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CODEN: IJRSFP (USA)

International Journal of Recent Scientific Research
Vol. 8, Issue, 9, pp. 20433-20436, September, 2017

ISSN: 0976-3031

International Journal of Recent Scientific Research

DOI: 10.24327/IJRSR

Research Article

INFLUENCE OF HUMIC ACID AND NAA ON OIL CONTENT AND YIELD PARAMETERS OF LINSEED

Minakshi R. Neware[1]., Deotale R. D[2] and Manapure P. R[3]

[1]Botany Section, College of Agriculture, Nagpur (MH)
[2]Botany Section, College of Agriculture, Nagpur
[3]Linseed breeder, AICRP on oilseed, Nagpur

DOI: http://dx.doi.org/10.24327/ijrsr.2017.0809.0893

ARTICLE INFO

Article History:

Received 15th June, 2017
Received in revised form 25th July, 2017
Accepted 23rd August, 2017
Published online 28th September, 2017

Key Words:

Linseed, humic acid through vermicompost wash, NAA, foliar spary

ABSTRACT

The investigation was carried out for evaluate effect of humic acid and NAA on oil content of linseed at the experimental farm of Agricultural Botany Section, College of Agriculture, Nagpur during year 2015-16. Experiment treatment included different concentrations of humic acid (300, 350, 400, 450 and 500 ppm) and NAA (25 and 50 ppm) individually and in combinations were tested with two times foliar spraying method (35 and 55 DAS). The obtained results revealed that 350 ppm HA through VCW + 50 ppm NAA followed by 300 ppm HA through VCW + 50 ppm NAA had significant promotive effect on oil content in seed, number of capsules plant^{-1}, number of seeds capsules^{-1}, 1000 seed weight, seed yield plant^{-1}, plot^{-1}, ha^{-1} when compared with the control treatment.

INTRODUCTION

Linseed (also known as Flax), with binomial name *Linum ustitatissimum,* is a member of the genus *Linum* in the family Linaceae. Globally, Linseed is grown as either oil crop or a fiber crop with fiber linen derived from the stem of fiber varieties and oil from the seed of linseed varieties (Diederichsen *et al*., 2003; Vaisey-Genser *et al*., 2003). The plant is native to west Asia and the Mediterranean. As the source of linen fiber linseed has been cultivated since at least 5000 BC, today it is mainly grown for its oil (Berugland, 2002; Oomah, 2001). Linseed is grown for it's oil, used as a nutritional supplement, and as an ingredient in many wood-finishing products. Linseed is also grown as an ornamental plant in gardens. Linseed is the richest source of plant lignans (Thompson *et al*., 1991). Linseed is rich in fat, protein and dietary fibre. An analysis of brown Canadian linseed contain averaged 41% fat, 20% protein, 28% total dietary fibre (Morris, 2003). Linseed contain 57% 18:3 Omega-3 fatty acid (mostly ALA) and 16% 18:2 Omega-6 fatty acid. Linseed oil contain 53% 18:3 Omega-3 fatty acid (mostly ALA) and 13% 18:2 Omega-6 fatty acids.(Morris, 2003).

Humic Acid

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 is the product of breakdown of organic matter. Humic acid proved many binding sites for nutrient such as calcium, iron, potassium and phosphorus. These nutrients are stored in humic acid molecule in a form readily available to plant and are released when the plants require them, humic acid increases the absorption and translocation of nutrients in plant and ultimately influences yield. Humic acid supply polyphenols that catalyze plant respiration and increases plant growth.

Vermicompost Wash

Vermicompost wash is useful as foliar spray. It is transparent pale yellow biofertilizer. It is a mixture of excretory products and mucous secretion of earth worm *(Lampito mautrii* and *Eisenia fetida)* 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 Pookodi, 2005). Vermicompost wash is having N-0.29%, P-0.042%, K-0.143%,

Corresponding author:* **Minakshi R. Neware
Botany Section, College of Agriculture, Nagpur (MH)

Ca-0.186%, Mg- 0.11%, S-0.058%, Fe 0. 466 ppm, Mn 0.406 ppm, Zn 0.11 ppm, Cu 0.18 ppm. (Anonymous, 2007).

Naphthalene Acetic Acid

NAA (Naphthalene Acetic Acid) is the synthetic auxin with the identical properties to that naturally occuring 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 applications of humic acid through vermicompost wash and NAA on oil content of linseed.

MATERIALS AND METHODS

A field experiment was conducted at the farm of Agricultural Botany Section, College of Agriculture, Nagpur during year 2015-16. Linseed (PKV-NL-260 cultivar) was sown by drilling method at the rate 25 kg ha^{-1}. Plot was 3.30 m^2 (3 × 1.10 m). A experimental design used was a randomized block with three replications.

Humic acid through vermicompost wash and NAA were sprayed as alone and mixture like T_2 (25 ppm NAA), T_3 (50 ppm NAA), T_4 (300 ppm HA through VCW), T_5 (350 ppm HA through VCW)), T_6 (400 ppm HA through VCW)), T_7 (450 ppm HA through VCW)), T_8 (500 ppm HA through VCW), T_9 (300 ppm HA through VCW + 25 ppm NAA), T_{10} (350 ppm HA through VCW + 25 ppm NAA), T_{11} (400 ppm HA through VCW + 25 ppm NAA), T_{12} (450 ppm HA through VCW + 25 ppm NAA), T_{13} (500 ppm HA through VCW + 25 ppm NAA), T_{14} (300 ppm HA through VCW + 50 ppm NAA), T_{15} (350 ppm HA through VCW + 50 ppm NAA), T_{16} (400 ppm HA + 50 ppm NAA), T_{17} (450 ppm HA through VCW + 50 ppm NAA) and T_{18} (500 ppm HA through VCW + 50 ppm NAA) two times at 35 and 55 days after sowing. Control plants (T_1) were sprayed with water. Oil content in seed, number of capsules $plant^{-1}$, number of seeds $capsules^{-1}$, 1000 seed weight, seed yield $plant^{-1}$, $plot^{-1}$, ha^{-1} was recorded after harvesting.

RESULT AND DISCUSSION

Oil content in seed

Linseed is mainly known as oilseed crop. Although quality of crop products such as oil, protein and sucrose content and appearance is genetically controlled, nutrition of plants can have considerable impact on the expression of quality. It is therefore, essential to judiciously take care on the nutrient supply at grain formation stage. Oil content of seed is one of the considerable factors for seed quality determinations also.

Data showed significant variation by the application of HA and NAA. The range of oil content in seed was 35.18-40.67%. Significantly maximum seed oil was recorded in treatments T_{15} (350 ppm HA + 50 ppm NAA), T_{14} (300 ppm HA + 50 ppm NAA) and T_{10} (350 ppm HA + 25 ppm NAA) when compared with control and rest of the treatments. Similarly treatments T_9 (300 ppm HA + 25 ppm NAA), T_{16} (400 ppm HA + 50 ppm NAA), T_{11} (400 ppm HA + 25 ppm NAA), T_5 (350 ppm HA), T_4 (300 ppm HA), T_{17} (450 ppm HA + 50 ppm NAA), T_{12} (450 ppm HA + 25 ppm NAA) and T_{13} (500 ppm HA + 25 ppm NAA) also found significant over control and rest of the treatments. While treatments T_{18} (500 ppm HA + 50 ppm NAA), T_6 (400 ppm HA), T_7 (450 ppm HA), T_8 (500 ppm HA), T_3 (50 ppm NAA) and T_2 (25 ppm NAA) were found at par with control.

The increase in oil content of seed by the application of NAA might be due to increase in synthesis or activation of both the lypolitic enzymes. Increased oil content is a consequence of more synthesis of amino acid and increased conversion of carbohydrates to oil. Foliar application of HA and NAA increases the uptake and availability of nutrients and its further assimilation for biosynthesis of oil. These might be the reasons for increased oil content in seed in the present investigation.

The mode of action of humic acid on plant growth can be divided into direct and indirect effects as it affects the membranes resulting in improved transport of nutritional elements, enhanced photosynthesis, solubilisation of micro nutrients which ultimately enhances the oil synthesis.

Pawar *et al.* (2008) reported that the 4% cow urine + 50 ppm NAA when sprayed on groundnut increased oil content in kernel over control (RDF).

Arsode (2013) studied the effect of foliar application of humic acid through cowdung wash and NAA stated that, 50 ppm NAA + 300 ppm HA through cowdung wash significantly increased oil per cent in mustard.

Humic acid rich in both organic and mineral substances which are essential to vegetative growth of plant, it might be the reason for improvement in oil content in the present investigation.

Number of capsules $plant^{-1}$

Yield is complex character determined by several traits, internal plant processes and environmental factors.

Significant and highest number of capsules $plant^{-1}$ was recorded in treatments T_{15} (350 ppm HA + 50 ppm NAA), T_{14} (300 ppm HA + 50 ppm NAA) and T_{10} (350 ppm HA + 50 ppm NAA) when compared with control and rest of the treatments. Treatments T_9 (300 ppm HA + 25 ppm NAA), T_{16} (400 ppm HA + 50 ppm NAA), T_{11} (400 ppm HA + 25 ppm NAA), T_5 (350 ppm HA), T_4 (300 ppm HA), T_{17} (450 ppm HA + 50 ppm NAA),T_{12} (450 ppm HA + 25 ppm NAA) T_{13} (500 ppm HA + 25 ppm NAA), T_{18} (500 ppm HA + 50 ppm NAA), T_6 (400 ppm HA), T_7 (450 ppm HA) and T_8 (500 ppm HA) also exhibited significantly more number of capsules $plant^{-1}$ when compared with other remaining treatments and control. But treatments T_3 (50 ppm NAA) and T_2 (25 ppm NAA) were found at par with treatment T_1 (control).

Number of seeds $capsules^{-1}$

Number of seeds $capsules^{-1}$ increased significantly and it was maximum in treatments T_{15} (350 ppm HA + 50 ppm NAA), T_{14} (300 ppm HA +50 ppm NAA), T_{10} (350 ppm HA + 50 ppm NAA), T_9 (300 ppm HA + 25 ppm NAA), T_{16} (400 ppm HA + 50 ppm NAA) and T_{11} (400 ppm HA + 25 ppm NAA) in a descending manner when compared with remaining treatments and T_1 (control). Similarly treatments T_5 (350 ppm HA), T_4 (300 ppm HA), T_{17} (450 ppm HA + 50 ppm NAA), T_{12} (450 ppm HA + 25 ppm NAA), T_{13} (500 ppm HA + 25 ppm NAA) and T_{18} (500 ppm HA + 50 ppm NAA) showed their significance over control (T_1). While treatments T_6 (400 ppm HA), T_7 (450 ppm HA), T_8 (500 ppm HA), T_3 (50 ppm NAA) and T_2 (25 ppm NAA) were found at par with treatment T_1 (control).

Table 1 Effect of humic acid through vermicompost wash and NAA on seed oil content (%), number of capsules plant^{-1}, number of seeds capsules^{-1}, 1000 sees weight, and seed yield plant^{-1}, plot^{-1}, ha^{-1} in linseed

Treatments	Seed oil content (%)	Number of capsules plant^{-1}	Number of seeds capsules^{-1}	1000 seed weight (g)	Seed yield		
					Plant^{-1} (g)	Plot^{-1} (kg)	Ha^{-1} (q)
T_1 (control)	35.18	40.86	10.04	5.24	2.10	0.300	12.50
T_2 (25 ppm NAA)	35.46	41.88	10.20	5.30	2.16	0.308	12.83
T_3(50 ppm NAA)	36.21	42.48	10.86	5.52	2.22	0.319	13.29
T_4 (300 ppm HA through VCW)	37.57	67.07	13.51	6.33	2.60	0.392	16.33
T_5 (350ppm HA through VCW)	37.58	70.00	13.53	6.40	2.65	0.402	16.75
T_6 (400 ppm HA through VCW)	36.71	54.13	12.09	6.12	2.35	0.340	14.16
T_7 (450 ppm HA through VCW)	36.42	53.94	11.71	6.04	2.29	0.327	13.62
T_8 (500 ppm HA through VCW)	36.24	53.74	11.34	5.69	2.26	0.325	13.54
T_9 (300 ppm HA through VCW + 25 ppm NAA)	37.89	72.79	15.00	6.61	2.72	0.418	17.41
T_{10} (350 ppm HA through VCW + 25 ppm NAA)	38.34	77.79	15.83	6.78	2.75	0.420	17.50
T_{11} (400 ppm HA through VCW + 25 ppm NAA)	37.70	70.47	14.65	6.43	2.68	0.407	16.95
T_{12} (450 ppm HA through VCW + 25 ppm NAA)	37.26	62.24	12.53	6.26	2.49	0.371	15.45
T_{13} (500 ppm HA through VCW + 25 ppm NAA)	37.16	57.84	12.43	6.23	2.45	0.362	15.08
T_{14} (300 ppm HA through VCW + 50 ppm NAA)	39.86	79.14	16.31	6.96	2.76	0.426	17.75
T_{15} (350 ppm HA through VCW + 50 ppm NAA)	40.67	85.48	16.87	7.18	2.79	0.432	18.00
T_{16} (400 ppm HA through VCW + 50 ppm NAA)	37.87	72.00	14.78	6.53	2.71	0.417	16.36
T_{17} (450 ppm HA through VCW + 50 ppm NAA)	37.39	63.82	13.02	6.31	2.54	0.381	15.87
T_{18} (500 ppm HA through VCW + 50 ppm NAA)	36.73	54.34	12.41	6.16	2.39	0.348	14.50
SE (m)±	0.700	3.617	0.763	0.222	0.136	0.019	0.89
CD at 5%	2.010	10.395	2.192	0.639	0.381	0.054	2.65

Higher number of seeds capsules^{-1} might be due to the indirect positive effect of HA on chlorophyll content. The increase in chlorophyll content promotes photosynthetic activities which, in turn, diverts more photo-assimilates towards higher number of seeds capsules^{-1} (Nardi *et al*., 2002).

1000 seed weight

The 1000 seed weight was significantly maximum in treatments T_{15} (350 ppm HA + 50 ppm NAA), T_{14} (300 ppm HA +50 ppm NAA), T_{10} (350 ppm HA + 50 ppm NAA), T_9 (300 ppm HA + 25 ppm NAA) and T_{16} (400 ppm HA + 50 ppm NAA). Treatments T_{11} (400 ppm HA + 25 ppm NAA), T_5 (350 ppm HA), T_4 (300 ppm HA), T_{17} (450 ppm HA + 50 ppm NAA), T_{12} (450 ppm HA + 25 ppm NAA), T_{13} (500 ppm HA + 25 ppm NAA), T_{18} (500 ppm HA + 50 ppm NAA), T_6 (400 ppm HA) and T_7 (450 ppm HA) also significantly increased 1000 seed weight when compared with remaining treatments and control (T_1). Treatments T_8 (500 ppm HA), T_3 (50 ppm NAA) and T_2 (25 ppm NAA) were found at par with control (T_1).

Application of humic acid as a foliar spray increases the seed weight due to better mobilization of nutrients to seed. Nardi *et al*. (1999) found that the biological activity of humic acid was attributed to their chemical structure and their functional groups, which could interact with harmonic-binding proteins in the membrane system, evoking a hormone like response.

Waqas *et al*. (2014) conducted triplicate field experiment to evaluate the different concentrations of humic acid on yield components of mung bean. 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} resulted significantly higher number of pods plant^{-1}, 1000 seed weight and seed yield.

Seed yield is the economic yield which is final results of physiological activities of plants. Economic yield is that part of biomass that is converted into economic product (Nichiporvic, 1960).

Significantly maximum seed yield plant^{-1}, plot^{-1}, ha^{-1} was recorded in treatments T_{15} (350 ppm HA + 50 ppm NAA), T_{14} (300 ppm HA + 50 ppm NAA),T_{10} (350 ppm HA + 50 ppm NAA), T_9 (300 ppm HA + 25 ppm NAA), T_{16} (400 ppm HA + 50 ppm NAA),T_{11} (400 ppm HA + 25 ppm NAA),T_5 (350 ppm HA),T_4 (300 ppm HA), T_{17} (450 ppm HA + 50 ppm NAA) and T_{12} (450 ppm HA + 25 ppm NAA) in a descending manner when compared with control and rest of the treatments. But, treatments T_{13} (500 ppm HA + 25 ppm NAA),T_{18} (500 ppm HA + 50 ppm NAA), T_6 (400 ppm HA),T_7 (450 ppm HA),T_8 (500 ppm HA),T_3 (50 ppm NAA) and T_2 (25 ppm NAA) were found at par with T_1 (control).

The growth hormone reduces flower drop, abscission of flower and ultimately increased seed yield and biomass production in linseed. Hormones play a key role in the long distance movement of metabolites in plant. Auxin have 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).

Arsode (2013) studied the effect of foliar application of humic acid through cowdung wash and NAA on mustard and reported that 50 ppm NAA and 300 ppm HA significantly increased seed yield over control and rest of treatments.

Waqas *et al*. (2014) conducted triplicate field experiment to evaluate the different concentrations of humic acid on yield components of mung bean. 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 resulted increase in yield significantly.

Kapase *et al*. (2014) evaluated the effect of humic acid through vermicompost wash and NAA on chickpea and stated that foliar spray of 50 ppm NAA + 400 ppm HA through VCW followed by 50 ppm NAA and 300 ppm HA through VCW significantly increased seed yield ha^{-1}.

A field experiment was conducted by Nadimpoor and Mani (2015) to investigate the effect of different levels of humic acid and harvest time of forage on the forage and grain yield of dual purpose barley. Data showed that grain yield significantly increased with the 1000 ppm humic acid.

CONCLUSION

Considering the different concentrations applied, two foliar sprays of 350 ppm HA through VCW + 50 ppm NAA at 35 and 55 DAS stood first in rank and significantly enhanced oil content and yield parameters in linseed under study when compared with control and rest the treatments.

Hence, the two foliar sprays of 350 ppm HA through VCW + 50 ppm NAA at 35 and 55 DAS can be considered as the effective nutrient management treatment form all the treatments under study.

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How to cite this article:

Minakshi R. Neware.2017, Influence of HUMIC Acid And Naa On Oil Content And Yield Parameters of Linseed. *Int J Recent Sci Res.* 8(9), pp. 20433-20436. DOI: http://dx.doi.org/10.24327/ijrsr.2017.0809.0893

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