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Kandrekula Vasu Gangadhar

M.Sc. Research Scholar,
Department of Agronomy,
School of Agriculture, Lovely
Professional University,
Jalandhar, Punjab, India

Response of phosphorous and growth regulators on oil seed crops: A review

Kandrekula Vasu Gangadhar

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Abstract

Oilseeds are rich in protein, and additionally, they contain a high level of fat. Hence, they're not only good sources of protein but also concentrated sources of energy. The proteins in oilseeds are often fed either as a part of the oil-intact seed or as a meal from which the oil has been removed. For better production of oilseeds, it's compulsory to specialize in the appliance of various essential nutrients within the sort of fertilizers. We've to focus on the foremost important oilseed crops within the world. As practices, a properly balanced supply of phosphorous and application of plant growth regulators (PGRs) is one among the foremost important factors to extend higher yield and oil content in oilseed crops. PGRs play a crucial role in mitigating stress, increasing flower set, yield, and physiological efficiency of the crop. Many field experiments conducted on different oilseed crops from which it is often reported that the optimum level of phosphorous and growth regulators significantly enhanced the expansion, yield, oil content, and protein in oilseeds. This paper directly focuses on the role of phosphorous and growth regulators of naphthalene acetic acid and salicylic acid in improving oilseed crop production.

Keywords: Phosphorous, growth regulators, naphthalene acetic acid, salicylic acid, oilseeds, growth and yield attributes

Introduction

India is one of the main oilseed grower and importer of edible oils. India's oil economy is the world's fourth-largest economy after the USA, China & Brazil. Oilseed represents 13% of the Gross Cropped Area, 3% of the Gross National Product, and 10% of all agricultural commodities. (Pooja K. Patel *et al.*, 2019) ^[39]. Oilseeds are leading suppliers of superior quality and specialty vegetable oils to nutritional products, natural food, and premium dish worldwide. (Muhammad Farhan Sarwar *et al.*, 2013) ^[42]. In India, oil seeds are cultivated over an area of 24.65 million hectares with a production of 31.31 million tonnes (Anon, 2018). Groundnut, sesame, rapeseed mustard, Niger, castor, linseed, and safflower oilseed crops are cultivated for an extended time, and soybean and sunflower are recently introduced in India. Whereas sarson, toria, and taramira are rapeseeds, the Raya is mustard. The country's oilseed supplies depend totally on seven edible and two non-edible oilseeds (castor and linseed). (A.L. Singh 1999) ^[24]. Due to high protein and vitamin A or oil, oilseeds add substantial nutritional value to the diet. Oilseeds, are the most important source of vegetable oils albeit most oil-bearing tree fruits provide the very best oil yields (olive, coconut and palm trees) (Sarwar, 2013) ^[42]. Oilseeds also are utilized in animal feed due to their high protein content. Their seeds contain energy primarily as oil for the sprouting embryo, compared to cereals that contain energy within the starch form (McKevith, 2005) ^[30].

India is the main contributor to the worldwide production of castor (79.6%) and also contributes significantly to the assembly of sesame (31.2%) and groundnut (25.1%). it is the second-largest groundnut and rapeseed- mustard manufacturer. Oilseed crops cover an area of roughly 28.53 million hectares in India, with an annual production of 32.88 million tonnes on annual (Ministry of Agriculture, GOI, 2013-14). Oil and fats are important parts of the human diet and quite 90% of the world's production from vegetables, animals, and marine sources is employed as food or as an ingredient in food products. Edible vegetable oils are foodstuffs consisting mainly of fatty acid glycerides that are derived only from vegetable sources. They contain small amount of other lipids like phosphatides, of unsaponifiable constituents and free Fatty acids naturally present within the fat or oil.

Corresponding Author:**Kandrekula Vasu Gangadhar**

M.Sc. Research Scholar,
Department of Agronomy,
School of Agriculture, Lovely
Professional University,
Jalandhar, Punjab, India

(Praduman Yadav *et al.*, 2018) ^[51] Additionally, to oilseed crops, secondary sources of edible oils like rice bran, cottonseed, coconut, vegetable oil, and oil palm oilseeds also are popular in India. In oilseeds quality criteria are carboxylic acid composition, tocopherols, phenolic compounds of the seed oil, and therefore, the intended use of the oil. Oilseeds form a crucial component of the human diet in Asia and therefore, the Pacific. Oilseeds are grown on diverse soils mostly under unirrigated and fewer than ideal conditions and plant nutrients are one among the foremost important constraints on their growth and yield (Reid 1981).

Role of phosphorous

To increase this production level of oilseed crops, it's necessary to manage improved technology packages, balanced application of Phosphorous is also a crucial element, and it plays an important role within the stability of edible oil within the country to unravel domestic requirements. Phosphorus (P) is an important macro-nutrient, necessary for the normal growth and development of upper plants. It's a component of several macro-molecules, like nucleic acids and phospholipid, and forms phosphate esters as intermediates within the metabolic pathways, and in energy-rich metabolites or coenzymes; thus, it plays an important role in the cellular structure and energy metabolism (Hawkesford *et al.*, 2012) ^[18]. The United Nations (UN)'s Food and Agricultural Organization (FAO) estimates that plants only absorb approximately 20–30% of P in applied fertilizers annually (Syers *et al.*, 2008) ^[46]. Phosphorus is a crucial constituent of energy-rich compounds, including ATP (ATP), cytosine triphosphate (CTP), guanosine triphosphate (GTP), uridine triphosphate (UTP), phosphoenolpyruvate, and other phosphorylated intermediate compounds. Hence, it supplies energy to drive various cellular endergonic processes. Being a constituent of nucleic acids (DNA, RNA), it's essential for copy and protein synthesis. To take care of its role under phosphate (Pi-deprived conditions), plants undergo various morphological, physiological, and biochemical adaptations. These include alterations in root architecture, the formation of cluster roots, shoot development, organic acid exudation, and alternative glycolysis and respiratory pathways (Vance *et al.*, 2003) ^[49]. Phosphorous may be a constituent of several essential cell components like nucleotides, nucleic acids, and phospholipids. It's particularly important in the early growth stages. Phosphorous plays an important role within the energy storage and transfer within the sort of AMP, ATP, NADP or NADPH (Tandon, 1987).

Plant nutrition may be a key input to extend the productivity of soybean seed crop. Out of several nutrients provided to plants, phosphorus may be a major and essential nutrient for better plant growth and yield as this crop is exhaustive in nature and requires more energy. It's involved in wide selection of plant processes from permitting cellular division to development of excellent rootage. It regulates pod setting, seed formation, development and protein synthesis. The enhancement of symbiotic N-fixation by root nodules as a results of phosphorus nutrition is supported due to high phosphorus requirement of the Bacteroides. (Sandeep kumar *et al.*, 2017). Soybean consistency is affected by the availability of nutrients and phosphorus has a beneficial effect on the content of oil and protein (Gaydou and Arrivets, 1983) ^[15]. Very high values of soil phosphate can depress the content of seed protein and oil or induce deficiencies of zinc and iron (Weiss, 1983). Additionally, to proper dose of phosphorus, an appropriate sort of groundnut should be

identified to extend its production. The yield of groundnut could also be increased through appropriate combination of levels of phosphorus (SJ Mouri 2018) ^[33]. Due to its high uptake of nutrients, sunflower responds alright to applied nutrients. Phosphorous applications have improved sunflower seed yield by 50 percent. (Chorey and Thosar, 1997) ^[7]. among the various nutrients required by sunflower, nitrogen and phosphorus are the first limiting nutrients under most environments (Devidayal and Agarwal, 1998; Baldev Raj *et al.*, 1999). Further this may fulfil the demand of ever-increasing edible oil. In spite of such a significance the productivity of Niger crop is extremely low which can be enhanced by adequate and integrated supply of nutrient especially phosphorus, because being oilseed crop Niger respond well to phosphorus, hence yield potential of this crop are often improved through adequate supply of phosphorus (NS Lende 2017) ^[28].

Phosphorous is a fascinating plant nutrient, it is involved in a wide range of plant processes from permitting cell division to the development of a good root system and ensure timely uniform repining of the crop. It is needed mostly to be young fast-growing tissues and perform a number of functions related to growth, development, photosynthesis, and utilization of carbohydrates (F.C. Oad *et al.*, 2001) ^[38]. It is evident, therefore that oilseed requires a high P-supply in order to generate a high content of high oil-containing energy. It is evident, therefore that oilseed requires a high P-supply in order to generate a high content of high oil-containing energy. Indian soils that are usually low to medium in phosphorous accessible and the availability of "P" by fertilizers is still below the optimum level due to very high phosphatic fertilizer prices. Phosphorous in growing plants is quite mobile. When the deficiency of phosphorous starts to develop in a plant, the absorbed phosphorous migrates from older to young plant parts. Symptoms of phosphorous deficiency, therefore, appear first on older leaves, gradually bluish-green to reddish color develops which can lead to stunted growth and death of the plant. If the phosphorous deficiency appears, then soil and plant tests should be done and fertilizer must be added by rectifying and shortcomings in fertilizer practices particularly while aiming for high yield and profits (Tandon, 1987).

Role of plant growth regulators

Plant hormones are naturally produced by plants and are important for the control of their own growth. They function by regulating or altering the growth processes of plants, such as the formation of leaves and flowers, stem elongation, fruit production and ripening. In modern agriculture, people have established the advantages of extending the utilization of plant hormones to manage growth of other plants (Abubakar Siddik *et al.*, 2016) ^[45]. Plant growth regulators (PGRs) which may improve the physiological efficiencies of plant could play a major role in increasing crop yield and quality, when applied as foliar spray at proper crop growth stage in optimum concentration. Plant growth regulators (PGRs) have the capacity to change every phase of plant growth spanning from seed germination to crop maturity. Since most plant growth and seed development processes are regulated by natural plant hormones, many of those processes could be manipulated either by altering the endogenous hormone level or by changing the capacity of the plant to respond to its natural hormones. It's accepted that plant hormones are involved in grain filling and seed development (Al- Jobori, 2012) ^[2]. Plant growth promoters and growth retardants have great potential

in increasing agricultural production and help in removing many of the barriers imposed by genetics and environment. They play a crucial role in mitigating stress, increasing flower set, yield and physiological efficiency of the crop (P Prasanth Kumar and Dr. Suchit A John 2018) [26]. The process is physiological and biochemical and thus increases the yield of the crop. The localized application of some plant growth regulators is reported to possess profound effects on assimilate partitioning, enhancing the crop productivity plant growth regulators are effective on several crop plants to balance the source sink relationship and manipulate a spread of growth and developmental phenomena in various crops (S. Behera 2017) [6].

The application of NAA can increase fruit setting ratio, prevent fruit dropping, promote flower sex ratio (Rahul A Kengare *et al.*, 2018). The most role of NAA rests with the efficient transport of sugars from the photosynthesizing parts of the plant to the developing grains. The NAA enhance endogenous levels of PGRs including gibberellins because auxin is important to gibberellins biosynthesis, which affect growth, physiological attributes and eventually yield in sesame (Md. Abubakar Siddik *et al.*, 2015) [45]. Growth-stimulating chemicals are wont to modify the growth and development of the mustard plant to extend its yield and also to enhance the standard of products. Naphthalene ethanoic acid (NAA) is a crucial synthetic auxin (Yamamoto & Yamamoto, 1998) [52]. NAA is synthetic auxin with identical properties to that of present auxin i.e., IAA in plant. Auxin in low concentration promotes cell elongation i.e., growth, but in higher concentration it inhibits the growth. The increase in production of linseed is only being possible due to increase in area under crop and by applying growth promoting substances like cow urine and NAA (Kekita H. Chute *et al.*, 2017) [8]. 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 had been observed that the growth regulators are involved within the direct transport of assimilates from source to sink (Sharma *et al.*, 1989) [29].

Salicylic acid (SA) acts as a possible non-enzymatic antioxidant the maximum amount as plant phytohormone, playing a crucial role in regulating a variety of plant physiological processes (Fariduddin *et al.*, 2003; Raskin, 1992) [14]. SA is one of the numerous phenolic compounds, containing an aromatic ring with a hydroxyl or its derivatives, found in plants. There has been considerable speculation that phenolics generally function as plant growth regulators (Aberg, 1981) [1]. salicylic acid (SA) as a potent signaling molecule in plants is involved in defense mechanisms by regulating physiological and biochemical functions and has diverse effects on tolerance to biotic and abiotic stress factors (Gunes *et al.*, 2007; Nazar *et al.*, 2011) [16, 36]. Exogenously supplied SA was shown to affect a large form of processes in plants, including stomatal closure, seed germination, fruit yield, and glycolysis (Cutt *et al.*, 1992) [9]. 2-hydroxybenzoic acid is involved in many plant physiological processes like photosynthesis, transpiration, nutrient uptake, chlorophyll, and protein synthesis. When applied at physiological concentration, foliar application of 2-hydroxybenzoic acid exerted a major effect on plant growth and metabolism and thus acted together with the substances controlling plant growths. Salicylic acid hormone and plays diverse physiological roles in plants including thermogenesis generate a good range of metabolic and physiological responses thereby affecting their growth and development (Hayat *et al.*,

2010) [14, 19]. 2-hydroxybenzoic acid plays diverse physiological roles in plants which incorporates plant growth, thermogenesis, flower induction, nutrient uptake, ethylene biosynthesis, stomatal movements, photosynthesis, and enzyme activities (Hayat & Ahmed, 2007) [14, 19]. Further, salicylic acid also plays a crucial role in the regulation of varied plant physiological processes like photosynthesis or non-enzymatic antioxidant (ElKhallal *et al.*, 2009; Salarizdah *et al.*, 2012). The concentration of glucosinolates in their leaves was increased by applying SA to oilseed rape plants. The group of thioglucosides present in cruciferous plants is glucosinolates. When tissues are damaged, glucosinolates are hydrolyzed and release various products which are thought to contribute to the plant's defense against microorganisms and pests. (Kiddle *et al.*, 1994) [25] demonstrated a rise in secondary metabolite content in response to salicylic acid.

Impact of phosphorous on growth attributes in oilseeds

F.C. Oad *et al.*, (2001) [38] detailed that in Brassica, the use of 90:60:30 or 120:80:40 NPK kg per ha shows most elevated plant tallness and number of Branches per plant was noticed contrast with lower fertilizer doses of 30:20:10 and 60:40:20. Khanam. M *et al.*, (2016) [23] founded that in soya bean, Combined impact of P and K fertilizers although the two of them assumed a significant function on growth attributes. The use of Triple Super Phosphate (TSP) at 175 kg/ha and MOP at 120 kg/ha had critical impact on number of nodules and most noteworthy number of pods/plants was noticed. Mouri SJ *et al.*, (2018) [33] announced that in Ground nut, the utilization of Phosphorous at 60kg/ha had huge increment on development of the on growth attributes that the highest value of all the parameters like leaf area index, dry matter, number of primary branches/plant, number of secondary branches/ plant, number of pegs/ plant was recorded contrasted with 40, 20 and 0 kg P/ha. Myo Win *et al.*, (2010) [50] revealed that in soya bean, Phosphorus use efficiencies and dry matter accumulation in the soybean assortments considered expanded with increasing phosphorus supplement application up to the amount of 1.0 mM P. Increasing the outer phosphorous focus to more than 1.0 mM, caused a decrease in P-usage efficiencies, as the P fixation in the tissues expanded with no extra development. An expansion in P-use efficiencies was related with an increment in the overall extents of dry matter P in shoot tissues. Hina Malhotra *et al.*, (2018) [29] detailed that, Phosphorous is a significant factor for seed germination and improved seedling life, increase growth attributes plant tallness, leaf area, leaf number and shoot dry biomass, Flower and Seed Formation.

Impact of phosphorous on yield and oil content attributes in oilseeds

F.C. Oad *et al.*, (2001) [38] announced that in Brassica, the use of 90:60:30 or 120:80:40 NPK kg per ha shows highest number of siliquae, seed weight, seed index and oil content of mustard crop was recorded. And indicated productivity for increasing greatest yield ascribes with the use of higher fertilizer dosage contrast with lower fertilizer dosages of 30:20:10 and 60:40:20. Thavaprakash, N *et al.*, (2002) [47] revealed that in sunflower, Higher seed yields of sunflower acquired in the treatment getting N/P proportion of 1.0 with 2.00 N: 2.00 P: 1.00 K fertilizer level produced larger heads, more head weight at harvest, more seed weight plant/ha and more 1000- seed weight as with the treatments receiving N/P ratio of >1.0 with 2.00 N: 1.25 P: 1.00 K fertilizer level. Khanam. M *et al.*, (2016) [23] detailed that in soya bean,

Combined impact of P and K fertilizers enhanced the number of filled pods/ plant, The maximum seeds/pod, Pod length (cm), seed index, seed yield, Stover yield (t ha⁻¹), Biological yield (t ha⁻¹) and Harvest index (%) of soybean respectively. Mouri SJ *et al.*, (2018) [33] revealed that in Ground nut, the impact of Phosphorous at 60kg/ha shows critical increase number of total pods/ plant, weight of 100-pods, weight of 100-seeds, shelling percentage, pod yield, seed yield, Stover yield and harvest index expanded continuously with the expanding level of phosphorus manure at 60 kg P/ha. Myo Win *et al.*, (2010) [50] detailed that in soya bean, the use of 1.0 and 2.0mM P caused critical declines in the seed protein content by 4 and 5%, individually, when contrasted with that of 0.5 mM P. Sandeep Kumar *et al.*, (2017) announced that in soya bean, Application of 90 kg P₂O₅/ha with 45 kg S/ha recorded highest seed and Stover yield in soybean. Phosphorus and sulphur application significantly huge expansion in the supplement convergence of full scale just as micronutrients in seed. On the utilization of 90 kg P₂O₅/ha, most noteworthy supplement substance of N, P, K, Ca, Mg. At more significant levels of phosphorus application, Zn content of seed reduced and it was most noteworthy at 30 kg P₂O₅ ha⁻¹. With utilization of 45 kg S ha⁻¹, the substance of N, P, K, Ca, Mg and S was expanded. Shubhangi J. Dhage *et al.*, (2014) detailed that the soybean seed and straw yield expanded altogether because of utilization of phosphorus. The utilization of 90 kg P₂O₅/ha indicated fundamentally better outcome over rest of the treatment aside from crop getting 60 kg P₂O₅/ha. The use of 90 and 60 kg P₂O₅ demonstrated most elevated and practically same convergence of protein and in pooled. Increment in oil content was to the tune of 2% to 7.2% because of utilization of 30 to 90 kg P over control. Soodabeh Bastani *et al.*, (2017) [4] detailed that in foliar application of oilseed rape plant had preferences over root application maintaining root P acquisition capacity from soil however, In addition to the reduction in fruit yield, a lower recovery rate was observed for foliar-applied P at the reproductive level. According to these results, as indicated by these outcomes, foliar P fertigation in oilseed rape plants is suggested distinctly at before flowering stages. Lende NS *et al.*, (2017) [28] announced that in Niger, the treatment combination of N@40 kg/ha and P@20 kg/ha done by blend of SSP+PSB maximum number of capitulate per plant and number of seeds per capitula were recorded. Use of phosphorus expanded the photosynthetic and microbial activities and movement of photosynthates, which brought about higher seed yield. The treatment blend of N@40 kg/ha and P@20 kg/ha through SSP+PSB gave fundamentally higher seed yield and highest B: C ratio.

Role of Naphthalene acetic acid in increasing growth and flowering ascribes in oilseed crops

P Prasanth Kumar and Dr. Suchit A John (2018) [26] presumed that impact of plant growth promoters and growth retardants, GA₃, NAA, Cycocel and Ethrel at various concentrations on mustard. The maximum plant height (cm) and highest growth rate was recorded at 90 DAS in NAA@ 100ppm compared with different treatments and control. It very well may be utilized as a successful plant growth regulator advertiser for the growth and development. The utilization of growth retardants i.e., Compared with control, Cycocel @ 300ppm suggested a decrease in plant stature (cm). The higher number of branches per plant, number of leaves per plant, total dry matter content (gm) per plant was recorded by Cycocel @ 100, 200, 300ppm as compared to control. The utilization of

Ethrel @ 100, 200 and 300ppm has recorded higher growth rate compared with control. Md. Abubakar Siddik *et al.*, (2015) [45] revealed that, the morpho-physiological parameters, utilization of 50 ppm NAA essentially expanded morphological characters-plant height, leaf number/plant, branch number/plant, fresh and dry weight of shoot and root other than leaf and branch number/plant at 30 and 40 DAS. Ferdousi Begum *et al.*, (2018) [5] detailed that, the naphthalene acetic acid fundamentally affected the biochemical character of rapeseed oil. 70 ppm NAA ha⁻¹ confirmed the most important chlorophyll substance of rapeseed leaves at 50 days after emergence. The most extreme nitrogen content in the leaves was likewise found in a similar NAA level at 45 DAE. Kekita H. Chute *et al.*, (2017) [8] announced that in linseed, linseed, foliar sprays of cow urine and NAA showed their significance over control. Treatment (4% cow urine + 50 ppm NAA) followed by (6% cow urine + 50ppm NAA) significantly increased chlorophyll content in leaves, leaf nitrogen content, leaf phosphorus content and leaf potassium content. Shanker Lal Khaswa *et al.*, (2014) [24] revealed that 40kg P₂O₅/ha, SSP and foliar spray of 100 ppm NAA resulted in sustained higher soybean productivity due to enhancement in phosphorous use efficiency that resulted in significantly higher pooled plant height, number of branches per plant. Utilization of PGRs resulted in significantly early setting of 50% flowering and significant improvement in performance of various growth parameters.

Role of Naphthalene acetic acid in increasing yield and oil content ascribes in oilseed crops

Rahul A Kengare *et al.*, (2018) reported that in sunflower the foliar sprays of PGR's were given at the time of 50% flowering and seed formation. The impact of boron (0.2%), Kinetin (200 ppm) and TIBA (240 ppm) shows more Total number of filled seeds/head, Total number of seeds/head, Seed Filling Percentage (%), Head Diameter (cm), Yield q/ha, Harvest Index (%) and Oil Content (%) compared to NAA (50 ppm). Md. Abubakar Siddik *et al.*, (2015) [45] reported that, as morphological parameters NAA also significantly improves yield contributing characters of sesame the number of pods/plant, diameter and length of pod, seed weight/plant/plot, thousand seed weight compared to without NAA. Foliar application of 50 ppm NAA would be helpful to enhance the seed yield of sesame. Ferdousi Begum *et al.*, (2018) [5] announced that, an estimation of 70 ppm NAA confirmed the highest oil content the most elevated oil content. A value of 70 ppm NAA also showed the highest oil content. The minimum acid, peroxide and saponification values were observed in 70 ppm NAA. The same treatment also showed the highest iodine value. By decreasing the NAA level, nonessential fatty acids were increased in the mustard plant, while necessary fatty acids were highest in 70 ppm NAA/ha. So, 70 ppm NAA/ha can be used to grow quality mustard. Kekita H. Chute *et al.*, (2017) [8] revealed that in linseed, foliar sprays of cow urine and NAA showed their significance over control. Treatment (4% cow urine + 50 ppm NAA) followed by (6% cow urine + 50ppm NAA) significantly increased oil content in seed, number of capsules/plant, number of seeds/capsules, test weight, seed yield/plant (g) and seed yield/plot (kg). Minakshi R. *et al.*, (2017) [31] revealed that the use of 350 ppm humic Acid through vermicompost wash + 50 ppm NAA followed by 300 ppm humic acid through vermicompost wash + 50 ppm NAA in linseed had significant promotive impact on oil content in seed, number of capsules plant-1, number of seeds capsules-1,

1000 seed weight, seed yield/plot/ha when compared with the control treatment. Hence, the two foliar sprays of 350 ppm HA through VCW + 50 ppm NAA at 35 and 55 DAS can be considered as the successful supplement the nutrient management treatment. Shanker Lal Khaswa *et al.*, (2014)^[24] reported that 40kg P₂O₅/ha, SSP and foliar spray of 100 ppm NAA resulted in higher oil content, oil yield, seed protein yield, grain yield and Stover yield. Use of PGRs resulted in significantly prolonged crop maturity period besides significant improvement in performance of various dry matter productivity and quality parameters of soybean. Siddik *et al.*, (2016)^[45] stated that in sesame, seed yield and yield contributing parameters of sesame are positively correlated with N and NAA application. The combined use of 60 kg N/ha and 50 ppm NAA along with recommended doses of other fertilizer would be beneficial to increase the seed yield of sesame.

Role of salicylic acid on growth qualities in oilseed crops

Faizan Ullah *et al.*, (2012)^[48] concluded that in canola (*Brassica napus* L.) the effect of SA appears to be mediated by improving photosynthetic pigments consequently enhancing photosynthesis, economizing the water budget as obvious by increased Leaf relative water content and by augmenting osmoregulating proline production and preventing proteins from getting degraded. EL Sabagh *et al.*, (2017)^[13] reported that in canola, the irrigation intervals have a significant influence on growth traits. Application of antioxidants salicylic acid 200 ppm, Ascorbic acid 200 ppm had a significant increase on the growth attributes of plant height, a number of branches /plant, and Relative water content (%). S. H. Jadhav *et al.*, (2011)^[8] concluded that in groundnut, application of Salicylic acid with 50 ppm concentration showed significant germination in all groundnut cultivars. SA also showed a positive impact on root and shoot growth parameters in groundnut. Siddhi Gupta *et al.*, (2017)^[17] revealed that in soybean, there was an improved inhibitory impact on seed germination percentage, root length, shoot length, tolerance index, fresh weight, and dry weight of soybean seedlings from the application of 0.5mM SA with lead concentrations. SA mitigated the adverse effects of lead and zinc stress on the growth parameters of soybean plants in the early seedlings' growth stage. Refat A. Youssef *et al.*, (2017)^[53] reported that in sunflower, increasing the rate of salicylic acid from 0 to 1.4 mM led to increasing significantly leaf area, plant height of sunflower plants under all levels of soil salinity. High physiological composition values (chlorophyll a and b, carotenoids) were administered with high salicylic acid levels of 1.4 mM. Mona G. Dawood *et al.*, (2019)^[10] reported that in flax, Salicylic acid was the most efficient phenolic acids in increasing growth parameters. And various improving biochemical parameters, where salicylic acid at 100 mg/l was the most effective treatment. Improved growth parameters, photosynthetic pigments, IAA, phenolic material with the application of various phenolic acids. Nitish Sharma *et al.*, (2018)^[29] stated that in mustard *Brassica juncea* (L.) Foliar application of plant growth regulators significantly improved the total chlorophyll contents in leaf up to 60 DAS and after 60 DAS the declining trend was recorded in total chlorophyll content in leaf. Total chlorophyll content in leaf and maximum increase in the number of flowers per plant was observed in GA3 50 ppm followed by salicylic acid 0.5 mM and Minimum kinetin increase of 25 ppm over control at the full blooming stage. S Muthulakshmi *et al.*, (2017)^[35] reported that Salicylic acid which is a

secondary plant product performs important actions in the growth and development processes of plants. In plants, it is an important signaling molecule and is involved in eliciting responses to biotic and abiotic stress. Salicylic acid has been studied as a phytohormone, which modulates many plant responses. Therefore, SA acts as a standard phytohormone for plants.

Role of Salicylic acid on yield qualities in oilseed crops

R. Nazar *et al.*, (2015)^[37] revealed that SA application by foliar spray at a concentration of 0.5 mM could protect the mustard (*Brassica juncea* L.). Application of 0.5 mM SA under drought stress conditions significantly increased proline content by 168.6% compared with control. Under no-stress condition 0.5 mM, SA increased proline accumulation of 67.2% in comparison to control. Sarita muhal *et al.*, (2014)^[34] reported that in *Brassica juncea* var. Bio- 902 sown during SMW 41 found better yield compare to SMW 43 and SMW 45 sown crops and also a foliar spray of 100 ppm SA increased seed yield of *Brassica*. Faizan Ullah *et al.*, (2012)^[48] concluded that in canola (*Brassica napus* L.) the effect of Salicylic Acid improved seed proteins under drought stress. EL Sabagh *et al.*, (2017)^[13] reported that in canola, the irrigation intervals have a significant influence on yield and quality trials. Application of antioxidants salicylic acid 200 ppm, Ascorbic acid 200 ppm had a significant increase on the seed yield and quality traits of canola under water-deficient conditions. The maximum seed yield/ha was achieved by the applications of a combination of both antioxidants' salicylic acid 200ppm and Ascorbic acid 200ppm with irrigation every 25 days. Refat A. Youssef *et al.*, (2017)^[53] reported that in sunflower, increasing the rate of salicylic acid from 0 to 1.4 mM led to increasing significantly all yield components of sunflower plants under all levels of soil salinity. Under high levels of salicylic acid 1.4 mM was given high values of physiological compositions (total carbohydrate, protein content, and proline). Mona G. Dawood *et al.*, (2019)^[10] reported that in flax, Salicylic acid was the most efficient phenolic acids in increasing yield parameters. Application of different phenolic acids increased seed yield, and yield components as well as oil and carbohydrate percentages in the yielded seeds.

Conclusion

It is concluded that phosphorous and growth regulators of Naphthalene acetic acid and salicylic acid play an important role to increase the yield of oilseed crops. Phosphorus is considered a crucial component and has proven to be vital for the development, growth, and productivity of oilseeds. The optimum dose of phosphorous and plant growth regulators significantly enhanced oil content, protein content, grain yield, stover yield, and early setting of 50% flowering and prolonged crop maturity besides significant improvement in the performance of various growth parameters, dry matter production, and quality parameters of oilseed crops.

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