E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2023; 6(1): 18-21
Received: 09-10-2022
Accepted: 12-11-2022

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Foliar application of humic acid with varied nutrient levels on performance of sweet corn

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DOI: https://doi.org/10.33545/2618060X.2023.v6.i1a.157

Abstract
A field experiment was conducted at AHRS Kathalagere, KSNUAHS, Shivamogga, to study the effect of foliar application of humic acid with varied nutrient levels on performance of sweet corn during summer season of 2021. The experiment was laid out in RCBD with eight treatments replicated thrice. The results revealed that significantly higher total dry matter accumulation (218.59 g plant^{-1}) at harvest, furthermore cob length (21.42 cm), cob girth (15.77 cm), fresh cob yield (198.18 q ha^{-1}) and green fodder yield (263.80 q ha^{-1}), total uptake of NPK (198.51, 48.94, 169.16 kg ha^{-1}, respectively), gross returns (Rs. 284,009 ha^{-1}), net returns (Rs. 197,328 ha^{-1}) and B: C ratio (3.28) were recorded with the application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray as compared to recommended dose of fertilizers applied treatment. It can be concluded that foliar application of humic acid can be supplemented to agriculture to enhance the crop productivity.

Keywords: Humic acid, yield, gross returns

Introduction
In India, sweet corn is grown in a relatively limited area by some farmers and other private organizations to meet domestic requirements. The net income of sweet corn is quite high compared to traditional maize types. Cobs are harvested at milky stage, 20- 30 days earlier than grain corn and optimum kernel moisture content of 70 to 74 per cent is required to achieve acceptable frozen cobs. The yield potential of sweet corn is low in India compared to the potentially achievable yield because of inadequate application of fertilizers, conventional cultivation of low yielding cultivars and lack of good management practices. The maximum yield potential can be achieved by balanced application of nutrients which includes the four basic principles *i.e*. right time, right rate, right source and right method that would ensure higher economic return with environmental balance (Majumdar *et al*., 2012) [5]. One of the agronomic approaches to increase yield and nutrition is the foliar application of humic acid. More recently, foliar application has been widely used and accepted as an one of the important technique that could be effective for 6-20 times more than soil application to achieve higher crop productivity and production. The benefits of foliar feeding have been well documented and increasing efforts have been made to achieve consistent responses.

Natural organic substances such as humic acid play an essential role in ensuring soil fertility and plant nutrition. Addition of such molecules either to the soil or through foliar application 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 substances have chelating, plant growth stimulating effects and positive effect on the growth of various groups of microorganisms. With the above mentioned facts, a field experiment was carried out to study the foliar application of humic acid with varied nutrient levels on performance of sweet corn at field unit.

Material and Methods
A field experiment was conducted at AHRS Kathalagere, KSNUAHS, Shivamogga, to study the

effect of foliar application of humic acid with varied nutrient levels on performance of sweet corn during summer season of 2021. The experiment was laid out in RCBD with eight treatments replicated thrice. The treatments include *viz.*, absolute control (T_1), 75% RDF (T_2), 100% RDF (T_3), 125% RDF (T_4), humic acid at 0.2% foliar spray (T_5), 75% RDF + humic acid at 0.2% foliar spray (T_6), 100% RDF + humic acid at 0.2% foliar spray (T_7) and 125% RDF + humic acid at 0.2% foliar spray (T_8). The soil was analyzed for pH, organic carbon, available nitrogen, phosphorus, potassium status before sowing. The soil of the experimental site was slightly acidic in reaction (pH 6.3) with a low salt load (EC 0.18 dS m^{-1}). The organic carbon content was medium (0.63%) and medium in nitrogen (284.85 kg ha^{-1}) and potassium (281.65 kg ha^{-1}) and high in phosphorus (65.64 kg ha^{-1}). Yield (biological and economical) was recorded from individual plots at harvest and converted to kg/ha. Composite soil sample were used to assess soil nutrient status. Standard statistical methods were used for comparing the treatment means.

Yield components

Application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray recorded significantly higher dry matter accumulation (218.59 g $plant^{-1}$) at harvest of crop duration as compared to application of 100 per cent RDF (181.78 g $plant^{-1}$) (Table 1). The increase in assimilatory surface area due to both humic acid and recommended dose of fertilizers could be ascribed to the overall development in plant growth, vigour and production of sufficient photosynthesis through increased leaf area thereby increased in dry matter production. The humic acid is known to increase uptake of certain elements and stimulate the dry matter production of shoots. The results confirm the findings of Miyauchi *et al.* (2012) and Hafez Magda (2003). Among the different treatments, application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray recorded significantly higher cob length (21.42 cm) and cob girth (15.77 cm), followed by 125 per cent RDF (19.82 and 15.11 cm, respectively) as compared to 100 per cent RDF (18.60 and 13.63 cm, respectively). Better NPK status of plant at reproductive stage consequent to an increasing availability of nutrients to sweet corn maintained complimentary source sink relationship because of the increasing NPK fertilization improved growth, photosynthesis and other plant growth and yield components. These finding are supported by Sulok Kevin *et al.* (2007) [10]. Application of humic acid, stimulates plant enzymes and increase their production, it acts as an organic catalyst in many biological process, promotes the development of chlorophyll, sugars and amino acids in plants and aid in photosynthesis, increases vitamin and mineral content of plants and thickens the cell wall in reproductive parts (Dhanasekaran and Govindasamy, 2002) [2].

Yield

Significantly higher fresh cob yield (198.18 q ha^{-1}) and green fodder yield (263.80 q ha^{-1}) was obtained with the application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray, followed by 125 per cent RDF (181.17 and 254.87 q ha^{-1}, respectively) compared to 100 per cent RDF (158.19 and 223.78 q ha^{-1}, respectively). Application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray resulted in increasing the fresh cob yield and green fodder yield to an extent of 25.27 and 17.88 per cent, respectively over application of 100 per cent RDF. Combined application of both organic and inorganic sources which facilitated greater availability of nutrients for the development of vegetative structures, increased in photosynthetic activity, acceleration of the respiration process, hormonal growth responses and increasing penetration in plant membranes, cell division, number of grains, husked weight, more dry matter accumulation, nutrient uptake, improved translocation of photosynthates from source to sink and partitioning which resulted in higher fresh cob yield and green fodder yield. Similar observations were also reported by Rao *et al.* (1987) [7], Reddy *et al.* (2018) [8] and Shahzad *et al.* (2017) [9].

Nutrient uptake and availability

Significantly higher total uptake of nitrogen (198.51 kg ha^{-1} at harvest) was recorded with the application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray compared to application of 100 per cent RDF (170.02 kg ha^{-1} at harvest). Increase in nitrogen uptake with the application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray was to an extent of 16.75 per cent at harvest over application of 100 per cent RDF. This might be attributed to the effect of humic acid on the membrane permeability and the better developed root system (Manal *et al.*, 2016). Further, higher uptake was manifested with combined application of RDF and humic acid as a result of increase in nitrogen concentration and dry matter accumulation. Application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray recorded significantly higher total uptake of phosphorus (48.94 kg ha^{-1} harvest) in comparison with application of 100 per cent RDF (39.62 kg ha^{-1} at harvest). The magnitude of increase in total phosphorus uptake with application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray was to an extent of 23.52 per cent at harvest over application of 100 per cent RDF. This is mainly because humic acid increases the cell membrane permeability that results in increased nutrient uptake and accumulation in plant cells. This is related to the surface activity of humic substances resulting from the presence of both hydrophilic and hydrophobic sites. Therefore, humic substances may interact with phospholipid structures of the cell membranes and react as carriers of nutrients through them (Chen and Schnitzer, 1978) [1]. Significantly higher total potassium uptake (169.16 kg ha^{-1} at harvest) was recorded with the application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray as compared to application of 100 per cent RDF (144.20 kg ha^{-1} at harvest). Increased total potassium uptake with the application of 125 per cent RDF + humic acid at 0.2 per cent foliar spray was to an extent of 17.3 per cent at harvest over application of 100 per cent RDF. Humic acid enhances cell permeability, which in turn made for rapid entry of minerals in leave cells and so resulted in higher uptake of plant nutrients. Similar observations were also reported by Habashy and Laila (2005) [3]. Humic acid promotes hormonal activity in plants as well as promotes antioxidant production in plants which in turn, reduces free radicals thereby increase root vitality and improved nutrient uptake (Khaled and Fawy, 2011) [4].

Progressive increase in NPK application resulted in more available nutrient content in soil. Higher application of NPK to soil leads to excess availability of nutrients which are left in the field after uptake by the crop. Significantly higher available nitrogen (241.39 kg ha^{-1}) and available potassium (190.26 kg ha^{-1}) were recorded in 125% RDF + Humic acid at 0.2% foliar spray which was supplied with 125 per cent RDF + humic acid at 0.2 per cent foliar spray and significantly higher available phosphorous (85.32 kg ha^{-1}) was recorded with the application of 125 per cent RDF. While least available nitrogen (137.13 kg ha^{-1}), available phosphorous (25.41 kg ha^{-1}) and available potassium (130.87 kg ha^{-1}) were recorded in treatment absolute control as result of mining of nutrients. Depending on the levels of fertilizers applied and uptake by the crop, available soil nutrients status varied after the harvest.

Economics

Higher gross return (Rs. 284,009 ha^{-1}), net return (Rs. 197,328 ha^{-1}) and B: C ratio (3.28) was recorded in the treatment 125% RDF + Humic acid at 0.2% foliar spray which received 125 per cent RDF + humic acid at 0.2 per cent foliar spray. The higher gross return and net return was mainly attributed to higher fresh cob yield and green fodder yield of sweet corn. Similar findings were also observed by Patel (2011) [6] in wheat.

Table 1: Total dry matter and yield attributes of sweet corn at harvest as influenced by foliar application of humic acid with varied nutrient levels

Treatments	TDM (g/plant)	Cob length (cm)	Cob girth (cm)	Fresh cob yield (q ha^{-1})	Green fodder yield (q ha^{-1})
T_1: Absolute control	153.93	13.92	9.72	103.72	148.70
T_2: 75% RDF	168.56	16.42	10.17	142.91	205.65
T_3: 100% RDF	181.78	18.60	13.63	158.19	223.78
T_4: 125% RDF	206.98	19.82	15.11	181.17	254.87
T_5: Humic acid at 0.2% foliar spray	169.95	14.97	10.70	120.62	173.61
T_6: 75% RDF + Humic acid at 0.2% foliar spray	178.60	17.13	11.85	153.84	212.43
T_7: 100% RDF + Humic acid at 0.2% foliar spray	199.99	19.63	14.43	171.45	240.15
T_8: 125% RDF + Humic acid at 0.2% foliar spray	218.59	21.42	15.77	198.18	263.80
S.Em ±	4.34	0.34	0.32	7.21	11.78
CD @ 5%	12.92	1.01	0.97	21.49	29.28

Table 2: Nutrient uptake and availability by sweet corn at harvest as influenced by foliar application of humic acid with varied nutrient levels

Treatments	Nutrient uptake			Nutrient availability		
	Nitrogen (kg ha^{-1})	Phosphorus (kg ha^{-1})	Potassium (kg ha^{-1})	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})
T_1: Absolute control	102.69	26.12	87.21	137.13	25.41	130.87
T_2: 75% RDF	151.91	35.87	125.53	198.29	60.57	165.25
T_3: 100% RDF	170.02	39.62	144.20	215.55	74.62	169.04
T_4: 125% RDF	188.15	45.34	161.39	237.76	85.32	188.48
T_5: Humic acid at 0.2% foliar spray	129.84	28.25	108.75	152.83	34.19	142.32
T_6: 75% RDF + Humic acid at 0.2% foliar spray	161.20	40.36	132.41	190.46	56.11	154.73
T_7: 100% RDF + Humic acid at 0.2% foliar spray	179.72	43.48	150.85	204.68	69.43	181.17
T_8: 125% RDF + Humic acid at 0.2% foliar spray	198.51	48.94	169.16	241.39	80.28	190.26
S.Em ±	2.88	1.62	1.95	5.31	1.42	3.67
CD @ 5%	8.59	4.83	5.83	15.84	4.23	10.95

Table 3: Economics of sweet corn cultivation as influenced by foliar application of humic acid with varied nutrient levels

Treatments	Cost of cultivation (Rs.ha^{-1})	Gross returns (Rs.ha^{-1})	Net returns (Rs.ha^{-1})	B:C
T_1: Absolute control	61,000	118,590	57590	1.94
T_2: 75% RDF	81,563	206,344	124781	2.53
T_3: 100% RDF	83,459	228,025	144566	2.73
T_4: 125% RDF	84,881	261,008	176127	3.07
T_5: Humic acid at 0.2% foliar spray	78,850	174,167	95317	2.21
T_6: 75% RDF + Humic acid at 0.2% foliar spray	83,363	221,237	137874	2.65
T_7: 100% RDF + Humic acid at 0.2% foliar spray	85,259	246,904	161645	2.90
T_8: 125% RDF + Humic acid at 0.2% foliar spray	86,681	284,009	197328	3.28

Reference

1. Chen Y, Schnitzer M. Effect of humic substances on plant growth. In MacCarthy, P. (ed.) Humic substances in soil and crop Sciences: Selected Readings. ASA-SSSA, Madison. 1978, 161-186.
2. Dhanashekaran K, Govindaswamy R. Effect of urea coated with lignite derived humic substances on the performance of rice in a Typic Chromustert soil. Adv. Plant Sci. 2002;15(2):505-509.
3. Habashy NR, Laila KM. Effects of organic growth-promoting substances as humic acids and indol-acetic acid on wheat crop with special reference of some chemical composition. J Agril. Res. 2005;30(5):1607-1624.
4. Khaled H, Fawy HA. Effect of different levels of humic Acids on the nutrient content, plant growth and soil properties under conditions of salinity. Soil. Water Res. 2011;6:21-29.
5. Majumdar K, Kumar AS, Satyanarayan T, Jat ML. Economics of potassium fertilizer application in rice, wheat, and maize grown in the Indo-Gangetic plains. Indian J Fertilizer. 2012;8(5):4453.
6. Patel GG. Effect of organic and inorganic fertilizers in comparison with humic acid on growth, yield and quality of wheat (*Triticum aestivum* L.). Ph.D. Thesis, Anand Agric. Univ., Anand, Gujarat, 2011.
7. Rao MM, Govindasamy R, Chandrasekaran S. Effect of humic acid on Sorghum. Curr. Sci. 1987;1273-1276.
8. Reddy BH, Bulbule AV, Gajbhije PN, Patil DS. Effect of

foliar application of plant nutrients on growth and yield and economics of finger millet (*Eleusine coracana* L.). Int. J Curr. Microbiol. App. Sci. 2018;7(3):2203-2209.

9. Shahzad AN, Fatima A, Sarwar N, Bashir S, Rizwan M, Qayyum MF, *et al*. Foliar application of potassium sulphate partially alleviates pre- anthesis drought-induced kernel abortion in maize. Int. J Agric. Biol. 2017;19:495-501.
10. Sulok Kevin MT, Ahmad OH, Asrin W, Rajan A, Ahzam M. Towards growing boro rice on low land soils: A preliminary nitrogen and potassium fertilization trial. American. J Agric. Biol. Sci. 2007;2(2):99-105.