Plant Archives Vol. 26, Supplement 1, 2026 pp. 464-468 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org

DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2026.v26.supplement-1.062

PLANT GROWTH REGULATOR'S IMPACT ON SESAME CROP (*SESAMUM INDICUM* L.) GROWTH AND YIELD: A REVIEW

Nilotpal Das[1]*, Argha Mandal[2] and SK Moinuddin[3]

[1]Department of Agronomy, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan-731236, West Bengal, India,

[2]Department of Soil Science and Agricultural Chemistry, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan-731236, West Bengal, India,

[3]Department of Agronomy, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India

*Corresponding authors E-mail: rangandas1996@gmail.com

(Date of Receiving : 24-08-2025; Date of Acceptance : 02-11-2025)

ABSTRACT

Sesame (*Sesamum indicum* L.) is a pre-historic oil seed crop with high quality edible oil, high protein oil seeds and nutraceutical benefits. Sesame productivity is low because it is not growing well, is sensitive to environmental stress, and use of modern agronomic methods. Plant Growth Regulators (PGRs) have proved useful in altering crop physiology, optimising growth processes and increasing crop yield potential. This research was an attempt to determine the effects of various PGRs on growth, yield characteristics, and productivity of sesame. Use of growth promoters like gibberellic acid (GA_3), naphthalene acetic acid (NAA) and salicylic acid and growth retardants like cycocel (CCC) had a strong impact on crop performances. GA_3 and NAA treatments increased plant height, leaf area index, chlorophyll content and photosynthetic activity which led to improved flower initiation and capsule set. Application of salicylic acid promoted the mechanism of stress tolerance in terms of seed filling and oil accumulation in the field scenario. CCC on the other hand was successful in controlling undesirable vegetative growth and encouraging a healthy source-sink interaction. Yield parameters like the number of capsules per plant, seeds per capsule, the weight of 1000 seeds and oil content were significantly enhanced using optimum PGR treatments over the untreated control. GA_3 100 ppm, and NAA 40 ppm had the highest seed yield and biological yield, as well as a high harvest index. The research finds that the use of PGRs is judicious to enhance growth efficiency, optimize reproductive success, and improve yield and oil quality in sesame. The implementation of plant growth regulators and good agronomic practices may be an effective and viable approach to enhancing the productivity as well as long-term sustainable growth of sesame under varying agro-ecological conditions.

***Keywords* :** Sesame, Plant growth regulators, Yield, Gibberellic acid, NAA, CCC.

Introduction

Sesame (*Sesamum indicum* L.) Queen of oil seeds. It is also known as Til, Gingeli, Sim and is the ancient most significant oil seed crop in the tropics. Sesame has been theorized to be of African origin. Sesame was introduced to India by the earliest human migrants of Africa, a crop is grown during a period of elevated atmospheric evaporative pressure and when little irrigation water is available. In the situation where there is requirement of efficient utilisation of water resources (Ashri, 1989 and Mermould, 2005) or Physiological manipulation of the crop with growth regulator to overcome the water stress situation (Ashri, 1989 and Tian *et al.,* 1993) despite being grown everywhere in the world due to its significance in food, medicine as well as industries. China (19.97), Myanmar (16.68), Sudan (9.98) and others (Uganda, Nigeria, Pakistan, Ethiopia and Bangladesh) are the largest world producers of sesame with less than 5 percent each. Compared to the worlds (29.3 %) area (25 %) of production, we find that the productivity of sesame in India is 6.76 kg/ha compared to the worlds

(29.3 %) of 63.35 kg/kg of dietary energy in the seeds (Kumar & Goel, 1994 and Manubhai, H.D.K, 2021) this implies that the yield of sesame has yield potential of about 20t/ha, but low in productivity, 6.76 kg/ha. Sesame is among the origin of consumption oilseeds used as food (Weiss, 2000) and used primarily to produce Ghee (Yermonas *et al.,* 1972). Sesame is a source of good foodstuff, health care, edible oil and bio- medicine. it is also digestive, regenerative, anti-ageing and source of good oil. It is rich in vitamin-c, vitamin-a, vitamin -b-complex, Niacin, Calcium, phosphorous, and iron; copper, magnesium, zinc, and potassium. Sesame cake is byproduct of oil milling industry and is livestock feed as it is rich in methane by 8.6 kg/ha (statistical report, 2003-04) (Ashri, 1989). Industrial-wise Sesame is used in production of soaps, cosmetic, perfumes, insecticides and Pharmaceutical Products.

It is noted that, water stress tolerance is present in almost all plant species. The conventional methods of breeding plants have transitioned to the physiological parameter of growth because they are time consuming and also because they rely on the existing genetic variation of the plants (Manubhai, 2021). Protection of plants against abiotic stress is now increasingly receiving attention, due to the use of plant growth regulators, since the tolerance to an abiotic stress factor has a very complex nature, due to the complexity of interaction between the stress factor and other molecular, biochemical, physiological phenomena affecting plant growth and development (Manubhai, 2021). Although the ground nut mustard-rape seed is the second largest oil seed crop in India after sesame, it is inherently a low yield crop due to physiological problems that have been given as possible reasons to explain the low yield. Plant growth regulators have been reported to alter growth and developmental pattern of plants by altering many physiological and biochemical processes and thereby increasing crop production (Manubhai, 2021). It is desired that the localised application of certain plant growth regulators has far reaching effects on assimilates partitioning which increases the crop productivity. It is also reported that it can be used as a supplement in increasing crop productivity on a variety of crops. Very minimal research has been carried out with respect to application of plant growth regulators in oil seed crops during Rabi seasons (Manubhai, 2021). All these discussed causes notwithstanding, hinderance remains in physiological issues, in the form of hormonal imbalance, which will lead to a reduction in the crop yield of growth plants (Manubhai, 2021). The importance of plant growth regulators was first observed in the 1930s. Since, it has also been discovered that there are natural and artificial substances that alter the functions, shape and size of crop plants as well. Nevertheless, this kind of manipulations of growth and yield would prove handy information to examine the impact of plant growth regulators now a days.

Growth Parameter

Dorrel (1973) tested CCC and other treatments i.e. 0,100,1000,10000 ppm using sunflower cultivar. In a single experiment, Dhopte and Hudge (1976) reported how GA_3 influences the growth and yield of soybean. On spraying soybean plant with growth retardant CCC 250 ppm and growth promoter, GA_3, soybean height was enhanced; Ramrao *et al.,* (1982) conducted an experiment on soybean and found out that foliar spray of CCC reduced the height by a significant margin and foliar spray of GA3 promoted growth. Bruce (1990) and Manubhai, (2021) treated the soybean with the growth retardants viz., MC, lihocin (CCC) and MH and he reported that NAA 40 ppm significantly enhanced plant height, number of the branch per plant and the total dry weight of the plant. Chetti (1991) and Manubhai, (2021) treated groundnut with growth retardants viz., MC, lihocin (CCC) and MH and he reported that NAA 40 ppm had significant effect on increasing the plant height, the number of the branch per plant and Sontakey *et al.,* (1991) conducted an experiment on sesame which was sprayed with 100, 250, 500 ppm IAA and GA during the pre-flowering stage. Kene *et al.* (1995) sprayed IBA, GA and IAA at 15 ppm and 30 ppm at bud stage (35 DAS) and flowering (65 DAS). Plant height was much higher in the IBA, GA and IAA 15 ppm treatments at the bud stage. The reason is that an experiment conducted on lentil at Faisalabad, Pakistan found that GA_3 at 200ppm was the best to enhance the plant height, first node length, and stem diameter. Naeem *et al.* (2004) at Faisalabad, Pakistan, found that at the various stages of growth, GA_3 followed by NAA and then Kinetin exhibited the highest RGR, CGR and NAR. This gave the maximum production of grain (g)/plant in NAA-20 ppm which exceeded that in all the levels of GA_3 and Kinetin levels. Significantly, the treatment of NAA before the application of GA_3 and Kinetin measured all the concentrations of this chemical; maximum number of pod per plant; test weight, biological yield and harvest index (Manubhai, 2021).

Sarkar *et al.* (2006) used higher concentration of cycocel and recorded great increase in number of seeds per capsule of sesame. According to Shah and Prathapasenan (2008), when compared to control, water spray, and growth retardants, cycocel 500 ppm produced the highest amount of chlorophyll and recorded a notable increase in the number of seed per capsule of sesame. In Athari and Talebi (2014), the concentration of salicylic acid (SA) used was relatively low (0.05 mM) and this concentration had a significant effect on the number of pods per plant. However with higher levels of SA starting with 0.05 mM, then 1 mM some of the characters decreased significantly. In their research study Hussain *et al.* (2015) investigated the consequences of Exogenous application of drought stressed sesame plant with salicylic acid and kinestin which may confer tolerance to drought stress by growth and other physiological processes that drought stress affects adversely. Nazim (2016) conducted a field experiment on groundnut and concluded that the highest rate of foliar spray of salicylic acid was best applied to groundnut based on morphological parameters such as plant height (16.97 cm), number of branches (12.35), number of leaves (32.41) and leaf area (1211.63 cm^2). The number of flowers per plant, accretion of dry matter in leaves, stem, root, pod and total dry matter respectively at flowering were found to increase significantly (29.32, 26.41, 28.63, 26.12, 30.64 and 26.26) followed by comparing the result with control in the presence of salicylic acid at 150 ppm level.

Khan and Khan (2016) conducted a field experiment at Parbhani, Maharashtra on soybean. They noted that GA_3 use improves the plant height, leaf number, leaf dry weight, leaf area, stem dry weight, and total dry weight over the control. He further suggested that other growth parameters like AGR, NAR, RGR, CGR and LAI were also enhanced with use of GA_3, though, when lower salicylic acid(SA) concentrations were used, the deleterious effect of drought stress could not be alleviated, but could help to enhance growth of sesame under drought stress condition. As such, the need to carry out further researches to help in explaining the current processes of salicylic acid in vegetation with the aid of various procedures in vegetation when salicylic acid is sprayed on vegetation at 200 mg/l solution. In their trial on sesame, Behera *et al.* (2017) found that Foliar application of salicylicacid at saline conditions has a tendency to increase the levels of various physiological and biochemical parameters (6.37, 56.72 and 69.22 cm) and leaf area (6.5, 11.57 and 15.53 dm^2). During their experiment on cotton, Sabale *et al.* (2018) found that the NAA application Fang *et al.* (2019) described an experiment carried out at Jeddah, Saudi Arabia on shara plant (*Plectran thustenuiflorus*) and stated, salicylic acid when sprayed at 0.05 mM reduced the adverse effects of water deficit and consequently, improved the growth parameters, including the dry weight, relative growth rate (RGR) and photosynthetic pigments. They discovered salicylic acid had the potential to enhance the tolerance ability of the plant to drought stress.

Yield parameters

Rafique Uddin (1984) and Manubhai, (2021) examined how two variants of kidney beans respond to foliar application of cycocel (CCC) at various levels of concentration of 100-1000 ppm of cycocel throughout the crop growth cycle. This study found that yield improvement in large-seeded cultivars occurred primarily because the number of seeds per pod increased, but in small-seeded cultivars it was because of more pods per plant (Manubhai, 2021). Foliar spraying of CCC with the concentration of 400 ppm gave the highest yield. Like wise, Singh *et al.* (1987) indicated that 300 ppm cycocel and 200 ppm ethrel used as foliar applied during flowering initiation stage stimulated flowering and growth of pods in soybean resulting in increased seed production. According to Kumar *et al.* (2002) found an increase in pod and seed per plant with 250 ppm CCC.

Bibi *et al.* (2003) emphasized that increased levels of GA III contributed to the oil content of sunflower over time. Akter *et al.* (2007) observed that 50 ppm GA_3 had significant impact on plant height, fertile siliquae, flowering, seed setting and harvest index of mustard, but 75 ppm GA_3 only had an impact on flowering but not on yields. Shah and Prathapasenan (2008) found 1000 ppm CCC had the greatest positive effect on the pod and seed counts in green gram and the optimum yield was reached at 2000 ppm CCC. According to Kalyankar *et al.* (2008), GA_3, NAA and CCC had a positive effect of increasing pod numbers, seed weight, harvest index and overall yield of soybean. Salunkhe *et al.* (2008) also found out that NAA (50 ppm) among other PGRs was unusual in improving the yield characteristics of soybean culture JS-335 and Phule Kalyani.

Athari *et al.* (2014) established that foliar application of 0.05 mM salicylic acid on sesame resulted in a significant increase in the number of pods, weight, protein content, oil content and yield of sesame. Similarly, Siddik *et al.* (2015) reported that NAA 50 ppm enhanced sesame yield (1.22 t ha^3), and yield-related traits and did not affect yield anymore in presence of NAA 75 ppm. Nazim (2015) found out that groundnut sprayed with salicylic acid at 150 ppm flowering achieved better yield of pods, kernel, shelling percent, harvest index and pods.

Sawan (2016) suggested two sprays using NAA (20 ppm) when cotton is 90 and 105 days old because it significantly improves yield. Khan and Khan (2016) found that GA_3 150 ppm gave the maximum grain yield and other related yield characteristics in soybean with 100 and 200 ppm. Khatun *et al.* (2016) have also indicated that PGRs had great effect on the enhancement of pod length, the number of seeds, weight of seeds, and the content of the seeds including proteins in soybean with salicylic acid yielding the highest seed production. Sawan (2016) also established that cycocel 500 ppm enhanced cotton yield attributes without influencing fiber quality.

Saini *et al.* (2017) observed foliar spray of GA_3 at 125 ppm to be the most effective in maximizing siliqua number, siliqua length, seed number and seed yield per hectare in mustard. Nehal *et al*. (2018) also established that PGRs enhanced seed production of Indian mustard. Secondo and Reddy (2018) concluded that growth retardants in the recommended concentrations yielded better results by increasing the sink strength of the sunflower crop without decreasing the overall biomass. Sabale *et al.,* (2018) established that NAA (30 ppm) sprayed at 80 DAS was a significant plant growth promoter of seed cotton. Recently, Patil *et al.* (2020) found that terminal nipping at 30 DAS coupled with salicylic acid spray (100 ppm) and DAP (2%) at the 30 DAS stage resulted in the best number of capsules (89.7) and yield (541 kg ha^{-1}) of sesame.

Conclusion

Plant growth regulators (PGRs) are important in enhancing growth, development, and yield of sesame (*Sesamum indicum* L.), which is a valuable oil seed crop cultivated in different agro-climate conditions. Sesame is usually cultivated in marginal and stressful conditions where growth and potential yield are restrained by inadequate soil fertility, drought stress, and sloppy crop management. PGRs, including gibberellins, NAA, CCC releasers, and growth retardants can also be used in exogenous fashion to effectively regulate physiological and biochemical processes of plants to enhance seedling vigor, foliage area growth, photosynthetic efficiency, flowering, and seed filling.

The results of the research indicate that in addition to promoting vegetative growth and reproductive efficiency, PGRs have the advantage of synchronizing flowering and the loss of flowers and capsule, which pose significant limiting factors to yield in sesame. In addition, they are positively affecting the oil content and quality of the seed by increasing the nutrient use efficiency and translocation of assimilates. Use of PGRs, however, depends on type of regulator used, concentration, application stage, and environmental conditions.

In general, PGRs have potential use in maximizing the yield potential of sesame, specifically in intensive systems and systems subjected to stress. They can be integrated with appropriate agronomic practices and nutrient management systems to provide sustainable sesame production at a better profit. Further studies need to be conducted with the aim of determining crop- and region-specific PGR compounds and standardizing application procedures to enable the use of PGRs by larger numbers of farmers.

References

Akter, A., Ali, E., Islam, M. M. Z., Karim, R., & Razzaque, A. H. M. (2007). Effect of GA3 on growth and yield of mustard. *International Journal of Sustainable Crop Production,* **2(2),** 16-20.

Ashri, A. (1989). Oil crops of the world sesame. *McGraw-Hill*, New York, 375-387.

Athari, N. S., & Talebi, R. (2014). Effect of exogenous foliar salicylic acid application on sesame (*Sesamum indicum* L.) morphological characters, seed yield and oil content under different irrigation regimes. *International Journal of Biosciences,* **5(9),** 70-74. https,//doi.org/10.12692 /ijb/5.9.70-74

Behera, S., Padhiyari, A. K., & Rout, R. K. (2017). Effect of plant growth regulators on morphophysiological and yield parameters of some sesame (*Sesamum indicum* L.) cultivars. *International Journal of Current Microbiology and Applied Sciences,* ***6*****(11),** 1784-1809. https,//doi.org/ 10.20546/ijcmas.2017.611.215

Bhatt, J. G., & Ramanujam, T. (1996). Effect of cycocel on yield, chlorophyll content and fibre properties of lint of MCU cottons.

Bibi, M., Hussain, M., Qureshi, M. S., & Kousar, S. (2003). Morpho-chemical and physiological response of sunflower (*Helianthus annuus* L.) to gibberellic acid and nitrogen. *Pakistan Journal of Life and Social Science,* ***1***, 51-53.

Bora, R. K., & Sharma, C. M. (2006). Effect of gibberellic acid and cycocel on growth, yield and protein content of pea. *Asian Journal of Plant Science,* ***5***, 324-330.

Bruce, A. P. (1990). The use of plant growth regulators to enhance yield and production efficiency of soybean (*Glycine max* L.).

Chetti, M. B. (1991). Evaluation of Chamatkar on groundnut. *Pestology,* ***15*****(8),** 43-50.

Devi, K. N., Vyas, A. K., Singh, M. S., & Singh, N. G. (2011). Effect of bioregulators on growth, yield and chemical constituents of soybean (*Glycine max*). *Journal of Agricultural Sciences,* ***3*****(4),** 151-159.

Dhopte, A. M., & Hudge, V. S. (1976). Effect of GA on growth and yield of soybean. *Oilseeds Journal,* ***6*****,** 35-39.

Fang, S., Gao, K., Hu, W., Wang, S., Chen, B., & Zhou, Z. (2019). Foliar and seed application of plant growth regulators affects cotton yield by altering leaf physiology and floral bud carbohydrate accumulation. *Field Crops Research,* ***231***, 105-114.

Kalyankar, S. V., Kadam, G. R., Borgaonkar, S. B., Deshmukh, D. D. and Kadam, B. P. (2008). Effect of foliar application of growth regulators on seed yield and yield component of soybean (*Glycine max* L.). *Asian Journal Biological Science*, **3(1),** 229-230.

Kene, H.K., Sontakey, P.Y. and Kale, M.R. (1995). Effect of foliar application of growth regulators on growth, yield and oil content of sunflower. *PKV Research Journal*, **19(2)**, 182.

Khan, R. and Khan, N. (2016). Effect of plant growth regulators on physio-logical and biochemical parameters in soybean (*Glycine max* L.). M.Sc. (Ag.)Thesis, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. 103.

Khatun, S., Roy, T.S., Haque, M.N. and Alamgir, B. (2016). Effect of plant growth regulators and their time of application on yield attributes and quality of soybean. *International Journal Plant and Soil Science*, **11**, 1-9.

Kobayashi, T. (1991). Cytogenetics of sesame (*Sesamum indicum* L.). International chromosome engineering plants Genetic Breeding Evolution (Eds.), Netherlands, 581-592.

Kumar S., and Goel S.C. (1994). Population dynamics of a pyralid Antigastra catalaunalis Dup on sesame in relation to abiotic factors, *Journal Entomological Research*, **18(1),** 61-64

Kumar, P., Hiremath, S.M., Deshmukh, P.S. and Kushwaha, S.R. (2002). Effect of growth regulators on growth, yield and metabolism of soybean genotypes. *Indian Journal Agricultural Research*, **36**, 254-258.

Manubhai, H.D.K. (2021). *Effect of plant growth regulators on growth and yield of sesame (Sesamum indicum L.) under rainfed condition* (Master's thesis, Sardar Krushinagar Dantiwada Agricultural University, Chimanbhai Patel College of Agriculture, Sardarkrushinagar, Krishikosh, India).

Naeem, M., Bhatti, I., Ahmad, R.H. and Ashraf, M.Y. (2004). Effect of some growth hormones (GA_3, IAA and Kinetin) on the morphology and early or delayed initiation of bud of lentil (*Lens Culinaris* Medik). *Pakistan Journal of Botany*, **36(4)**, 801-809.

Nayar, N. M. and Simmonds, N.W. (1984). Evolution of crop plants in sesame. Longman, London, 231-233.

Nazim, P.M. (2016). Physiological effect of salicylic acid on pod setting and yield of groundnut (*Arachis hypogaea* L.). M.Sc. Thesis, Acharya N.G. Ranga Agricultural University, AP, 146.

Nehal, N., Khan, A., Sharma, N., Tripathi, S. K. and Singh, M. (2018). Role of GA_3, SA and ABA on growth and yield of Indian mustard (*Brassica juncea* L.) under rainfed condition. *Journal of Pharmacognosy and Phytochemistry*, 199-203.

Patil, Y.G., Mahajan, H.S., Patil, T.R., Bedis, M.R. and Patil, S.C. (2020). Influence of terminal nipping and growth regulators on yield maximization of sesame (*Sesamum indicum* L.). *International Journal of Current Microbiology and Applied Sciences*, **9(1),** 1322-1326.

Rafique-Uddin, M. (1984). Effects of cycocel on yield and yield contributing characters of kidney beans (*Phaseolus vulgaris*). *Legume Research*, **7(1),**43-47.

Ramesh, R. and Ramprasad, E. (2014). Effect of plant growth regulators on morphological, physiological and biochemical parameters of soybean (*Glycine max* L. Merrill). *Biotechnology and Bioforensics*, 61-71.

Ramrao, R.C., Venkateswarlu, M.S. and Sankara Reddy, S.R. (1982). Effect of growth regulators on growth and yield of TMV-2 groundnut of various plant densities. *The Andhra agriculture journal*, **29**, 46-50.

Sabale, S.S., Lahane, G.R. and Shaikh, S.A. (2018). Effect of various plant growth regulators on yield of American cotton (*Gossypium hirsutum*). *Journal of Pharmacognosy and Phytochemistry*, **7(5),** 1203-1209.

Saini, P.K., Yadav, R.K. and Pratap, M. (2017). Effect of foliar application of GA3on yield and quality of Indian mustard [*Brassica juncea* (L.) Czern. &Coss.] under sodic soil.

Salunkhe, T.E., Khairnar, A.V., Patil, H.M., Shinde. S.D. (2008). Influence of plant growth regulators on yield attributes and quality of soybean. *International Journal Agricultital Science*, **4(2),** 621-623.

Sarkar, S., Datta, J. and Bandhu, S. (2006).Influence of growth regulators on performance of sesame under varying irrigation levels. *Journal of crop and weed*, **2(2)**, 1-4.

Sarkar, P.K., Haque, M.S. and Karim, M.A. (2002). Effects of GA and IAA and their frequency of application on morphology, yield contributing characters and yield of soybean. *Pakistan Journal of Agronomy*, **1(4),** 119-122.

Sawan, Z. M. (2016). Plant density, plant growth retardants, Its direct and residual effects on cotton yield and fiber properties. *Cogent Biology*, **2(1).**

Secondo, E. S. P. and Reddy, Y. A. N. (2018). Plant growth regulators improve sink strength and yield of sunflower. *International Journal Microbiology and Applied Science*, **7(10),** 111-119.

Shah, T. and Prathapasenan, G. (2008). Effect of CCC on the growth and yield of mung Bean (*Vigna radiata* [L.] Wilczek var. Guj-2). *Journal Agricultural Science*, **166(1)**, 40 47.

Siddik, M.A., Islam, M.M., Hoque, M.A., Islam, S., Parvin, S. and Rabin, M.H. (2015). Morpho-physiological and yield contributing characters and yield of sesame with 1-Napthalene Acetic Acid (NAA). *Journal of Plant Sciences*, **3(6),** 329-333.

Singh, H. (1987). Effect of growth regulators on flower initiation, pod development and seed yield of soybean. *Comparative physiology and ecology*, **14(2),**74-77.

Sontakey, P.Y., Belsore, W.Y., Deotale, R.D. and Wankhede, S.Z. (1991). Relative influence of growth hormones on growth and yield performance of sesamum. New agric., **1(2)**, 208-208.

Tian, W. X., Zhao, J.Y., Bai, B.Z., Liu, G.R., Li, M.Y. and Qi, G.Q. (1993). Paclobutrazol affecting yield and quality of sugar beet. *Journal of Jilin Agricultural University*, **15** , 97-105.

Wang, X., Zheng, H., Tang, Q., Mo, W. and Ma, J. (2019). Effects of Gibberellic Acid Application after Anthesis on Seed Vigor of Indica Hybrid Rice (*Oryza sativa* L.). *Agronomy*, **9**,861.

Weiss EA, (2000). Oilseed crops. 2nd ed. Oxford, Blackwell Science. Oxford, U.K. 131-164pp.