH-1) was sown on 6^{th} of July 2012 adopting a spacing 60 x 30 cm. Irrigation was given as required considering the rainfall. During the crop period a total of 519.2 mm rainfall was received in 33 rainy days. Pre- emergence herbicide pendimethalin 30 % EC @ 240 ml ha^{-1} was sprayed one day after sowing in optimum soil moisture. The crop was harvested on 7^{th} October; threshed, dried and seed yield was recorded.
A uniform dose of 60 kg P_2O_5 and 30 kg K_2O ha^{-1} was applied through single super phosphate and muriate of potash as basal dose to all the plots. Nitrogen (60 kg ha^{-1}) was applied through urea, half at sowing, one fourth at bud initiation stage and the remaining one fourth at flowering stage. Humic acid granules @ 12.5 kg ha^{-1} were applied at sowing as a basal application. Foliar spray of humic and fulvic acid @ 0.5 % and 1.0 % was done at button and flowering stages respectively. To minimize the drift losses spraying was done during early hours. FYM (5 t ha^{-1}) was applied (T_2) 15 days before sowing. The farm yard manure contained 0.3 %, 0.1 % and 0.2 % N, P_2O_5 and K_2O respectively.
The soil samples were collected from experimental site from 0-15 and 15-30 cm depth after harvest of sunflower crop and composite sample was dried under shade, gently powdered to pass through a 2 mm sieve and soil samples were subjected to chemical analysis as per the standard procedures. The available nitrogen was determined by Alkaline Permanganate method (Subbaiah and Asija 1956). Available phosphorus was determined by Olsen method (Olsen *et al.,* 1954) and potassium was determined by Flame Photometer (Jackson 1973). The plant samples collected from the destructive sampling at harvest in all experimental plots for recording dry matter accumulation were used for estimation of nitrogen, phosphorus and potassium after recording their dry weights. Nitrogen content in plant samples was estimated by Modified Microkjeldahl method (Piper 1966) after digesting the organic matter by H_2SO_4 and H_2O_2. Phosphorus and potassium contents were determined after digesting the plant material with tri-acid mixture of 9:4:1 (HNO_3: H_2SO_4: $HClO_4$) (Piper 1966). Phosphorus content was determined by Vanado – Molybdo phosphoric yellow colour method as described by (Jackson 1979) using Spectrophotometer at 420 nm. Potassium content was determined with ELICO – Flame Photometer (Piper 1966).The nutrient concentration was expressed in percentage.

RESULTS AND DISCUSSION

Nitrogen application increases the availability of nitrogen thus resulting in higher nitrogen uptake and higher nitrogen content in plant. Tan (1978) reported that, at pH 7.0, humic and fulvic acids were capable of dissolving small amounts of K from the minerals by chelating action, complex reactions or both. The results showed that nutrient uptake (nitrogen 39.7 kg ha^{-1}), phosphorus (6.8 kg ha^{-1}) and potassium (16.5 kg ha^{-1}) by seed was higher with the same treatment. (Table 1) Further, combined application of recommended dose of fertilizer and 12.5 kg ha^{-1} humic acid granules recorded significantly higher nitrogen uptake by stalk (45.6 kg ha^{-1}) over foliar spray of 0.5 and 1.0% fulvic acid + RDF at capitulum initiation and flowering stage (35.7 and 34.4 kg ha^{-1}) followed by application of RDF + FYM @ 5 tha^{-1} (31.0 kg ha^{-1}) and plots fertilized with recommended dose of fertilizer alone (28.9 kg ha^{-1}) and it was on par with foliar spray of humic acid @ 1.0 and 0.5 % + RDF (40.1 and 39.6 kg ha^{-1}). While, in terms of phosphorus and potassium uptake by stalk combined application of recommended dose of fertilizer and 12.5 kg ha^{-1} humic acid granules recorded significantly higher over rest of the treatments. Nutrient uptake is the resultant of nutrient content and dry matter accumulation.
Higher nitrogen uptake manifested by crop under (T_3) was mainly due to the consistent supply of nitrogen resulting in improved dry matter accumulation and nutrient content. Further, increased nitrogen uptake was also due to efficient root system with improved cell permeability coupled with better absorption due to better availability of nutrients in the soil solution (Sumathi and Rao 2007). Enhanced P uptake under treatments involving humic acid granules application might be due to the conversion of insoluble form of P to soluble form resulting in its increased availability. Similar increase of P uptake with the addition of humic substances was reported by Khan *et al.,* (1997). Humic substances play definite role in liberating fixed K because of their chelating power apart from the priming effect of solubilizing native i.e. fixed and non- exchangeable form of K. The enhanced microbial activity due to humic acid application would also have paved way for increased availability of K by reducing its fixation in the soil and dissolution of fixed K. (Schnitzer and Kodama 1972 and Tan and McCrery 1975). The NPK content in the stem was low at seed filling as compared to flowering stage. Obviously, this reduction is also owed to their translocation to the sink (seed). At maturity, most of the leaves senesced and were not functional.

This was in confirmation with the findings of Amruthavalli and Reddy (2000), Thavaprakash *et al.,* (2002) and Day *et al.,* (2011).

With respect to soil pH, electrical conductivity and organic carbon there were no significant differences among the treatments. Lower organic carbon content (0.4 %) was observed in plots fertilized with recommended dose of fertilizer alone. Higher organic content under the treatments consisting humic substances either as soil application or in the foliar spray and FYM might be attributed to the increased addition of crop residues in comparison to rest of the treatments. With respect to post harvest available nitrogen status did not differ significantly among the different treatments. However post harvest soil phosphorus and potassium status differed significantly among different treatments. Combined application of recommended dose of fertilizer and 12.5 kg ha^{-1} humic acid granules (T_3) recorded significantly higher phosphorus and potassium status (35.1 and 280.5 kg ha^{-1} respectively) over (T_2) RDF + FYM @ 5 t ha^{-1} (29.3 and 247.6 kg ha^{-1}) and (T_1) plots fertilized with recommended dose of fertilizer alone (27.2 and 232.1 kg ha^{-1}). The soil available phosphorus and potassium status under T_3 was on par with foliar spray of 0.5 and 1.0% humic and fulvic acid along with RDF. Lower post harvest P and K status of soil observed with RDF alone might be due to crop removal and also due to their transformation in the soil. (Table 2)

The Bacterial, Actinomycetes and Fungal population was higher with application of humic acid @ 12.5 kg ha^{-1} with RDF. While, lowest microbial population observed in plots fertilized with RDF alone. This favorable effect of humic acid on microbial population might be due to attributed to stimulating effect of humic acid on the growth of micro organisms Kudrina, 1951. A favorable increase in microbial population in seed soaking than in foliar spray was noticed by Bhuma and Selvakumari, 2003. (Table 3).

Table 1. Seed yield, stalk yield, nitrogen, phosphorus and potassium uptake (kg ha^{-1}) at harvest as influenced by different treatments.

Treatments	Nitrogen (kg ha^{-1})		Phosphorus (kg ha^{-1})		Potassium (kg ha^{-1})	
	Seed	Stalk	Seed	Stalk	Seed	Stalk
T_1 – RDF (60:60:30)	21.4 (1.57)	28.9 (0.58)	3.9 (0.29)	9.1 (0.18)	9.1 (0.67)	26.9 (0.54)
T_2 – RDF + FYM @ 5 t ha^{-1}	24.1 (1.64)	31.0 (0.60)	4.3 (0.30)	9.6 (0.19)	10.4 (0.71)	29.0 (0.56)
T_3 – RDF + 12.5 kg ha^{-1} humic acid granules	39.7 (2.12)	45.6 (0.76)	6.8 (0.37)	13.7 (0.23)	16.5 (0.88)	49.0 (0.82)
T_4 – RDF + FS of HA @ 0.5 %	30.7 (1.78)	39.6 (0.71)	5.3 (0.31)	10.6 (0.19)	12.9 (0.75)	38.1 (0.68)
T_5 – RDF + FS of HA @ 1.0 %	30.7 (1.79)	40.1 (0.71)	5.6 (0.33)	11.1 (0.20)	13.8 (0.80)	42.4 (0.75)
T_6 – RDF + FS of FA @ 0.5 %	29.6 (1.74)	35.7 (0.65)	5.1 (0.30)	10.7 (0.19)	12.5 (0.74)	37.1 (0.67)
T_7 – RDF + FS of FA @ 1.0 %	28.0 (1.72)	34.4 (0.63)	4.9 (0.30)	10.4 (0.19)	11.8 (0.73)	35.4 (0.64)
S.Em. ±	1.8	2.1	0.2	0.4	0.6	1.6
CD (P=0.05)	5.5	6.5	0.9	1.3	1.8	5.0

Note*: FS: Foliar spray HA: Humic acid FA: Fulvic acid
- Figures in parenthesis are nutrient concentration.

Table 2. Post harvest available soil nutrient status (kg ha^{-1}) and soil fertility properties as influenced by different treatments.

Treatment	Nitrogen	Phosphorus	Potassium	Soil pH	Organic carbon (%)	EC (ds m^{-1})
T_1 – RDF (60:60:30 kg N, P_2O_5 and K_2O ha^{-1})	209.4	27.2	232.1	6.9	0.4	0.3
T_2 – RDF + FYM @ 5 t ha^{-1}	222.7	29.3	247.6	7.0	0.4	0.3
T_3 – RDF + 12.5 kg ha^{-1} humic acid granules	253.4	35.1	280.5	7.3	0.4	0.3
T_4 – RDF + FS of HA @ 0.5 %	242.5	33.0	272.6	7.2	0.4	0.3
T_5 – RDF + FS of HA @ 1.0 %	244.7	33.1	277.3	7.2	0.4	0.3
T_6 – RDF + FS of FA @ 0.5 %	241.5	32.4	271.4	7.2	0.4	0.3
T_7 – RDF + FS of FA @ 1.0 %	237.5	32.2	268.9	7.2	0.4	0.3
S.Em. ±	13.1	1.1	8.2	0.2	0.01	0.01
CD (P=0.05)	NS	3.4	25.5	NS	NS	NS
Initial	**244.6**	**25.9**	**240.3**	**7.3**	**0.41**	**0.21**

Table 3. The bacterial, Actinomycetes and fungal population (CFU gram soil^{-1}) influenced by different treatments in sunflower

Treatment	Bacteria (x 10^6)	Actinomycetes (x 10^4)	Fungi (x 10^4)
T_1 – RDF (60:60:30)	42 x 10^6	71.5 x 10^4	92.5 x 10^4
T_2 – RDF + FYM @ 5 t ha^{-1}	73.5 x 10^6	78 x 10^4	130.5 x 10^4
T_3 – RDF + 12.5 kg ha^{-1} humic acid granules (soil application)	91 x 10^6	121.5 x 10^4	164 x 10^4
T_4 – RDF + FS of HA @ 0.5 % (capitulum and flowering stage)	50 x 10^6	82.5 x 10^4	121 x 10^4
T_5 – RDF + FS of HA @ 1.0 % (capitulum and flowering stage)	63.5 x 10^6	93.5 x 10^4	134 x 10^4
T_6 – RDF + FS of FA @ 0.5 % (capitulum and flowering stage)	48 x 10^6	72 x 10^4	140.5 x 10^4
T_7 – RDF + FS of FA @ 1.0 % (capitulum and flowering stage)	54 x 10^6	76.5 x 10^4	139 x 10^4
Initial			

Note*: FS: Foliar Spray CFU: Colony Forming Unit
HA: Humic Acid FA: Fulvic acid

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