Effect of Foliar Application of Plant Growth Regulators on Growth, Yield, Quality and Economics of Broad bean (*Vicia faba* L.) under Low Hills of Uttarakhand

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Abstract

An experimental study was conducted during the year 2023-24 at Horticulture Research Block, Department of Horticulture, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun, Uttarakhand, India to examine the "Effect of Foliar application of Plant growth regulators on growth, yield, quality and economics of Broad bean (*Vicia faba* L.) under low hills of Uttarakhand". The experiment was laid out in Randomized Block Design with three replications and ten treatments. The treatments comprised following levels of different Plant growth regulators with different concentrations viz. T_0 (Control), T_1 (GA_3 @50ppm), T_2 (GA_3 @ 75ppm), T_3 (GA_3 @100ppm), T_4 (NAA @50ppm), T_5 (NAA @75ppm), T_6 (NAA @100ppm), T_7 (GA_3 @50ppm + NAA @50ppm), T_8 (GA_3 @75ppm + NAA @75ppm) and T_9 (GA_3 @100ppm + NAA @100ppm). Sowing of Broad bean cv. Bakla Komal was done on 04-11-2023. Various growth and pod attributes, yield and quality factors as well as economic data were systematically recorded at regular intervals through the application of standard measurement methodologies. Among all the PGR treatments, T_9 was found to be most effective for increasing the number of pods per cluster (3.80), number of pods per branch (12.10), number of seeds per pod (3.53), fresh weight of seed (15.37g) and dry weight of seed (3.37g). However, total soluble solids (7.47 ^{0}Brix), moisture content of pods (86.67%) and moisture content of seeds (58.52%) were recorded maximum in control.

Keywords: Broad bean, pod attributes, number of pods per cluster, fresh weight of seed, dry weight of seed, total soluble solids

Introduction

The broad bean, scientifically known as *Vicia faba* L., is a member of the Fabaceae family and has a diploid chromosome number of 2n=12. This leguminous plant falls under the Kingdom Plantae, within the clade of angiosperms, and is classified in the order Fabales, family Fabaceae, subfamily Faboideae, and tribe Fabeae. Notably, the broad bean is unique as it is the only bean cultivated as a cool-season crop during the winter months. The broad bean is an amazing crop that serves as a complete food source. However, in some parts of the world, including India, it remains underutilized and not fully tapped into. The ability of broad bean to produce large quantity of biological N fixation is well documented. It is recognized as a viable alternative to cereal crops, with the ability to fix up to 300 kg of nitrogen per hectare (Dayoub *et al.,* 2017; Denton *et al.,* 2017; Barłóg *et al.,* 2018 and Gebremariam and Assefa, 2018). To enhance its acceptance in other countries, there is a need to address its anti-nutritional factors. Efforts are underway to increase its production area and overall acceptability, supported by technology, given its significant potential for food and nutritional security. The broad bean is known by various names, often referring to specific subgroups rather than the entire species. Despite its many benefits, challenges such as anti-nutritional elements, taste, and aroma still need to be overcome (Sharma *et al.,* 2022). Recently more attention has been made on using broad bean as a multi-purpose legume crop (Landry *et al.,* 2016) or in intercropping systems. broad beans fit nicely into various crop rotations, including double cropping with other vegetables and grains. Due to the diverse and significant ecological services broad bean has increasingly received attention (Etamadi *et al.,* 2018). In 1987, Korber-Grohne discovered that this crop was introduced in the late Neolithic era. Cubero noted that the Near East, particularly

Iraq and Iran, was the main area of origin, while secondary centres later appeared in Afghanistan and Ethiopia. There are also indications that *Vicia faba* could have originated in West or Central Asia. Currently, this crop is widely cultivated in the Mediterranean region, as well as in China, Africa, Europe, the Middle East, and Asia, serving as a vital food source for both people and livestock. In 2014, global production of broad bean grains reached 4.1 million tons, marking a 21% increase compared to 1994 figures (FAO, 2017). According to the National Horticulture Board, the total area dedicated to vegetable farming is 11,374,000 hectares, yielding 209,143,000 metric tons. Additionally, the Directorate of Horticulture and Food Processing Chaubatia reports that Uttarakhand's vegetable farming spans 58,268.28 hectares, producing 501,786.64 metric tons, with a productivity rate of 8.61 metric tons per hectare. This hardy plant can withstand chilly temperatures as low as 4 °C. For the best pod growth, a temperature range of 15-20 °C is preferred, but excessively high temperatures during the rainy season can lead to the dropping of flowers and pods. In colder agricultural climates, planting is postponed until late winter or early spring to avoid frost damage. Broad beans flourish with annual rainfall between 650 to 1000 mm, ideally distributed throughout the year. In tropical and subtropical areas, they can be grown at elevations from 1200 m to 2500 m above sea level. While broad beans are generally considered day-neutral, some varieties may require longer daylight hours to flower. Waterlogging during the flowering stage can hinder the growth and yield of broad beans (Pampana *et al.,* 2016). These plants prefer fine-textured soils but are quite adaptable to various soil types. Ideally, the soil pH for growing broad beans should be approximately 7. Interestingly, broad beans have shown resilience to brief periods of waterlogging (Tekalign *et al.,* 2016). Broad bean seeds boast a wealth of bioactive compounds, including polyphenols and carotenoids. The specific chemical profile can vary widely depending on the cultivar, growing conditions, and farming practices (Witten *et al.,* 2015). Unfortunately, broad beans are underutilized. They are abundant in dietary fiber, minerals, vitamins, lipids, γ-aminobutyric acid, and phenolic compounds, which nourish the human body and enhance the antioxidant system and biological functions (Mahdi *et al.,* 2021). In addition to its nutritional advantages, broad beans also have some anti-nutritional components, including saponins, tannins, phytic acid, lectins, oxalates, and trypsin inhibitors. Notably, vicine and convicine are present, which can trigger a condition known as "Favism" (Rizello *et al.,* 2016; Luzzatto and Arese, 2018; Khazaei *et al.,* 2019; Labba *et al.,* 2021). Favism triggers the creation of superoxide, leading to a swift oxidation of glutathione (GSH) in red blood cells. This condition is exclusive to individuals with G6PD deficiency. Various methods, including food processing, sprouting, breeding techniques, germination, and fermentation, have been shown to significantly lower the levels of these anti-nutritional factors (Coda *et al.,* 2015; Rizzello *et al.,* 2016; Shi *et al.,* 2016). Several farming techniques can lead to better fruit yields and improved quality across different fruit crops. One effective strategy is the use of plant growth regulators (PGRs), with GA_3 being a frequently chosen option. Evidence shows that PGRs can increase fruit size, total yield, and quality by directly affecting growth and development or indirectly by managing crop load and plant health (Devrari *et al.,* 2017). The motivation to investigate the influence of Plant Growth Regulators such as GA_3 and NAA on broad bean cultivation in the low hills of Uttarakhand stems from a notable research deficiency. There exists a distinct lack of studies focusing on the effects of these particular regulators on broad bean crops within this area, and this experiment aims to fill that void. By analysing the impact of GA_3 and NAA on broad bean growth under the specific conditions of Uttarakhand's low hills, we aspire to produce valuable insights that will aid local farmers and promote sustainable agricultural practices.

Materials and Method

An experimental research was carried out to investigate the "Effect of Foliar application of Plant growth regulator on growth, yield, quality and economics of Broad bean (*Vicia faba* L.) under low hills of Uttarakhand" during the rabi season of 2023-24 at the Research Block of the School of Agricultural Sciences at Shri Guru Ram Rai University, located in Pathri Bagh, Dehradun, Uttarakhand, India. This area is situated between the latitudes of 29º58' and 31º2'30" North and longitudes of 77º34'45" and 78º18'30" East. The "Bakla Komal" variety was employed for experimental trials. For this experiment, a randomized block design was put into action, consisting of ten treatments. A comprehensive list of these treatments and their symbols can be found in Table 1. The treatments are as follows: T_0 (Control), T_1 (GA_3 @50ppm), T_2 (GA_3 @75ppm), T_3 (GA_3 @100ppm), T_4 (NAA @50ppm), T_5 (NAA @75ppm), T_6 (NAA @100ppm), T_7 (GA_3 @50ppm + NAA @50ppm), T_8 (GA_3 @75ppm + NAA @75ppm), and T_9 (GA_3 @100ppm + NAA @100ppm). The allocation of treatments to the experimental units was done randomly, following the Fisher and Yates random table method (Panse and Sukhatme, 1985), and this was repeated three times to ensure statistical validity.

Table 1: Treatment combination with their concentration

Treatments	Treatment Combinations	Concentration
T_0	Control (No PGR)	-
T_1	GA_3	50 ppm
T_2	GA_3	75 ppm
T_3	GA_3	100 ppm
T_4	NAA	50 ppm
T_5	NAA	75 ppm
T_6	NAA	100 ppm
T_7	GA_3 + NAA	50 ppm + 50 ppm
T_8	GA_3 + NAA	75 ppm + 75 ppm
T_9	GA_3 + NAA	100 ppm + 100 ppm

Result and discussion

The research demonstrated that varying doses of plant growth regulators had a significant effect on growth and yield characteristics in comparison to the control. Tables 2 and 3 illustrated that notable enhancements were achieved with different combinations of plant growth regulators versus the control. The results of this study have been carefully noted and will be discussed in detail below:

Number of pods per cluster

The data presented in Table 2 and Fig 1 indicated that there was significant variation in number of pods per cluster among different plant growth regulators. At 90 DAS, the maximum number of pods per cluster (3.80) was recorded in T_9 with GA_3 @100ppm + NAA @100ppm and the minimum number of pods per cluster (2.27) was recorded in T_0 at Control. Whereas, T_6 (3.57) and T_8 (3.63) were at par with each other. The treatment T_3 (3.10), T_4 (3.33) and T_7 (3.27) were also at par with each other. However, the significant difference was found in T_2 (2.53) and T_5 (3.77). At Final harvest, the maximum number of pods per cluster (3.30) was recorded in T_9 with GA_3 @100ppm + NAA @100ppm which were at par with T_5 (3.27) and the minimum number of pods per cluster (1.77) was recorded in T_0 at Control. Whereas, T_2 (2.40) and T_3 (2.60) were at par with each other and T_4 (2.83) and T_7 (2.77) also at par with each other. The treatment T_6 (3.07) and T_8 (3.13) were also at par with each other. However, the significant difference was found in T_1 (2.03). The application of NAA is effective in preventing the loss of buds, flowers, and pods, and it also boosts the quick delivery of nutrients to growing areas, potentially resulting in a higher pod count per plant. In contrast, using GA_3 may lead to a lower number of pods because it shifts nutrients away from reproductive structures toward vegetative growth. These results agree with the reports of (Bairva *et al.,* 2012) in fenugreek and (Parmar *et al.,* 2011) in green gram.

Number of pods per branch

The data showed in Table 2 and Fig 2 depicted that there was significant variation in number of pods per branch among different plant growth regulators. At 90 DAS, the maximum number of pods per branch (12.10) was recorded in T_9 with GA_3 @100ppm) + NAA @100ppm and the minimum number of pods per branch (5.43) was recorded in T_0 at Control. Whereas, T_4 (9.13) and T_7 (8.73) were at par with each other. The treatment T_6 (10.40) and T_8 (10.10) were also at par with each other. However, the significant difference was found in T_1 (7.00), T_2 (7.43) and T_5 (9.73). At Final harvest, the maximum number of pods per branch (8.60) was recorded in T_9 with GA_3 @100ppm + NAA @100ppm which were at par with T_8 (8.60) and the minimum number of pods per branch (4.43) was recorded in T_0 at Control. Whereas, T_1 (5.00), T_2 (5.43) and T_3 (5.80) were at par with each other and T_5 (7.53) and T_6 (8.00) also at par with each other. However, the significant difference was found in T_4 (6.93) and T_7 (6.33). Spraying NAA is effective in preventing the drop of buds, flowers, and pods and it also enhances the quick movement of nutrients to growing areas, which could lead to a higher number of pods per plant. On the flip side, the use of GA_3 might result in fewer pods because it shifts nutrients away from reproductive structures to vegetative ones. These results are consistent with the studies by (Bairva *et al.,* 2012) in fenugreek and (Parmar *et al.,* 2011) in green gram.

Number of seeds per pod

The data pertaining to Table 2 and Fig 3 indicated that there was significant variation in number of seeds per pod among different plant growth regulators. At 90 DAS, the maximum number of seeds per pod (3.53) was recorded in T_9 with GA_3 @100ppm + NAA @100ppm and the minimum number of seeds per pod (1.80) was recorded in T_0 at Control which were at par with T_2 (1.83). Whereas, T_1 (2.13) and T_3 (2.20) were at par with each other. The treatment T_5 (2.67) and T_8 (2.57) were also at par with each other and T_4 (2.93) and T_6 (2.90) were also at par with each other. However, the significant difference was found in T_7 (3.07). At Final harvest, the maximum number of seeds per pod (3.87) was recorded in T_9 with GA_3 @100ppm + NAA @100ppm which were at par with T_6 (3.57) and the minimum number of seeds per pod (2.07) was recorded in T_0 at Control. Whereas, T_4 (3.50) and T_5 (3.50) were at par with each other and T_1 (2.53) and T_2 (2.87) also at par with each other. However, the significant difference was found in T_3 (3.20), T_7 (2.87) and T_8 (3.03). The increase in the number of seeds per plant may be attributed to a possible synergistic interaction resulting from the combination of the two growth regulators (Sharma *et al.,* 2024).

Fresh weight of seed (g)

The data presented in Table 2 and Fig 4 indicated that there was significant variation in Fresh weight of seed among different plant growth regulators. At 90 DAS, the maximum Fresh weight of seed (15.37 g) was recorded in T_9 with GA_3 @100ppm) + NAA @100ppm which is at par with T_8 (5.10 g) and the minimum Fresh weight of seed (2.50 g) was recorded in T_0 at Control. Whereas, T_6 (4.67 g) and T_7 (4.90 g) were at par with each other. However, the significant difference was found in T_2 (3.00 g), T_3 (3.23 g), T_4 (3.60 g), T_5 (4.07 g). At Final harvest, the maximum Fresh weight of seed (9.13 g) was recorded in T_9 with GA_3 @100ppm) and the minimum Fresh weight of seed (3.80 g) was recorded in T_0 at Control. Whereas, T_6 (8.43 g) and T_8 (8.30 g) were at par with each. However, the significant differences were found in T_4 (6.70 g), T_5 (7.40 g) and T_7 (7.73 g).

Dry weight of seed (g)

The data presented in Table 3 and Fig 5 reported that there was significant variation in Dry weight of seed among different plant growth regulators. At 90 DAS, the maximum Dry weight of seed (3.37 g) was recorded in T_9 with GA_3 @100ppm + NAA @100ppm and the minimum Dry weight of seed (1.03 g) was recorded in T_0 at Control. Whereas, T_1 (1.30 g), T_2 (1.30 g) and T_3 (1.40 g) were at par with each other. However, the significant difference was found in T_4 (1.70 g), T_5 (2.00 g) and T_6 (2.57 g). At Final harvest, the maximum Dry weight of seed (8.10 g) was recorded in T_9 with GA_3 @100ppm) and the minimum Dry weight of seed (2.10 g) was recorded in T_0 at Control. Whereas, T_3 (5.10 g) and T_7 (5.20 g) were at par with each other. However, the significant differences were recorded in T_2 (3.80 g), T_4 (5.67 g), T_5 (6.33 g) and T_6 (7.23 g).

Total soluble solids (ºBrix)

The data showed in Table 3 and Fig 6 depicted that there was significant variation in Total soluble solid of seed among different plant growth regulators. At 90 DAS, the maximum TSS (7.47 ^{0}Brix) was recorded in T_9 with GA_3 @100ppm + NAA @100ppm which were at par with T_8 (7.43 ^{0}Brix) and the minimum TSS (6.13 ^{0}Brix) was recorded in T_0 at Control which were at par with T_1 (6.23 ^{0}Brix). Whereas, T_2 (6.70 ^{0}Brix), T_6 (7.33 ^{0}Brix) and T_7 (7.33 ^{0}Brix) were at par with each other. Also, T_3 (6.83 ^{0}Brix) and T_4 (6.67 ^{0}Brix) were at par with each other. However, the significant difference was found in T_5 (7.27 ^{0}Brix). At Final harvest, the maximum TSS (8.37 ^{0}Brix) was recorded in T_9 with GA_3 @100ppm) which were at par with T_8 (8.23 ^{0}Brix) and the minimum TSS (6.40) was recorded in T_0 at Control which were at par with T_1 (6.50 ^{0}Brix). Whereas, T_5 (8.17 ^{0}Brix) and T_7 (8.17 ^{0}Brix) were at par with each other and also, T_3 (7.87 ^{0}Brix) and T_4 (7.67 ^{0}Brix) at par with each other. However, the significant difference was found in T_2 (7.33 ^{0}Brix) and T_6 (8.03 ^{0}Brix). The increase in TSS seems to be linked to the buildup of metabolites that stimulate the activity of different enzymes in physiological processes. This leads to the breakdown of starch and supports metabolic activity, transforming available starch into sugar and TSS. These results agree with the reports of (Pandey *et al.,* 2021) in cucumber.

Moisture content (%) of pods

The data presented in Table 3 and Fig 7 indicates that there was significant variation in Moisture content (%) of pods among different plant growth regulators. At 90 DAS, the maximum Moisture content (%) of pods (86.67 %) was recorded in T_0 at Control and the minimum Moisture content (%) of pods (72.94 %) was recorded in T_9 with GA_3 @100ppm + NAA @100ppm which were at par with T_8 (74.65 %). Whereas, T_4 (78.73 %), T_5 (78.18 %) and T_6 (78.46 %) were at par with each other. However, the significant difference was found in T_2 (80.40 %), T_3 (79.40 %) and T_7 (77.32 %). At Final harvest, the maximum Moisture content (%) of pods (55.16 %) was recorded in T_0 at Control and the minimum Moisture content (%) of pods (33.72 %) was recorded in T_9 with GA_3 @100ppm + NAA @100ppm). Whereas, T_6 (39.56 %), T_7 (39.80 %) and T_8 (39.23 %) were at par with each. However, the significant difference was found in T_2 (77.32 %), T_3 (48.54 %) and T_4 (48.60 %). GA_3 facilitates growth by extending stem length, augmenting dry weight, and improving overall yield. This phenomenon is probably attributed to enhanced cell division, stem elongation, better photosynthetic pigments, and increased plant biomass, which encompasses the fresh weights of leaves, stems, roots, and nitrogen levels in the grains. Studies conducted by (Sallam *et al.,* 2014) and (Khalifa, 2019) have reported comparable results in Broad bean.

Moisture content (%) of seeds

The data presented in Table 3 and Fig 8 indicated that there was significant variation in Moisture content (%) of seeds among different plant growth regulators. At 90 DAS, the maximum Moisture content (%) of seeds (58.52 %) was recorded in T_0 at Control and the minimum Moisture content (%) of seeds (37.29 %) was recorded in T_8 with GA_3 @75ppm + NAA @75ppm. Whereas, T_2 (56.67 %), T_3 (56.58 %) were at par with each other. However, the significant difference was found in T_4 (52.75 %), T_5 (50.83 %) and T_9 (40.52 %). At Final harvest, the maximum Moisture content (%) of seeds (44.07 %) was recorded in T_0 at Control and the minimum Moisture content (%) of seeds (30.67%) was recorded in T_8 with GA_3 @75ppm + NAA @75ppm which were at par with T_9 (30.92 %). Whereas, moisture content (%) of seeds in T_1 (41.48 %) and T_2 (40.00 %) were at par with each. However, the significant difference was found in T_3 (37.26 %), T_5 (35.35 %) and T_7 (37.30 %). This effect is likely due to increased cell division, stem elongation, improved photosynthetic pigments and greater plant biomass, including the fresh weights of leaves, stems, roots, and nitrogen content in the grains. Research from (Sallam *et al.,* 2014) and (Khalifa, 2019) indicated similar findings in Broad bean.

Conclusion

On the basis of present experimental research on “Effect of Foliar application of Plant Growth Regulator on growth, yield, quality and economics of Broad bean (*Vicia faba* L.) under low hills of Uttarakhand” in cultivar Bakla Komal, it can be concluded that among different organic manures treatments, the combination of GA_3 @100ppm + NAA @100ppm i.e., T_9 was found to be most effective for increasing number of pods per cluster, number of pods per branch, number of seeds per pod, fresh weight of seed (g) and dry weight of seed (g). However, total soluble solids, moisture content of pods, moisture content of seeds were recorded maximum in T_0 i.e. control.

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Conflict of interest

The authors declare that they have no conflicts of interest.

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Table 2: Effect of GA_3 and NAA on number of pods per cluster, number of pods per branch, number of seeds per pod of broad bean

Treatment	Number of pods per cluster		Number of pods per branch		Number of seeds per pod		Fresh weight (g) of seed	
	90 DAS	At Final harvest	90 DAS	At Final harvest	90 DAS	At Final harvest	90 DAS	At final harvest
T_0	2.27	1.77	5.43	4.43	1.80	2.07	2.50	3.80
T_1	2.53	2.03	7.00	5.00	2.13	2.53	2.87	4.27
T_2	2.90	2.40	7.43	5.43	1.83	2.87	3.00	5.10
T_3	3.10	2.60	8.00	5.80	2.20	3.20	3.23	5.83
T_4	3.33	2.83	9.13	6.93	2.93	3.50	3.60	6.70
T_5	3.77	3.27	9.73	7.53	2.67	3.50	4.07	7.40
T_6	3.57	3.07	10.40	8.00	2.90	3.57	4.67	8.43
T_7	3.27	2.77	8.73	6.33	3.07	2.87	4.90	7.73
T_8	3.63	3.13	10.10	8.60	2.57	3.03	5.10	8.30
T_9	3.80	3.30	12.10	8.60	3.53	3.87	5.37	9.13
C.D (0.05%)	0.65	0.65	1.06	1.06	0.37	0.37	0.25	0.26
SE(m) ±	0.22	0.22	0.35	0.35	0.12	0.12	0.08	0.09
SE(d) ±	0.31	0.31	0.50	0.50	0.17	0.17	0.12	0.12
C.V.	1.73	3.89	2.95	1.17	2.30	2.90	3.74	2.26

Table 3: Effect of GA_3 and NAA on Dry weight of seed (g), Total soluble solid, Moisture content (%) of pod, Moisture content (%) of seeds of broad bean

Treatment	Dry weight (g) of seed		Total soluble solid (ºBrix)		Moisture content (%) of pod		Moisture content (%) of seed	
	90 DAS	At final harvest	90 DAS	At Final harvest	90 DAS	At Final harvest	90 DAS	At Final harvest
T_0	1.03	2.10	6.13	6.40	86.67	55.16	58.52	44.07
T_1	1.30	3.53	6.23	6.50	82.18	52.56	54.67	41.48
T_2	1.30	3.80	6.70	7.33	80.40	51.19	56.67	40.00
T_3	1.40	5.10	6.83	7.87	79.40	49.41	56.58	37.26
T_4	1.70	5.67	6.67	7.67	78.73	48.60	52.75	36.29
T_5	2.00	6.33	7.27	8.17	78.18	44.62	50.83	35.35
T_6	2.57	7.23	7.33	8.03	78.46	39.56	44.99	32.61
T_7	2.80	5.20	7.33	8.17	77.32	39.80	42.87	31.30
T_8	3.03	6.93	7.43	8.23	74.65	39.23	37.29	30.67
T_9	3.37	8.10	7.47	8.37	72.94	33.72	40.52	30.92
C.D (0.05%)	0.14	0.57	0.45	0.93	2.20	5.51	2.87	2.60
SE(m) ±	0.05	0.19	0.15	0.31	0.73	1.84	0.96	0.87

SE(d) ±	0.06	0.27	0.2	0.44	1.04	2.60	1.36	1.23
C.V.	3.86	1.09	1.78	7.02	1.61	2.02	3.35	2.17

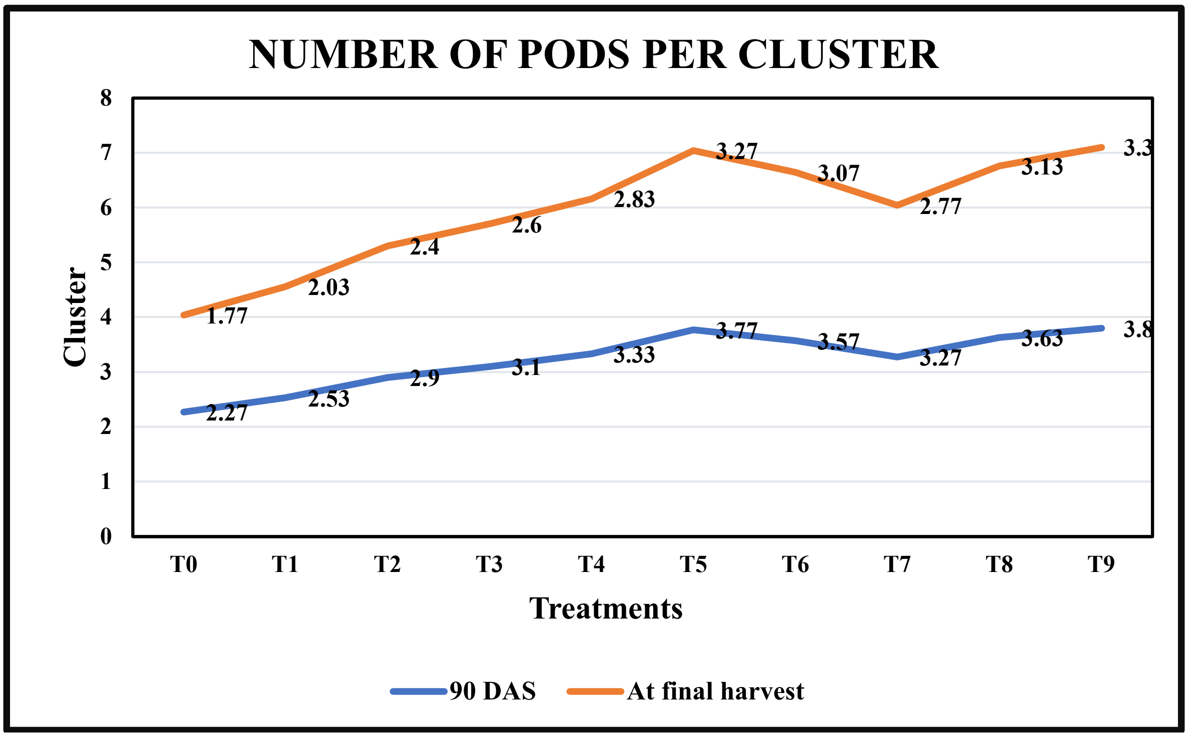

Fig. 1. Number of pods per cluster as influenced by application of GA_3 and NAA

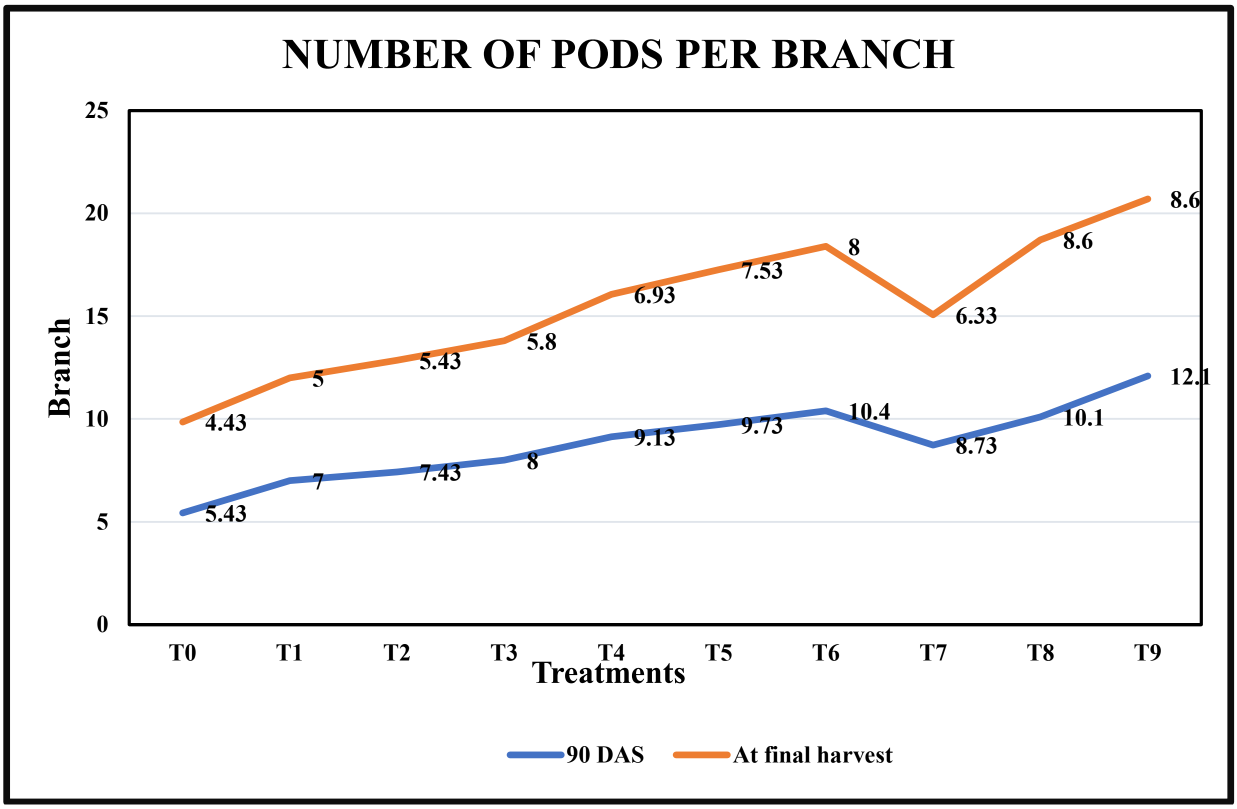

Fig. 2. Number of pods per branch as influenced by application of GA_3 and NAA

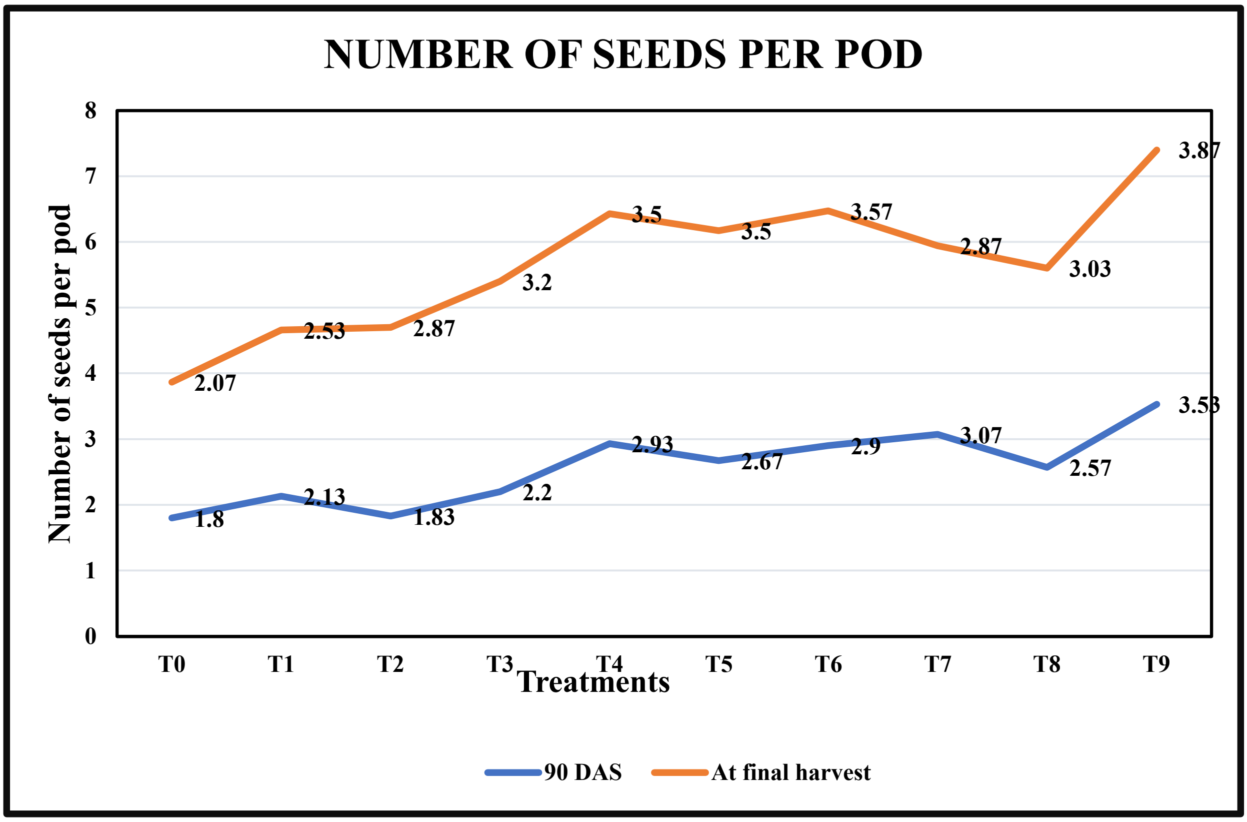

Fig. 3. Number of seeds per pod as influenced by application of GA_3 and NAA

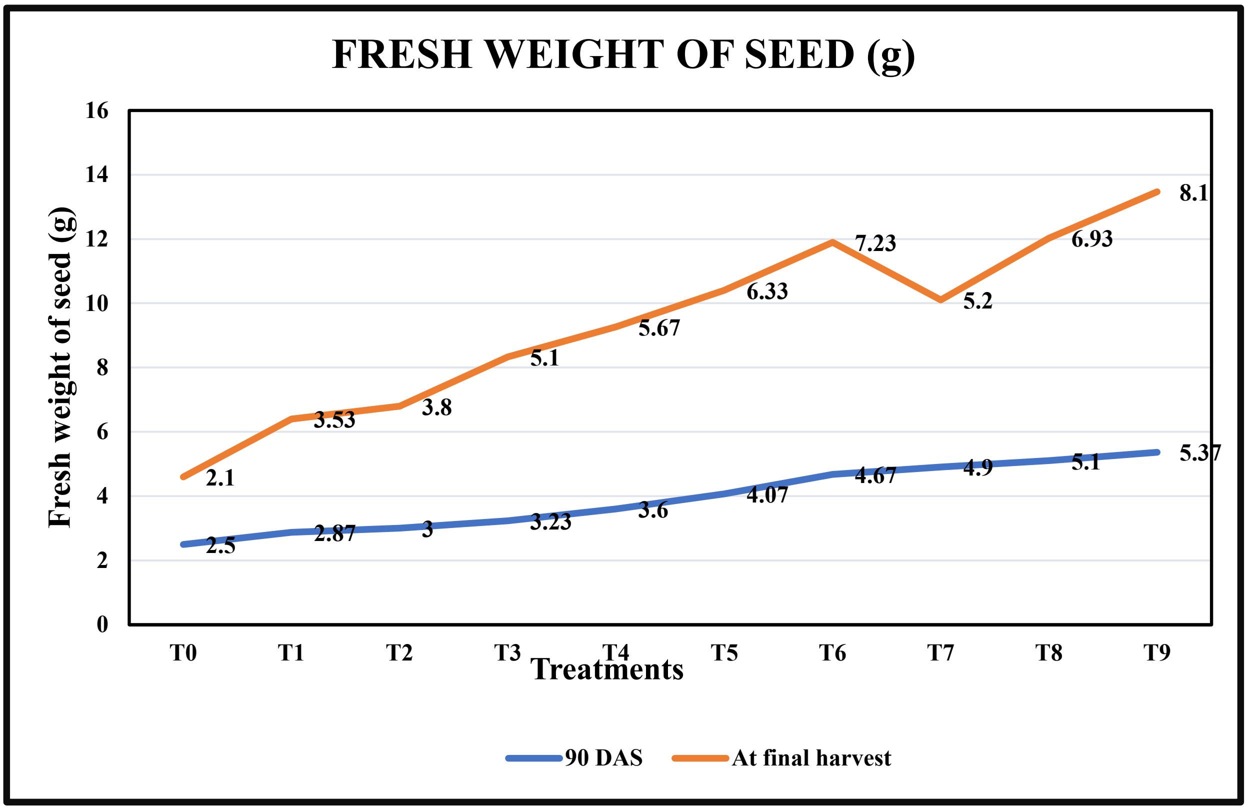

Fig. 4. Fresh weight of seed (g) as influenced by application of GA_3 and NAA

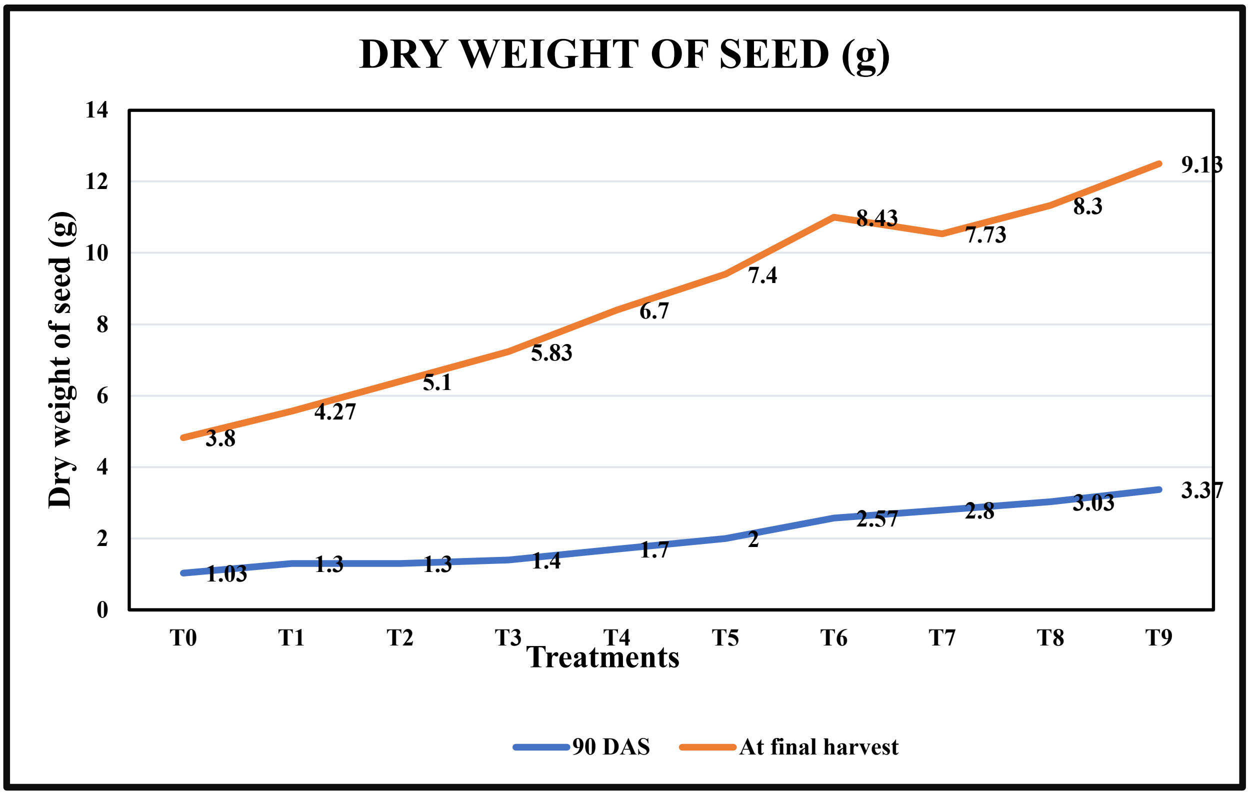

Fig. 5. Dry weight of seed (g) as influenced by application of GA_3 and NAA

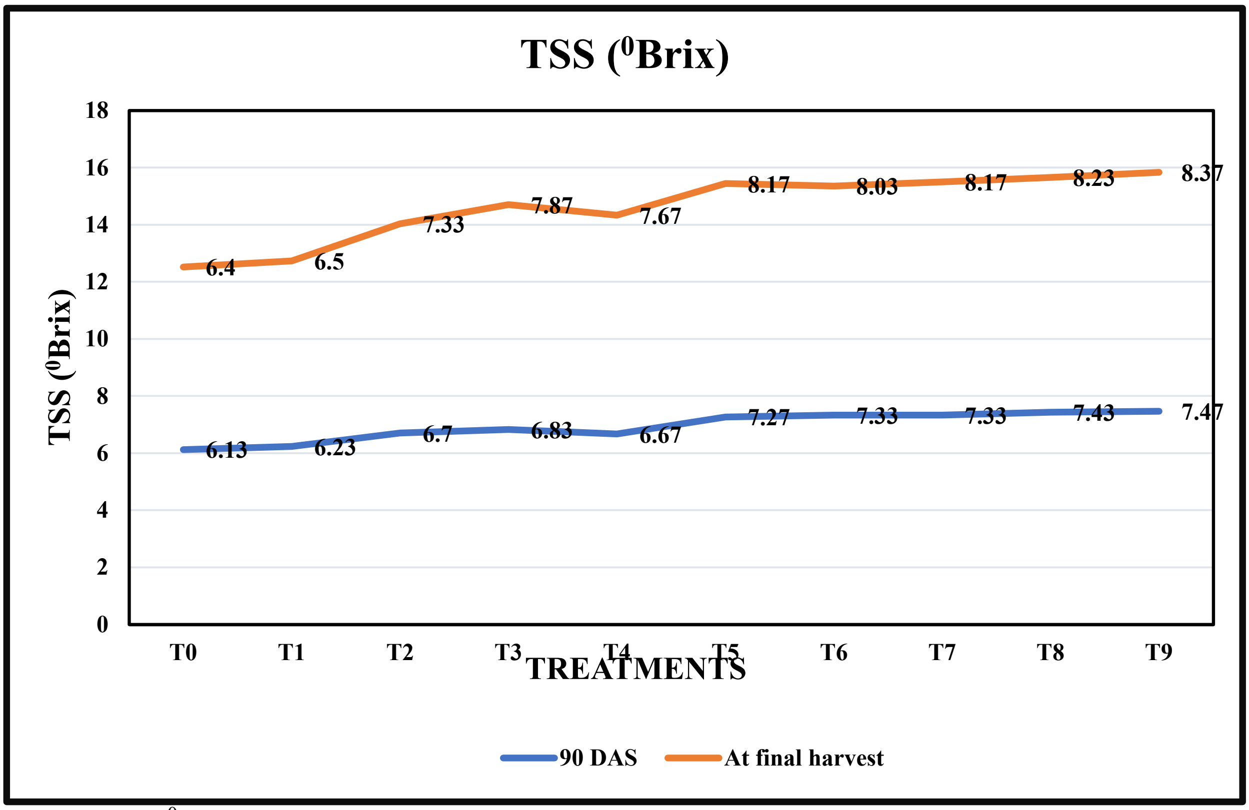

Fig. 6. TSS (^{0}Brix) as influenced by application of GA_3 and NAA

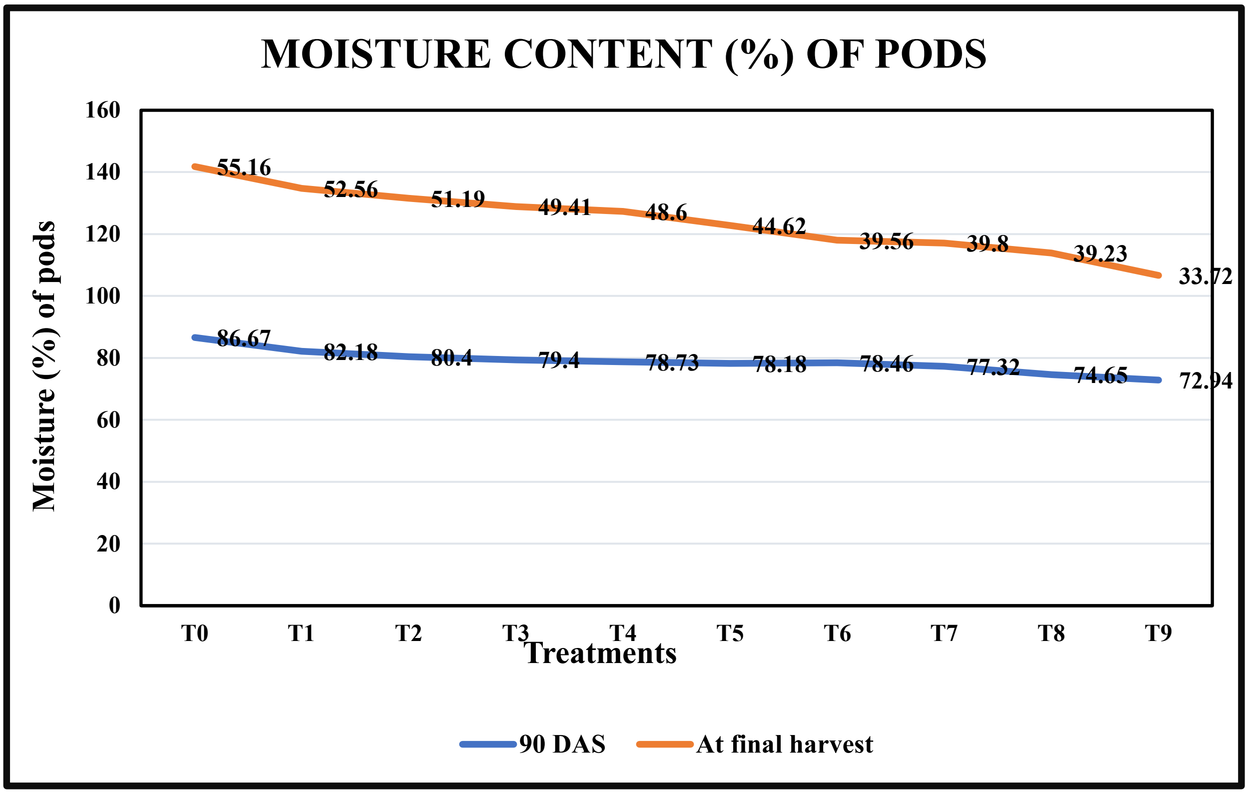

Fig. 7. Moisture content (%) of pods as influenced by application of GA_3 and NAA

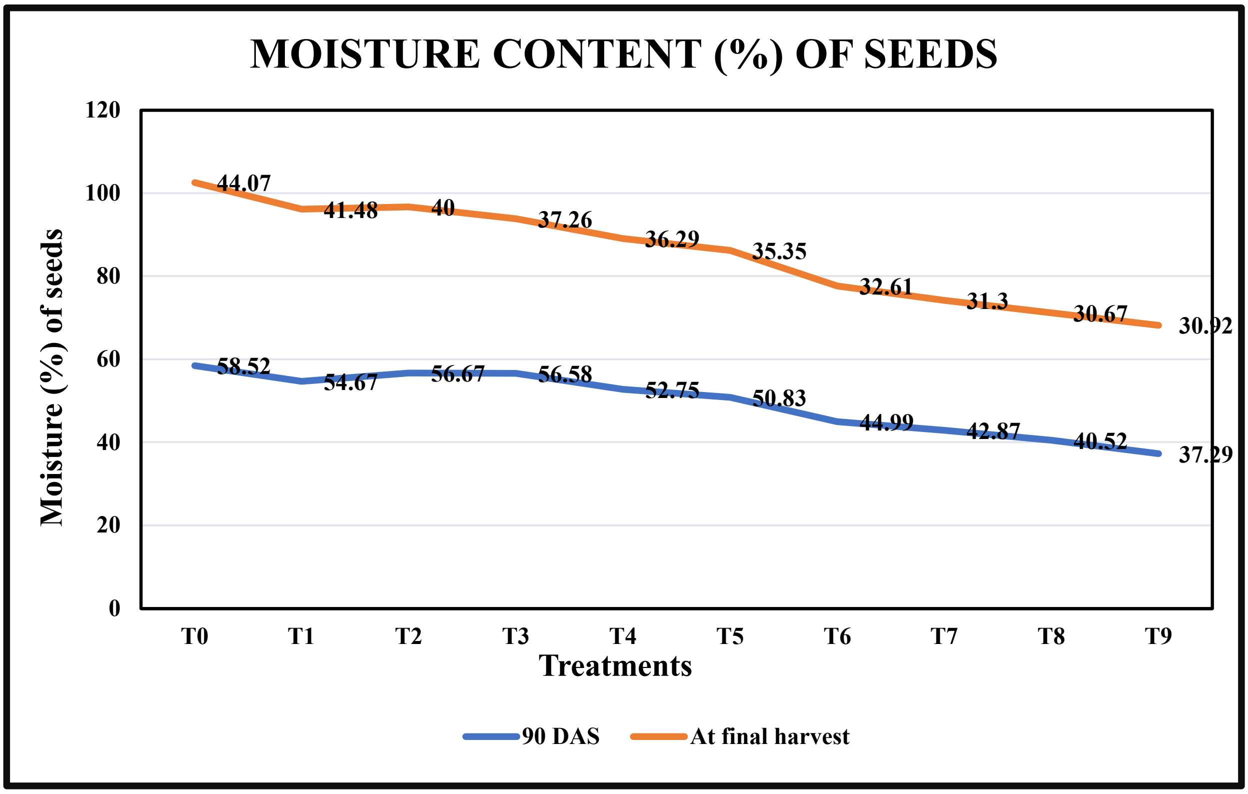

Fig. 8. Moisture content (%) of seeds as influenced by application of GA_3 and NAA