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OA Khan
Division of Soil Science and Agricultural Chemistry, Faculty of Agriculture, SKUAST-K, Wadura, Sopore, Jammu and Kashmir, India

JA Sofi
Division of Soil Science, Faculty of Horticulture, SKUAST-K, Shalimar, Jammu and Kashmir, India

NA Kirmani
Division of Soil Science, Faculty of Horticulture, SKUAST-K, Shalimar, Jammu and Kashmir, India

GI Hassan
Division of Fruit Science, Faculty of Horticulture, SKUAST-K, Shalimar, Jammu and Kashmir, India

SA Bhat
Division of Basic Science, Faculty of Horticulture, SKUAST-K, Shalimar, Jammu and Kashmir, India

MH Chesti
Directorate of Extension, SKUAST-K, Shalimar, Jammu and Kashmir, India

SM Ahmad
Directorate of Extension, SKUAST-K, Shalimar, Jammu and Kashmir, India

Correspondence
OA Khan
Division of Soil Science and Agricultural Chemistry, Faculty of Agriculture, SKUAST-K, Wadura, Sopore, Jammu and Kashmir, India

Effect of N, P and K Nano-fertilizers in comparison to humic and fulvic acid on yield and economics of red delicious (*Malus x domestica* Borukh.)

OA Khan, JA Sofi, NA Kirmani, GI Hassan, SA Bhat, MH Chesti and SM Ahmad

Abstract
A field experiment was carried out on comparative basis in Apple orchards of village Kanelwan of District Anantnag, during the year 2017 and 2018. The two orchards selected were managed on two contrasting aspects of cultivation. The conventional orchard was cultivated on the basis of recommendation from Sher-e-Kashmir University of Agricultural Sciences and Technology-Kashmir, however, the organic orchard was managed totally on organic basis of cultivation. The conventional orchard of apple was treated with Nitrogen (100 ppm, 200 ppm and 300 pmm), Phosphorous (30 ppm, 40, ppm and 50 ppm) and Potassium (100 ppm, 150 ppm and 200 ppm) nano- fertilizers, while the organic apple orchard was treated with Humic acid (0.05%, 0.10% and 0.15%) and Fulvic acid (1.5%, 2.5% and 3.5%). The experiment was conducted in Randomized Completely Blocked Design replicated thrice. The foliar application of N, P and K nano fertilizers and Humic and Fulvic acid was done at two stages to meet the fertilizer requirements, one just before the pink bud stage and the other just before the pea size stage of apple. The maximum yield was recorded under conventional orchard was recorded in N application @ 300 ppm in both the years (28.15 and 29.89 tons/ha respectively), furthermore, under organic apple cultivation application of Humic acid @ 0.15% recorded highest yield (19.96 and 20.97 tons/ha respectively). The economic assessment of the experiment revealed that application of P nano fertilizer @ 50 ppm resulted in highest net B:C ratio of 6.31 and application of humic acid @ 0.15% recorded highest B:C ratio of 5.51. The experimental results of the present study predicted that application of nano-fertilizers in conventional system and humic and fulvic acid in organic system will result in increased yield and returns.

Keywords: Nano, Humic, Fulvic, conventional orchard organic orchard, yield and economics

Introduction
Apple (*Malus x domestica* Borukh.) is a widely grown temperate fruit crop in the valley of Kashmir, which belongs to family *Rosaceae* and sub family *pomoideae*. Red delicious being highly nutritive and pertaining great food and medicinal properties, has been named as king of temperate fruits (Eccher *et al.* 2014) [6]. It is grown in almost all the temperate areas of the world, and in India the production is confined mainly to Jammu and Kashmir, Himachal Pradesh, Uttrakhand and a few places in Arunachal Pradesh. Red delicious is one of the important fruit crops that has played a vital role in socio-economic upliftment of farmers dedicated to cultivation of the crop in the valley of Kashmir. According to FAO statistics (2017) [7], 84.63 million tons of apple is produced worldwide, with China (40,924,707 metric tons), United States (5,185,078 metric tons), Poland (3,195,299 metric tons), India (2,497,680 metric tons), Turkey (2,480,444 metric tons), Italy (2,473,608 metric tons) Chile (1,757,225 metric tons), Russia (1,624,000 metric tons), Iran (1,572,844 metric tons) and France (1,531,625 metric tons) being the largest apple producing countries of world. The state of Jammu and Kashmir has an annual production of 1,966,417 metric tons with an area of 161,773 hectares and productivity of 12.16 MT/ha (FAO, statistics 2017) [7]. Nano fertilzers or nano-encapsulated nutrients might have properties that are effective to crops, released the nutrients on-demand, controlled release of chemicals fertilizers that regulate plant growth and enhanced target activity (DeRosa *et al.*, 2010; Nair *et al.*, 2010) [5, 11]. Loading of nanoparticles with nutrient fertilizer is one of these innovations which are done in three ways: (i) Nutrient can be encapsulated inside nanoporous materials, (ii) coated with thin polymer film, or (iii) delivered as particle or emulsions of nanoscale dimensions (Rai *et al.*, 2012) [14]. In many studies, humic and fulvic acids preparations were reported to promote the root length (Vaughan & Malcolm 1979; Canellas *et al.*, 2002) [16, 2],

increase the uptake of mineral elements (Maggioni *et al.*, 1987; De Kreij & Basar 1995; Mackowiak *et al.*, 2001) [10, 4, 9], and to increase the fresh and dry weights of crop plants (Chen *et al.*, 2004) [3]. Since, there has been visible effects on growth of plants due to these compounds (humic and fulvic acid), the use of same has been widely accepted by growers particularly in organic systems of cultivation in fruit crops. Taking the advantage of nano fertilizers and organic nutrients into consideration, the present study was taking into account for enhancing yield and returns in apple cultivation.

Material and Methods

Two experiments were conducted in apple orchards of Kanelwan Village of District Anantnag, in two apple orchards (Conventional and Organic Orchard) in the year 2017 and 2018. The inorganic/conventional orchard was treated with Nano-Nitrogen (100 ppm, 200 ppm and 300 pmm), Nano-Phosphorous (30 ppm, 40, ppm and 50 ppm) and Nano-Potassium (100 ppm, 150 ppm and 200 ppm) nano- fertilizers replicated thrice, however, all the treatments were given to separate plants individually, while as the other nutrients were given as per SKUAST-K recommendations, the control was fully treated as per recommendations of SKUAST-K. The organic apple orchard was treated with Humic acid (0.05%, 0.10% and 0.15%) and Fulvic acid (1.5%, 2.5% and 3.5%) replicated thrice, while the organic control was given an initial vermicompost dose of 20 kg/tree.

Result and Discussion

The yield of apple as a whole is sum total of all the manifestations due to the treatments and environmental factors that come across the apple cultivation system. The yield increments may be clearly attributed to the application of different treatments to the individual plants. The results pertaining to effect of N, P and K nano-fertilizers is presented in Table. 1, and revealed that application of N, P and K nano fertilizers had a significant effect on yield of apple in year 2017 and 2018. It was also found that application of N nano fertilizer had a significant effect on yield as compared to P and K nano fertilizers, with the effect being more pronounced in the second year of experiment. The application of N nano fertilizer @ 300 ppm recorded highest yield (28.15 and 29.89 tons/ha) and was at par with the highest treatment of P @ 50ppm (27.63 and 28.85 tons/ha) and K @ 200 ppm (27.38 and 28.54 tons/ha), respectively in the year 2017 and 2018, however all the highest treatments of N (300 ppm), P (50 ppm) and K (200 ppm) were significantly better than the control treatments. The results are in confirmation with the findings of Parizad *et al*, 2017 [12] and may be attributed to the fact that nitrogen being one of the essential nutrients that helps in increasing photosynthetic efficiency and is main part of the amino acids that form a good part of protein system, thus could have helped in producing a bulk of biomass (Akbarinia *et al*, 2013) [1].

With a general evaluation, the organic system of cultivation yields lower as compared to conventional or inorganic system of cultivation, the results recorded in organic apple cultivation when treated with different humic and fulvic acid concentrations does reveal the same and are presented in Table. 2. The application of Humic acid @ 0.15% recorded highest yield of 19.96 and 20.97 tons/hectare respectively in year 2017 and 2018, and the fulvic acid application of 3.5% recorded a yield of 20.81 and 19.96 tons/hectare, but were at par with one another, however, were significantly superior from the control treatments in both the years of experimentation. The above mentioned results due to humic and fulvic acid application can be attributed to the fact that humic acid has a tremendous potential of to stimulate growth and development through their action of stipulating activity of Plant Growth Promoting hormones like, cytokinins, auxins and gibberellins. The results are in accord with the findings of Taha *et al*, 2016 [15] and Pettit, 2004 [13].

The economic evaluation of experiments cannot be only considered on the basis of yield only, because of the fact that the apple produced from the higher treatments were better in quality as compared to control treatments, so fetch a good price from the market thus resulted in quite a good difference in the monetary returns of the treated plants as compared to the control plants. The economic evaluation of the experiment (Table. 3) suggested that application of P nano fertilizer @ 30 ppm had highest B:C ratio of 6.31 as compared control 4.82 when pooled over 2017 and 2018. However, the B:C ratio of organic cultivation was found to be on the lower side as compared to the cultivation in conventional/inorganic system of apple cultivation and the application of Humic acid @ 0.15% recorded highest B:C ratio as compared to other organic treatments. The results pertaining to higher B:C ratio as compared to control treatments is because of the fact that the produce of higher treatments were sold in A grade in the market, while those of the control were sold in B grade and lower due to reduced quality parameters. The results are in conformity with the findings of Kumar *et al* 2014 [8].

Conclusion

Nano fertilizers and humic acid & fulvic acid are now considered as the smart fertilizers in conventional and organic system of cultivation, respectively. It can be concluded from the above mentioned and discussed research that application of nano fertilizers and humic & fulvic acid can help to increase the yield very specifically. The economic assessment clearly concludes that the above treatments mentioned can help gain an extra 100 percent of benefits from the same land and resources.

Table 1: Effect of N, P and K nano-fertilizers on Yield (tons/ha) of apple in conventional cultivation.

Year\Treatment	2017	2018
Nano-N		
Control	22.27	22.35
100 ppm	24.62	25.78
200 ppm	26.92	28.16
300 ppm	28.15	29.89
Nano-P		
Control	22.31	22.34
30 ppm	25.67	26.78
40 ppm	26.67	27.83
50 ppm	27.63	28.85
Nano-K		
Control	22.33	22.38
100 ppm	25.07	26.15
150 ppm	26.42	27.55
200 ppm	27.38	28.54
±SEm	0.32	0.33
C.D($p \leq 0.05$)	0.89	0.92

Table 2: Effect of Humic and Fulvic acid on Yield of apple under organic cultivation.

Year\Treatment	2017	2018
Humic Acid		
Control	15.04	15.10
0.05%	17.68	17.83
0.10%	18.24	18.78
0.15%	19.96	20.97
Fulvic Acid		
Control	15.36	15.57
1.5%	17.53	18.73
2.5%	18.44	19.40
3.5%	19.62	20.81
±SEm	0.33	0.37
C.D($p \leq 0.05$)	0.99	1.14

Table 3: Application of N, P and K nano-fertilizers and Humic & Fulvic acid on B:C ratio of apple under conventional and organic apple orchards.

Treatment	Cost of Cultivation	Total Returns	Net Returns	B:C Ratio
Control Inorganic	229959.31	1338600	1108640.69	4.82
N 100 ppm	436543.47	2772000	2335456.53	5.35
N 200 ppm	449043.12	3029400	2580356.88	5.75
N 300 ppm	461542.77	3192200	2730657.23	5.92
P 30 ppm	423634.11	2884750	2461115.89	5.81
P 40 ppm	424467.42	2997500	2573032.58	6.06
P 50 ppm	425161.84	3106400	2681238.16	6.31
K100 ppm	423335.51	2817100	2393764.49	5.65
K 150 ppm	426668.75	2968350	2541681.25	5.96
K200 ppm	430140.87	3075600	2645459.13	6.15
Control Organic	159835.23	904200	744364.77	4.66
Humic 0.05%	260212.34	1597950	1337737.66	5.14
Humic 0.10%	271406.17	1665900	1394493.83	5.14
Humic 0.15%	282811.34	1841850	1559038.66	5.51
Fulvic 1.5%	276328.46	1631700	1355371.54	4.90
Fulvic 2.5%	282351.23	1702800	1420448.77	5.03
Fulvic 3.5%	294616.69	1819350	1524733.31	5.18

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