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EFFECT OF FOLIAR APPLICATION OF HUMIC ACID THROUGH VERMICOMPOST WASH AND NAA ON MORPHO-PHYSIOLOGICAL PARAMETERS AND YIELD OF SESAMUM

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ABSTRACT

A field experiment laid out in randomized block design was conducted to investigate the effect of different concentrations of humic acid and NAA on yield and yield components of sesamum at the experimental farm of Agriculture Botany Section, College of Agriculture, Nagpur during year 2017-18. Two foliar sprays of humic acid through vermicompost wash and NAA were given at 25 and 40 DAS. Three concentrations of humic acid (300, 400 and 500 ppm) and two concentrations of NAA (25 and 50 ppm) individually and in combination were tested. Foliar application of 400 ppm HA trough VCW+50 ppm NAA followed by 300 ppm HA through VCW+ 50 ppm NAA significantly enhanced plant height, number of branches, leaf area, dry weight, RGR, NAR, seed yield ha^{-1} and harvest index.

(Key words: Sesamum, humic acid through vermicompost wash, NAA, foliar spary)

INTRODUCTION

Sesame (*Sesamum indicum* L.) an oil seed crop of family Pedaliaceae, is one of the oldest cultivated crop in the world. Sesame occupies vital position in Indian agriculture and probably one of the ancient oilseed crop known and used by man. It is referred as "queen of oilseed". India rank first, both in the area and production of sesame in world. The sesame seed is a rich source of edible oil. Its oil content generally varies from 46 to 52% (Anonymous,2017 a). Sesame was cultivated on area of 13.98 lakh ha with the production of 6.09 lakh tonnes and productivity of 436 kg ha^{-1} during 2016-17 in the country (Anonymous, 2017 b). In Maharashtra, area was 0.330 lakh hectares with 0.70 lakh tonnes production and productivity of 232 kg ha^{-1}. In Vidarbha, area under sesame was 0.072 lakh hectares with 0.020 lakh tonnes production and productivity of 275 kg ha^{-1} (Anonymous,2017 c). The oil extracted from sesame is high quality, resistant to oxidation and rancidity even when stored at ambient air temperature.

Humic acid when externally supplied was observed to increase crop growth and ultimately the yield. It includes the nutritional status of soil and plant system. The high cation exchange capacity of humic acid prevents nutrients from leaching. It absorbs the nutrients from chemical fertilizers and these exchanged nutrients are slowly released to the plant. Humic acid proved many binding sights for nutrients such as calcium, iron, potassium and phosphorus. These nutrients are stored in humic acid molecule in a form of readily available to plant and are released when the plants required them. Humic acid increases the absorbance and translocation of nutrients in plants and ultimately influences yield.

Humic acid supplies polyphenols that catalyze plant respiration and increases plant growth.

Vermicompost wash is useful as foliar spray. It is transparent pale yellow bio fertilizer. It is a mixture of excretory products and mucous secretion of earthworm (*Lampitomautrii* and *Eiseniafoetida*) and organic micronutrients of soil, which may be promoted as "potent fertilizer" for better yield and growth (Shweta *et al.,* 2005). Vermicompost wash is having approximately 1300 ppm humic acid, 116 ppm dissolve oxygen, 50 ppm inorganic phosphate, 168 ppm potassium and 121 ppm sodium (Haripriya and Poonkodi, 2005). Vermicompost wash is having N-0.21%, P-0.042%, K-0.143%, Ca-0.186%, Mg-0.11%, S-0.058%, Fe-2.296 ppm, Zn-0.11 ppm, Cu-0.18 ppm (Anonymous, 2007).

NAA (Naphthalene Acetic Acid) is the synthetic auxin with the identical properties to that naturally occurring auxin. It prevents formation of abscission layer and thereby flower drop. It was observed that the growth regulators are involved in the direct transport of assimilates from source to sink (Sharma *et al.,* 1989).

This experiment aimed to investigate the effect of foliar application of humic acid through vermicompost wash and NAA on morpho-physiological parameters and yield of sesamum.

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MATERIALS AND METHODS

The field experiment was conducted during *rabi* season in 2017-18 at experimental farm of Agricultural Botany Section, College of Agriculture, Nagpur with the object to know the influence of foliar sprays of growth regulators on morpho- physiological parameters and yield of sesamum. This experiment was carried out in RBD with 3 replications (Table 1). The studied factors included three concentrations of humic acid through vermicompost wash (300, 400 and 500 ppm) and two concentrations of NAA (25 and 50 ppm) used as foliar spray alone or in combination like T_2 (25 ppm NAA), T_3 (50 ppm NAA), T_4 (300 ppm HA through VCW), T_5 (400 ppm HA through VCW), T_6 (500 ppm HA through VCW), T_7 (25 ppm NAA + 300 ppm HA through VCW), T_8 (25 ppm NAA + 400 ppm HA through VCW), T_9 (25 ppm NAA + 500 ppm HA through VCW), T_{10} (50 ppm NAA + 300 ppm HA through VCW), T_{11} (50 ppm NAA + 400 ppm HA through VCW), T_{12} (50 ppm NAA + 500 ppm HA through VCW) with T_1 (control).AKT-64 cultivar of sesamum was used in experiment. Observations on plant height and number of branches were recorded at the time of harvesting. Leaf area and dry weight of plant were recorded at 25, 40, 55 and 70 DAS stages. RGR and NAR also calculated at 25-40, 40-55 and 55-70 DAS stages. Seed yield ha^{-1} were recorded. Harvest index was also calculated.

RESULTS AND DISCUSSION

Plant height

Height is an important measure of growth. It is one of the visible measurements and is a function of internodes and leaf emergence. Since, leaves are born on stem, leaf area development and biomass production shows a close relationship with plant height.

Among the different concentrations of NAA and humic acid (through vermicompost wash) maximum increment in plant height was registered under the treatments T_{11} (400 ppm VCW +50 ppm NAA), T_{10} (300 ppm +50 VCW ppm NAA), and T_{12} (500 ppm VCW +50 ppm NAA). Treatments T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm VCW) and T_3 (50 ppm NAA) also recorded significantly maximum plant height over control and rest of the treatments. Treatments T_2 (25 ppm NAA), T_5 (400 ppm VCW), T_4 (300 ppm VCW), T_6 (500 ppm VCW) were found at par with control (T_1) in respect of plant height.

Number of branches plant^{-1}

Branches are the site of the leaves, flower and capsule formation. Hence, they are closely associated with the photosynthetic activity and yield of plant. So, number of branches is a desirable attribute for higher biomass production and yield.

A close examination of the data revealed marked effect of application of VCW and growth hormone on number of branches plant^{-1} as recorded at harvest. Minimum number of branches plant^{-1} was recorded in control (T_1) and the maximum number of branches plant^{-1} was recorded in combined application of VCW and growth hormone i.e. 50 ppm NAA + 400 ppm VCW, 50 ppm NAA + 300 ppm VCW and 50 ppm NAA + 500 ppm VCW when compared with control and rest of the treatments. It was also noticed that the treatments like T_8 (25 ppm NAA + 400 ppm VCW) , T_7 (25 ppm NAA + 300 ppm HA), T_9(25 ppm NAA + 500 ppm VCW), T_3(50 ppm NAA), T_2 (25 ppm NAA) and T_5 (400 ppm vcw) also increased number of the branches over control and remaining treatments. But treatments T_4 (300 ppm VCW), and T_6 (500 ppm VCW), were found at par with control in respect of number of branches plant^{-1}.

It is clear from above data that foliar application of HA and growth hormone alone and in combination increased number of branches plant^{-1}. It is known that the HA is a source of micro and macronutrients. These nutrients are quickly absorbed by the plant when HA is sprayed as a foliar spray. Macro nutrients like N, P and K are associated with the different plant processes *viz.,* cell enlargement, translocation of solutes, formation of carbohydrates etc. It is associated with the increase in height and number of branches in the present study.

Growth hormone like NAA when applied as foliar spray it enhances physiological and metabolic activities of plant and also enhances the uptake of nutrients from soil which helps in overall plant growth and ultimately increases the yield.

Leaf area plant^{-1}

Leaf area depends upon the number and size of leaves. Leaf area play important role in absorption of light, radiation and using it in photosynthesis process. Leaf size is influenced by light, moisture and nutrients. Hence, yield is dependent leaf area of crop. Significant variations were observed at 40, 55 and 70 DAS. The most pronounced effect was observed in plant exposed to the treatments T_{11} (50 ppm NAA + 400 ppm VCW), T_{10} (50 ppm NAA + 300 ppm VCW), T_{12}(50 ppm NAA + 500 ppm VCW), and T_8 (25 ppm NAA + 400 ppm VCW) in leaf area over the control (T_1) and rest of the treatments under study. Next to these treatments significantly more leaf area was also recorded in treatment T_7 (25 ppm NAA + 300 ppm humic acid). But, treatments T_9 (25 ppm NAA + 500 ppm VCW), T_3 (50 ppm NAA), T_2 (25 ppm NAA), T_5 (400 ppm HA), T_4 (300 ppm HA) and T_6 (500 ppm NAA) were found at par with control.

Perusal of the data indicated at 55 DAS that foliar application of 50 ppm NAA + 400 ppm VCW, 50 ppm NAA + 300 ppm VCW, 50 ppm NAA + 500 ppm VCW, 25 ppm NAA + 400 ppm VCW, 25 ppm NAA + 300 ppm VCW and 25 ppm NAA + 500 ppm VCW exhibited significantly higher leaf area over control and rest of the treatments. Treatments T_3 (50 ppm NAA), T_2 (25 ppm NAA), T_5 (400 ppm VCW), T_4 (300 ppm VCW) and T_6 (500 ppm VCW) were found at par with control.

The significant increase in leaf area over control was observed at 70 DAS in case of foliar spray of 50 ppm NAA + 400 ppm VCW, 50 ppm NAA + 300 ppm VCW, 50 ppm NAA + 500 ppm VCW, 25 ppm NAA + 400 ppm VCW, 25 ppm NAA + 300 ppm VCW, 25 ppm NAA + 500 ppm HA and 50 ppm NAA in a descending manner. But the treatments T_2 (25 ppm NAA), T_5 (400 ppm VCW), T_4 (300 ppm VCW) and T_6 (500 ppm VCW) were found at par with control.

According to Arsode (2013) foliar application of 50 ppm NAA + 300 ppm HA through cowdung wash at 30 and 45 DAS significantly enhanced leaf area in mustard**.**

Dry matter plant^{-1}

Dry matter is an important criterion. It determines the source-sink relationship and depends upon the net gain in the processes on anabolism and catabolism of plant. At 25 DAS the data regarding dry matter production were found non significant because foliar sprays of HA through VCW and NAA of different concentrations were given from this stage onwards (25 and 40 DAS).

Results at 40 DAS indicated that foliar application with 50 ppm NAA + 400 ppm VCW, 50 ppm NAA + 300 ppm VCW, and 50 ppm NAA + 500 ppm VCW significantly gave highest dry matter. Similarly treatments T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm HA), T_3 (50 ppm NAA) T_2 (25 ppm NAA) and T_5 (400 ppm VCW) also exhibited significantly moderate dry matter when compared with control (T_1) and rest of the treatments. Significantly lowest dry matter production was observed in treatments T_4 (300 ppm VCW) and T_6 (500 ppm VCW). These treatments were found at par with T_1 (control).

Data clearly indicate that at 55 DAS the range of dry matter production was 9.04 – 15.32 g. The highest dry matter production was noticed in treatment T_{11} (50 ppm NAA + 400 ppm VCW), T_{10} (50 ppm NAA + 300 ppm VCW), T_{12} (50 ppm NAA + 500 ppm VCW), T_8 (25 ppm NAA + 400 ppm VCW) and T_7 (25 ppm NAA + 300 ppm VCW), the next better treatments were T_9 (25 ppm NAA + 500 ppm HA) and T_3 (50 ppm NAA). While treatments T_2 (25 ppm NAA), T_5 (400 ppm VCW), T_4 (300 ppm VCW) and T_6 (500 ppm VCW) recorded minimum dry matter and remained at par with treatment T_1 (control).

In view of result at 70 DAS significantly maximum dry matter was exhibited in treatments T_{11} (50 ppm NAA + 400 ppm VCW), T_{10} (50 ppm NAA + 300 ppm VCW), and T_{12} (50 ppm NAA + 500 ppm VCW). Similarly treatments T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm VCW), T_3 (50 ppm NAA) and T_2 (25 ppm NAA) also exhibited significantly moderate dry matter when compared with control (T_1) and remaining treatments. But treatments T_5 (400 ppm VCW), T_4 (300 ppm VCW) and T_6 (500 ppm VCW) were found at par with control (T_1).

The inferences drawn from data it is clear that dry matter rapidly increased from 1st to 2nd stage of observation. Dry matter accumulation is a function of leaf area and more leaf area was observed during 25-40 DAS and it is period of maximum photosynthesis and yielded maximum dry matter production.

Kapase (2014) applied humic acid through vermicompost wash and NAA and noted that foliar spray of 50 ppm NAA + 400 ppm HA through VCW followed by 50 ppm NAA and 300 ppm HA through VCW significantly enhanced total dry matter production plant^{-1} in chickpea.

Growth analysis

Growth analysis is one of the measures for accessing the seed yield of plant. The physiological basis of yield difference can measured through an evaluation of difference in growth parameters and their impact on yield. The productivity of crop may be related with the parameters such as RGR, NAR and partitioning of total photosynthates into economic and non-economic sink.

Relative Growth Rate

The highest rate of RGR indicates the ability of maximum dry matter for development. The increment in RGR might be associated with maximum leaf area expansion and growth of stem and root. Increment in NAR is related with the increase in total dry weight of plant unit^{-1} of leaf area.

The results revealed significant variation in different treatments at 25-40 DAS. Considering the data treatments T_{11} (50 ppm NAA + 400 ppm VCW) and T_{10} (50 ppm NAA + 300 ppm VCW) were found significantly superior in RGR over control and rest of the treatments. Treatments T_{12} (50 ppm NAA + 500 ppm VCW), T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm VCW), T_3 (50 ppm NAA) and T_2 (25 ppm NAA), T_5 (400 ppm VCW) and T_4 (300 ppm VCW) also noted significantly more RGR over control (T_1) except treatment T_6 (500 ppm VCW), this treatment was found at par with control (T_1).

At 40-55 DAS treatment T_{11} (50 ppm NAA + 400 ppm VCW) and T_{10} (50 ppm NAA + 300 ppm VCW) were found significantly superior in RGR over control and rest of the treatments. Treatments T_{12} (50 ppm NAA + 500 ppm VCW), T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm VCW), T_3 (50 ppm NAA) T_2 (25 ppm NAA), T_5 (400 ppm VCW) and T_4 (300 ppm VCW) in a descending manner increased RGR significantly when compared with control. But the treatment T_6 (500 ppm VCW) was found at par with T_1 (control) in RGR.

At 55-70 DAS significantly highest RGR was observed in treatment T_{11} (50 ppm NAA + 400 ppm VCW). Treatments T_{10} (50 ppm NAA + 300 ppm VCW), T_{12} (50 ppm NAA + 500 ppm VCW), T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm VCW), T_3 (50 ppm NAA), T_2 (25 ppm NAA), T_5 (400 ppm VCW), T_4 (300 ppm VCW) and T_6 (500 ppm VCW) also showed maximum RGR in a descending manner when compared with control.

The decrease in RGR of plants during the growth season is due to increase of structural tissues in comparison to photosynthetic tissues (Motaghi and Nejad, 2014).

Net Assimilation Rate

NAR is closely connected with photosynthetic efficiency of leaves, but it is not a pure measure of photosynthesis. NAR depends upon the excess dry matter gained, over the loss in respiration. It is increase in plant dry weight unit^{-1} area of assimilatory tissue unit^{-1} time.

The results obtained during investigation NAR at 25-40 DAS was significantly enhanced by the treatment T_{11} (50 ppm NAA + 400 ppm VCW). Among the HA and NAA concentrations treatments T_{10} (50 ppm NAA + 300 ppm VCW), T_{12} (50 ppm NAA + 500 ppm VCW), T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm VCW), T_3 (50 ppm NAA), T_2 (25 ppm NAA), T_5 (400 ppm VCW) and T_4 (300 ppm VCW) performed significantly best in NAR over control. But treatment T_6 (500 ppm VCW) recorded minimum NAR and remained at par with treatment T_1 (control).

In view of result at 40-55 DAS significantly highest NAR was observed in treatments T_{11} (50 ppm NAA + 400 ppm VCW) followed by treatments T_{10} (50 ppm NAA + 300 ppm VCW), T_{12} (50 ppm NAA + 500 ppm VCW), T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm VCW), T_3 (50 ppm NAA), T_2 (25 ppm NAA), T_5 (400 ppm VCW) T_4 (300 ppm VCW) and T_6 (500 ppm VCW) in descending manner when compared with (T_1) control.

The NAR between 55-70 DAS was calculated and reflected in table 2. From the data it is revealed that the highest NAR was recorded in treatment 50 ppm NAA + 400 ppm VCW (T_{11}) followed by treatments T_{10} (50 ppm NAA + 300 ppm VCW), T_{12} (50 ppm NAA + 500 ppm VCW), T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm VCW), T_3 (50 ppm NAA), T_2 (25 ppm NAA), T_5 (400 ppm VCW) and T_4 (300 ppm VCW). While, treatment T_6 (500 ppm VCW) was found at par with control.

Net assimilation rate (NAR) synonymously called as unit leaf rate, expresses the rate of dry weight increase at any instant on a leaf area basis with leaf representing an estimate of the size of the assimilatory surface area (Gregory, 1926). Decrease in NAR during reproductive phase might be due to decrease efficiency of leaves for photosynthesis as a response to photosynthetic apparatus to increase demand for assimilates by growing seed fraction and sink demand on photosynthetic rate of leaves.

Kapase (2014) checked the effect of humic acid through vermicompost wash and NAA and reported that foliar spray of 50 ppm NAA + 400 ppm HA through VCW followed by 50 ppm NAA and 300 ppm HA through VCW significantly enhanced NAR in chickpea.

Neware *et al.* (2017) tried foliar spray of NAA and humic acid through vermicompost wash at 35 and 55 DAS and stated that 350 ppm HA through VCW + 50 ppm NAA concentration significantly increased NAR in linseed.

Seed yield ha^{-1}

Seed yield is the economic yield which is final result of physiological activities of plant. Economic yield is the part of biomass that is converted into economic product (Nichiporovic,1960).

Among the HA and NAA concentrations significantly maximum seed yield ha^{-1} was recorded in treatments T_{11} (50 ppm NAA + 400 ppm VCW), T_{10} (50 ppm NAA + 300 ppm VCW), T_{12} (50 ppm NAA + 500 ppm VCW), T_8 (25 ppm NAA + 400 ppm VCW), T_7 (25 ppm NAA + 300 ppm VCW) and T_9 (25 ppm NAA + 500 ppm VCW) in a descending manner when compared with control and rest of the treatments. But treatments T_3 (50 ppm NAA), T_2 (25 ppm NAA), T_5 (400 ppm VCW), T_4 (300 ppm VCW) and T_6 (500 ppm VCW) could not achived their target and remained at par with control (T_1) in seed yield ha^{-1}.

The growth hormone reduces flower drop, abscission of flower and ultimately increased seed yield and biomass production in sesamum. Hormones play a key role in the long distance movement of metabolites in plant. Auxin has effect on phloem transport. The metabolites and nutrients are moved from leaves and other parts of the plant into the fruits (Seth and Wareing, 1967).

A field experiment was carried out by Waqas (2014) to test the different concentrations of humic acid on yield components of mungbean. The treatments comprised of three methods of humic acid application i. e. seed priming with 0% (water soaked), 1%, 2% humic acid solution, foliar spray with 0.01%, 0.05% and 0.1% humic acid solution and soil application of humic acid 3 kg ha^{-1}and reported significantly more number of pods plant^{-1}, 1000 grain weight and grain yield.

Nadimpoor and Mani (2015) investigated the effect of different levels of humic acid and harvest time of forage on the forage and grain yield of dual purpose barley. Data revealed that yield contributing parameters *viz*., grain yield, number of spikes unit^{-1} area, number of grains spike^{-1} significantly enhanced with the 1000 ppm humic acid.

Harvest index

Harvest index is the proportion of biological yield represented by economic yield. It is the coefficient of effectiveness or the migration coefficient. Harvest index reflects the proportion of assimilate distribution between the economic and total biomass (Donald and Hamblin, 1976).

Treatments involving foliar spray of both humic acid and NAA @ 400, 300 and 500 ppm with 50 ppm NAA concentrations had profound influence on harvest index. While the treatments T_7 (25 ppm NAA + 300 ppm VCW), T_9 (25 ppm NAA + 500 ppm VCW), T_3 (50 ppm NAA), T_2 (25 ppm NAA), T_5 (400 ppm VCW), T_4 (300 ppm VCW) and T_6 (500 ppm VCW) were remained at par with control (T_1).

Humic acid rich in both organic and mineral substances which are essential to vegetative growth of plant,

Table 1.Effect of humic acid through vermicompost wash and NAA on plant height plant^{-1}, number of branches plant^{-1}, leaf area (dm^2) and dry weight plant^{-1} (g)in sesamum

Treatments	Plant height plant^{-1} (cm)	Number of branches plant^{-1}	Leaf area (dm^2)				Dry weight (g)			
			25 DAS	**40 DAS**	**55 DAS**	**70 DAS**	**25 DAS**	**40 DAS**	**55 DAS**	**70 DAS**
T_1 (Control)	95.20	2.82	1.26	5.69	10.12	6.32	0.86	3.24	9.04	10.95
T_2 (25 ppm NAA)	101.09	3.21	1.32	6.09	11.59	7.03	0.85	3.48	11.25	14.25
T_3 (50 ppm NAA)	103.76	3.29	1.23	6.27	11.87	7.29	0.82	3.52	11.98	15.24
T_4 (300 ppm HA)	98.25	3.04	1.30	5.92	10.90	6.81	0.87	3.38	9.78	12.23
T_5 (400 ppm HA)	99.39	3.16	1.38	5.99	11.23	6.89	0.85	3.45	10.94	13.81
T_6 (500 ppm HA)	96.47	2.91	1.26	5.78	10.67	6.56	0.88	3.32	9.38	11.42
T_7 (300 ppm HA + 25 ppm NAA)	109.82	3.42	1.44	6.40	12.78	7.63	0.80	3.76	13.43	17.38
T_8 (400 ppm HA + 25 ppm NAA)	111.53	3.54	1.36	6.87	13.09	7.85	0.78	3.82	13.94	18.30
T_9 (500 ppm HA + 25 ppm NAA)	106.69	3.37	1.36	6.36	12.37	7.52	0.81	3.65	12.54	15.98
T_{10} (300 ppm HA + 50 ppm NAA)	119.97	3.77	1.33	7.02	13.47	7.96	0.77	3.94	14.42	20.04
T_{11} (400 ppm HA + 50 ppm NAA)	121.14	3.84	1.36	7.21	13.93	7.99	0.79	4.06	15.32	21.89
T_{12} (500 ppm HA + 50 ppm NAA)	114.87	3.69	1.30	6.93	13.31	7.81	0.78	3.89	14.22	19.12
SE(M) ±	2.47	0.094	0.083	0.234	0.765	0.271	0.052	0.061	0.773	1.021
CD at 5%	7.26	0.275	-	0.688	2.245	0.796	-	0.181	2.267	2.994

Table 2.Effect of humic acid through VCW and NAA on RGR and NAR,seed yield ha^{-1}, harvest index, per cent increase in yield and B:C ratio in sesamum

Treatments	RGR ($g\ g^{-1}\ day^{-1}$)			NAR ($g\ dm^{-2}\ day^{-1}$)			Seed yield ha^{-1}	Harvest Index (%)	Per cent increase in yield	B:C Ratio
	25 -40 DAS	**40-55 DAS**	**55 -70 DAS**	**25 -40 DAS**	**40-55 DAS**	**55 -70 DAS**				
T_1 (Control)	0.0884	0.0684	0.0128	0.0538	0.0503	0.0158	5.36	22.56	-	2.38
T_2 (25 ppm NAA)	0.0940	0.0782	0.0158	0.0562	0.0606	0.0219	6.13	25.30	14.36	2.68
T_3 (50 ppm NAA)	0.0971	0.0817	0.0160	0.0582	0.0643	0.0231	6.39	25.99	19.21	2.74
T_4 (300 ppm HA)	0.0905	0.0708	0.0149	0.0549	0.0523	0.0188	5.76	23.84	7.46	2.39
T_5 (400 ppm HA)	0.0934	0.0769	0.0155	0.0552	0.0599	0.0215	5.99	24.87	11.75	2.43
T_6 (500 ppm HA)	0.0885	0.0690	0.0131	0.0540	0.0506	0.0161	5.63	23.11	15.03	2.41
T_7 (300 ppm HA + 25 ppm NAA)	0.1032	0.0849	0.0172	0.0593	0.0699	0.0264	6.69	26.91	24.81	2.72
T_8 (400 ppm HA + 25 ppm NAA)	0.1059	0.0863	0.0181	0.0596	0.0699	0.0284	6.89	27.61	28.54	2.74
T_9 (500 ppm HA + 25 ppm NAA)	0.1004	0.0823	0.0162	0.0584	0.0656	0.0235	6.56	26.32	22.38	2.55
T_{10} (300 ppm HA + 50 ppm NAA)	0.1088	0.0880	0.0219	0.0618	0.0706	0.0358	7.23	29.64	34.88	2.89
T_{11} (400 ppm HA + 50 ppm NAA)	0.1091	0.0885	0.0238	0.0622	0.0736	0.0410	7.36	30.85	37.31	2.88
T_{12} (500 ppm HA + 50 ppm NAA)	0.1071	0.0864	0.0197	0.0616	0.0704	0.0317	7.06	28.44	31.71	2.70
SE(M) ±	0.000084	0.000066	0.000014	0.000012	0.000071	0.00001	0.390	0.896	-	-
CD at 5%	0.00025	0.00019	0.000041	0.000035	0.00021	0.00003	1.15	2.62	-	-

it might be the reason for improvement in morpho-physiological parameters like plant height, number of branches, leaf area, dry matter and ultimately increase in yield and HI in the present investigation.

Considering the different concentrations applied, two foliar sprays of 400 ppm HA through VCW + 50 ppm NAA and 300 ppm HA through VCW + 50 ppm NAA at 25 and 40 DAS stood first and second in rank and significantly enhanced all parameters under study when compared with control and rest of the treatments. These treatments increased yield by 37.31 and 34.88 per cent respectively over control.

But considering the B:C ratio (2.89) two foliar sprays of 50 ppm NAA + 300 ppm humic acid through vermicompost wash at 25 and 40 DAS can be beneficial and profitable. Hence, this treatment can be considered for getting more yield in sesamum as compared to control (2.38).

REFERENCES

Anonymous, 2007. Annual report of state department of Agriculture, Nagpur.

Anonymous, 2017a.Directorate of economics and statistic department of Agricultural and co-operation. eands.dacnet.nic.in

Anonymous, 2017b .Economic survey of Maharashtra. www.maharashtra.gov.in

Anonymous, 2017c .Joint Director of Agriculture, Nagpur. www.mahaagri.gov.in

Arsode, S.V. 2013. Influence of foliar sprays of humic acid through cowdung wash and NAA on growth and yield of mustard M.Sc. (Agri.) thesis (unpub.) submitted to Dr. P.D.K.V., Akola

Donald, C. M. and J. Hamblin, 1976.Growth and development in physiology of crop plants.2nd Ed. Scientific publishers Jodhpur, pp.198-199.

Gregory, F. G. 1926. The effect of climatic conditions on the growth of barley.Ann. Bot. **40**: 1-26.

Haripriya, K. and P. Poonkodi, 2005.Role of organic mulches and foliar nutrition on changes, nutrient uptake and residual soil fertility in tuberose. Adv. Plant Sci. **18**(1): 175-178.

Kapase, P. V. 2014. Effect of foliar sprays of humic acid through vermicompost wash with NAA on growth and yield of chickpea. M. Sc. (Agri.) thesis (unpub.) submitted to Dr. P. D. K. V. Akola.

Motaghi, S. and T. S. Nejad, 2014.The effect of different levels of humic acid and potassium fertilizer on physiological indices of growth.Inernat. J. Bio. Sci. ISSN: 2220-6655, **5**(2): 99-105.

Nadimpoor, S. and M.Mani, 2015.The effect of humic acid application and harvest time of forage on grain and forage yield of dual purpose barley.Indian J. Fundamental appli. L. Sci. ISSN: 2231-6345 **5**(1): 231-237.

Neware, M., R. D. Deotale, V. R. Jaybhaye, Y. A. Chinmalwar, V. J. Surywanshi and B. B. Pandey, 2017. Effect of different concentrations of humic acid and NAA on morpho-physiological parameters and yield of linseed. J. Soils and Crops. **27**(1): 88-94.

Nichiporvic, A. A. 1960. Photosynthesis and the theory of obtaining high yields.Fld.Crop Abstr.**13** : 169-175.

Seth, A. K. and P. F. Wareing, 1967. Hormone directed transport of metabolites and its possible role in plant sensescence. J. Expt. Bot. **18**(54): 65-77.

Sharma, R., G. Singh and K. Sharma, 1989. Effect of triacontanol, mixatol and NAA on yield and it's components in mung bean. Indian J. agric. **3**(1): 59-60.

Shweta, A., K. Yadav, Kiran Kumar and Mamta Sharma, 2005.Vermiwash a liquid biofertilizer. Uttar Pra. J. **25** (1): 97 -99.

Seth, A. K. and P. F. Wareing, 1967. Hormone directed transport of metabolites and its possible role in plant sensescence. J. Expt. Bot. **18**(54): 65-77.

Waqas, M., B. Ahmad, M. Arif, F. Munsif, A. L. Khan, M. Amin, S. Kang, Y. Kim, I. Lee, 2014. Evaluation of humic acid application methods for yield and yield components of mungbean.American J. Plant Sci. **5**:2269-2276.

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