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Effect of seed priming with plant growth regulators on physiological changes of Indian mustard (*Brassica juncea* L. Czern & Coss.)

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Abstract
The investigation entitled "Effect of seed priming with plant growth regulators on physiological changes of Indian mustard (*Brassica juncea* L. Czern & Coss.)" was conducted during *rabi* season, 2016-17 at the Instructional Farm of Narendra Deva University of Agriculture & Technology, Kumarganj Faizabad (U.P.) in randomized block design with eight treatments, three replications and variety Narendra rai (NDR-8501).Various concentrations of GA_3 (100ppm, 150ppm, 200ppm) and SA (50ppm, 100ppm, 200ppm) were taken along with untreated control. Seed was soaked before 6 hrs of sowing. Observations were recorded at 40, 60, 80 DAS and at maturity. Biochemical parameters like, chlorophyll content, in green leaves, oil content (%) in dry seeds were taken. Seed soaking of different concentrations of GA_3 and SA influenced on all characters of mustard crop.

Keywords: SA, GA_3, mustard, chlorophyll, oil content, etc.

Introduction
Oilseeds crops are the second most important determinant of agricultural economy, next only to cereals. Today, the demand for vegetable oils is out pacing the supply with more than half of its annual requirements being met mainly through imports. India is the 5th largest vegetable oil economy in the world next to USA, China, Brazil and Argentina accounting for 7.4% world oilseed output, 6.1 % of oil meal production, 3.9% world oil meal export 5.8% vegetable oil production, 11.2% of world oil import and 9.3% of the world edible oil consumption (DRMR, 2013, Vision 2020). Rapeseed-mustard (Brassica spp.) is one of the most important oilseed crops of the world where India is ranking third in area and production in the world (DRMR, 2015). Among the seven edible oilseeds cultivated in India, rapeseed mustard contributes 28.6% in the total oilseeds production and ranks second after groundnut sharing 27.8% in the India's oilseed economy (Shekhawat *et al*., 2012) [27] however due to more oil content (ranging from 35-45%) rapeseed-mustard ranks first in terms of oil yield among all oilseeds crops. Its seed contains 37 to 49 percent edible oil (Singh *et al*., 2009) [24]. Demand of edible oil has increased with increasing population and improvement in the living standard of the people, resulting thereby in short supply of edible oils which is being met with imports of edible oil worth 44,000 crores per annum. Thus, there is need to boost the oilseed production through area expansion and productivity enhancement.

Indian mustard (*Brassica juncea* L. Czern) belongs to family Cruciferae, genus Brassica and species juncea popularly known as rai. Mustard is cultivated mostly under temperate climate. It is also cultivated in certain tropical and subtropical region as a cold weather crop. In India, rapeseed-mustard occupy 5.99 million ha area with production and productivity of 6.31 million tones and 1053 kg/ha respectively (India stat 2015-16). Indian mustard (*Brassica juncea* L.) is an important rabi crop of Haryana. In Haryana, rapeseed and mustard is one of the major growing crop occupying 0.56 million ha of area, with production and productivity of 0.699 million tones and 1248kg/ha respectively (India stat 2015-16).

Priming of seed is a physiological pre- conditioning which is widely used in various crops. Which includes subjective of seeds to cycle of wetting, drying and incubation at low temperature. Seed priming is normally practiced with water and can be improved further by selection of inorganic chemicals and growth regulators. Material used in seed priming are aqueous solution of salts (sodium chloride, sodium sulphate, potassium nitrate etc.) growth

regulators (gibberellic acid, cycocel, IAA).
Salicylic acid is ortho- hydroxyl benzoic acid and is a secondary metabolite acting as analogous of growth regulating substances. It helps in protection of nucleic acids and prevention of protein degradation. The salicylic acid is also known to induce many genes coding for parthenogenesis and proteins in response to biotic and abiotic stresses (Enyedi *et al*., 1992) [4]. Foliar application of salicylic acid increased the IAA content in broad bean leaves (Xin *et al*., 2000) [18]. Foliar application of salicylic acid exerted a significant effect on plant growth metabolism when applied at physiological concentrations, and thus acted as one of the plant growth regulating substances (Kalarani *et al*., 2001) [8]
Gibberellins constitute a group of tetracyclic diterpenes that best known for their influence on leaf expansion, stem elongation, flower, fruit development and plant morphology (Yamaguchi 2008; Chauhan *et al*., 2010) [29, 3]. GA_3 is the first widely available active form of commercial gibberellins which is economically an important secondary metabolite (Martin, 1983) [17]. GAs promotes cell elongation by induction of enzymes involved in cell wall loosening and expansion, such as xyloglucan endo transglycosylase (XET), expansin and pectic methyl esterase (PME). Several studies on different plant species have shown that the exogenous application of GA_3 can enhance the productivity of crops affecting the vital physiological process (Rahman *et al*., 2004; Bora and Sarma, 2006) [20, 1]. GA_3 increases shoot length by increasing its rate of elongation in majority of plants, including *Brassica compestris* (Pressman and Shaked, 1991) [19]. Root length was also observed to increase by GA_3 treatment in *Lupinusalbus* (Sidiras and Karsioti, 1996). GA_3 increased dry matter and leaf-area index in mustard plant (Khan, 1996) [5], and photosynthetic rate in leaves of bean (Khan *et al*., 2002) [6].

Materials and Methods
The Instructional Farm of the Narendra Deva University of Agriculture and Technology, (Narendra Nagar) Kumarganj, Faizabad (U.P.) during *Rabi* season of 2016-17 "Effect of seed priming with plant growth regulators on physiological changes of Indian mustard (*Brassica juncea* L. Czern & Coss.)" The experimental site is situated at the Instructional Farm of university on the Faizabad Raibareli road, at a distance of 42 km from Faizabad city and 23 km away from Jagdishpur. In the present study, Variety Narendra rai (NDR-8501) was taken as experimental materials to find out the response of GA_3 and SA on growth and yield contributing traits of mustard in randomized block design with eight treatments, three replications and variety Narendra rai (NDR-8501). Various concentrations of GA_3 (100ppm, 150ppm, 200ppm,) and SA (50ppm, 100ppm, 200ppm) were taken along with untreated control. Seed was soaked before 6 hrs of sowing. Observations were recorded at 40, 60, 80 DAS and at maturity. Biochemical parameters like chlorophyll content, in green leaves, oil content (%) in dry seeds were taken.

Results and Discussion
Chlorophyll content (SPAD value)
The data recorded on total chlorophyll showed that all the treatments applied as seed priming favoured better growth of crop by enhancing chlorophyll content (7.15, 11.19, 10.05mg g^{-1} fresh weight) in GA_3 and (7.74, 9.05, 10.04 mg g^{-1} fresh weight) in SA treated plants at 40, 60, 80 DAS. Chlorophylls enzyme which is responsible for chlorophyll degradation, might have been inhibited by plant growth regulators. Meyyappan (1991) reported that NAA application protect the chlorophyll molecules from photo-oxidation and thereby increased chlorophyll content. Jaya Kumar *et al.*, (2008) [7] also reported that foliar application of PGRs (NAA 40ppm and brassinostrodes 0.1ppm) on black gram significantly increased the chlorophyll content. These results are also in close agreement with those reported by Senthil (2003) [14] in Soyabean.

Table 1: Effect of PGRs on Chlorophyll content of mustard

Treatment	Chlorophyll content		
	40DAS	60 DAS	80 DAS
T_1 : Untreated control	8.05	11.60	9.90
T_2 : Seed soaking in 100ppm GA_3	8.37	9.74	9.40
T_3 : Seed soaking in 150ppm GA_3	7.90	9.77	9.01
T_4 : Seed soaking in 200ppm GA_3	7.15	11.19	10.05
T_5 : Seed soaking in 50ppm salicylic acid	8.60	9.42	7.99
T_6 : Seed soaking in 100ppm salicylic acid	7.74	9.05	10.04
T_7 : Seed soaking in 200ppm salicylic acid	8.42	8.37	8.88
T_8 : Seed soaking in distilled water	9.02	10.09	8.27
SEm±	0.28	0.33	0.37
CD at 5%	0.85	1.01	1.12

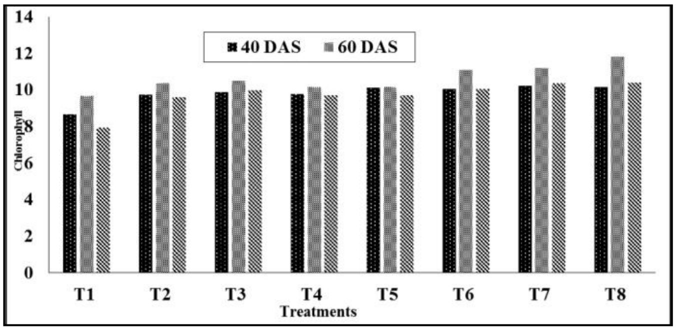

Fig 1: Effect of PGRs on Chlorophyll content of mustard

Oil content (%)
Over all treatments increased oil content (%) in dry seed of mustard. The maximum oil content (%) in dry seed was recorded with seed priming of $GA_3$200ppm and SA 100ppm, over other treatments. The oil content (%) increased significantly in all the treatments over control. This showed that the GA_3 and SA has much influence on oil content. The effect of GA_3 application on male sterility seed yield, oil content and fatty acid synthesis of safflower (*Carthamus tinctorius* L.) cv. GA_3 was applied at 0, 50, 100, 200 or 300ppm at 40, 55 and 70 DAS. GA_3 induced male sterility at rates of up to 93%, and decreased seed yield per plant. Although GA_3 did not affect fatty acid synthesis, oil synthesis increased with increasing GA_3 concentration from 33.8% in controls to 38.8% with the application of 300ppm at the budding stage. Moreover, Baydar (2000).

Table 3: Effect of PGRs on oil content (%) of mustard

Treatments	Oil content (%)
T_1 : Untreated control	38.67
T_2 : Seed soaking in 100ppm GA_3	39.18
T_3 : Seed soaking in 150ppm GA_3	39.65
T_4 : Seed soaking in 200ppm GA_3	39.71
T_5 : Seed soaking in 50ppm salicylic acid	39.26
T_6 : Seed soaking in 100ppm salicylic acid	40.15
T_7 : Seed soaking in 200ppm salicylic acid	39.80
T_8 : Seed soaking in distilled water	38.95
SEm±	1.59
CD at 5%	4.82

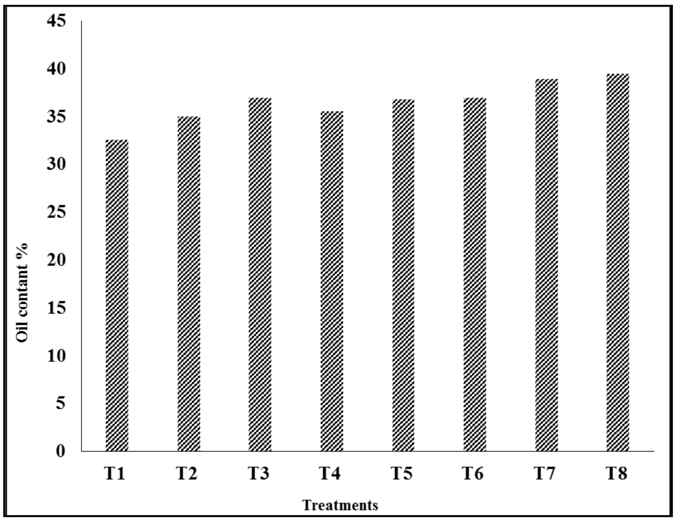

Fig 2: Effect of PGRs on oil content (%) of mustard

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