EFFECT OF PLANT GROWTH REGULATORS ON VIABILITY AND VIGOUR OF OKRA [*Abelmoschus esculentus* (L.) MOENCH]

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ABSTRACT

A laboratory experiment was conducted for two consecutive seasons (kharif 2015 and kharif 2016) to accomplish the objective to study the effect of plant growth regulators on viability and vigour of okra [Abelmoschus esculentus (L.) Moench]. Seeds of okra variety GJO 3 were treated with aqueous solution of growth regulators viz., GA_3, IBA and NAA, each at 50, 100 and 150 ppm concentrations and without growth regulators (water soaking). Observations on viability and vigour were recorded during both the seasons in laboratory before sowing the crop in the field following Completely Randomized Design in three repetitions. The results of seed quality parameters studied revealed that seeds treated with GA_3 150 ppm (T_3) was found most effective treatment and recorded significantly the highest germination percentage, seedling length, seedling dry weight, seedling vigour index (length), seedling vigour index (mass) and seed viability during both the years of experiment.

KEY WORDS: GA_3, IBA, NAA, okra, viability, vigour.

INTRODUCTION

Okra *Abelmoschus esculentus* L. (Moench), is an economically important vegetable crop grown in tropical and sub-tropical parts of the world (Tindall, 1986). It is commonly known as bhindi or lady's finger belonging to family Malvaceae. It is an important fruit vegetable crop cultivated in various states of India.

Okra provides an important source of vitamins (C, A, B- complex), calcium, potassium and other mineral matters, which are often lacking in the diet of developing countries (IBPGR, 1990; Lee *et al*., 1990; Adebooye, 1996). One hundred gram of fresh pod contained moisture (89.6 %), K (103 mg), Ca (90 mg), Mg (43 mg), P (56 mg), vitamin C (18 mg) and some important metals such as iron and aluminium (Markose and Peter, 1990). It is good for the people suffering from heart weakness (Yawalkar, 1969).

Plant growth regulators considered as a new generation of agrochemicals when added in small amounts can bring the changes in the phenotypes of plants and affect growth either by enhancing or by stimulating the natural growth regulatory systems from seed germination to senescence (Das and Das, 1995). These can improved the physiological efficiency of plants including photosynthetic capacity and effective partitioning of assimilates, resulting in to increase in yield. Several reports also indicated that, plant growth regulators effect not only on accelerating germination or growth, but also help in the augmentation of produce (Naylor and Davis, 1950; Ferres, 1951).

Gibberellic acid stimulates the cells of germinating seeds to produce mRNA molecules that code for hydrolytic enzymes (Bidwell, 1974). Several publications have reported that soaking okra seeds in growth regulators, particularly gibberellin, increases germination possibly due to a reduction in seed hardness (Passam and Polyzou, 1997). On the other hand, Pal and Hossain (2001) found no effect of GA_3 on okra seed germination and seed weight, but a significant effect of this hormone noted on plant height and the number of pods per plant.

From 1950 and onwards, expectations for naphthalene acetic acid (NAA) to improve crop production became high. Control flowering, enhancement of growth and productivity due to NAA application are well documented (Singh *et al.*, 1999). The influence of NAA on germinating seed are through effecting (a) germination (embryonic activity), and (b) substrate mobilization (Prasad and Kumar, 2014). IBA has been identified as a natural product in many plant species, in many text books it is still referred to as a 'synthetic auxin'. Since the 1930's, the plant growth regulator Indole-3-butyric acid (IBA) has been used for rooting of plant cuttings and other growth processes (Kroin, 1992).

Use of plant growth regulators has become one of the most important tools in the hand of horticulturists to produce maximum yield. Recently wide range of techniques of applying plant growth regulators are in practice. Among them, seed treatment with plant growth regulator is one of the most popular methods and has been claimed as the effective tool for improving rate of germination, increase in growth of shoot and root, increasing vegetable growth and seed yield (Patil *et al.,* 2008). Keeping all this in view, the effect of seed treatments of different growth regulators was examined on seed quality parameters in the laboratory for two consecutive years prior to sowing the seeds in the field.

MATERIALS AND METHODS

Genetically pure seeds of GJO 3 (Gujarat Junagadh Okra 3), which was obtained from Vegetable Research Station, Junagadh Agricultural University, Junagadh during *kharif* season of 2015 and 2016. Germination and vigour studies were conducted in Department of Seed Science and Technology, Junagadh Agricultural University, Junagadh. Aqueous solutions (50, 100 and 150 ppm) of different growth regulators IAA, GA_3 and NAA, was prepared separately. After preparation of solution of gibberellic acid (GA_3), indolebutyric acid (IBA) and naphthalene acetic acid (NAA), seeds of okra variety GJO 3 were soaked in desired solution made as per the treatments for 8 hours at 25^oC temperature. In the control treatment, the seeds were soaked in distilled water. After 8 hours of soaking, the solution were drained off and soaked seeds were air dried and thereafter, placed for germination in laboratory before sowing. Seeds were platted between germination papers. Germination papers were kept for germination at constant temperature i.e. 26 ± 1^oC in the germinator. Observations were recorded for seed quality parameters *viz*., germination percentage, seedlings length (cm), seedlings dry weight (mg), seedling vigour index (length), seedling vigour index (mass) and seed viability (%) were recorded during both the seasons before sowing the seeds in the field experiment using Completely Randomized Design in three repetitions.

RESULTS AND DISCUSSION

The analysis of variance carried out for the experimental design (CRD) revealed that mean squares due to all the seed quality parameters studied (before sowing) exhibited highly significant difference for all the treatments in both the years (*kharif* 2015 and 2016) indicated that treatments differed significantly for the seed quality parameters studied (Table 1).

The results are in accordance with the results of Singh (2003) in okra.

The germination percentage was significantly affected by growth regulators treatment in both the years of experimentation (Table 2). Seeds treated with GA_3 150 ppm (T_3) were found most effective and recorded significantly the highest germination percentage (93.67 %) during both the years of experimentation (*kharif* 2015 and 2016). Significantly the lowest germination percentage (77.33 %) was recorded by seeds treated with NAA 100 ppm (T_8) and NAA 150 ppm (T_9) in the first year of experimentation (*kharif* 2015), whereas significantly the lowest germination percentage (77.00 %) was recorded by seeds treated with NAA 150 ppm (T_9) during second year of experimentation (*kharif* 2016). This response of GA_3 might be due to the fact that gibberellic acid (GA_3) increases the stimulation of protoplasmic streaming, cell membrane permeability to water, synthesis and activity of enzymes, proteins and nucleic acid, formation of energy rich phosphate (ATP) and cell wall plasticity and decreases the viscosity and wall pressure (Kumar and Purohit, 1986). Similar beneficial effect of GA_3 on germination percentage in okra have also been reported by Singh and Singh (1977), Kumar *et al.* (1996), Patil *et al.* (2007), Patil *et al*. (2008), Patil *et al.* (2010) and Bhagure and Tambe (2013).

The effect of different growth regulators on seedlings length (cm) was significant during both the years of experiment (*kharif* 2015 and 2016) (Table 2). The findings revealed that among the growth regulators, seeds treated with GA_3 150 ppm (T_3) recorded significantly the highest seedling length (14.67 cm) and it was at par with GA_3 100 ppm (T_2) (14.17 cm) and GA_3 50 ppm (T_1) (13.74 cm) during *kharif* 2015, while during *kharif* 2016, seeds treated with GA_3 150 ppm (T_3) recorded significantly the highest seedling length (14.14 cm) and it was at par with GA_3 100 ppm (T_2) (14.07 cm) and GA_3 50 ppm (T_1) (13.97 cm). Significantly the lowest seedling length of 11.09 cm and 11.03 cm was recorded by control treatment (water soaked seeds) (T_{10}) during *kharif* 2015 and 2016, respectively. The well-known phenomenon of GA_3 is that it increases cell division and cell elongation. GA_3 induces substrate mobilization and increases the level of poly RNA, which is believed to contain the mRNA for the enzyme α-amylase synthesized by the aleurone cells, α-amylase hydrolysis starch to glucose. GA_3 also stimulate ribonuclease and protease synthesis in aleurone cells. In addition, GA_3 enhance the release of β-1, 3-glucanase, which dissolves the cell walls permitting an increased supply of nutrients from the endosperm to embryo (Kumar and Purohit, 1986). Similar beneficial effect of GA_3 on seedlings length was reported by Singh (2003) in okra.

Different growth regulators significantly affecting the seedling dry weight (mg) during both the years of experiment (*kharif* 2015 and 2016) (Table 2). The seedlings dry weight was more or less directly proportional to the total seedlings length. Seeds treated with GA_3 150 ppm (T_3) recorded significantly the highest seedling dry weight (29.42 and 28.92 mg) during both the years of experimentation. Significantly the lowest seedling dry weight (22.75 and 22.42 mg) was recorded by the seeds treated with IBA 50 ppm (T_4) during both the years of experimentation (*kharif* 2015 and 2016). Gibberellin activates the growth mechanism by efficient photosynthetic activity, thereby increasing carbohydrate accumulation and thus, dry matter contents (Muhammad *et al.*, 2001). The results are in agreement with those of Omran *et al.* (1980), Ahmed and Tahir (1996) and Ravat and Makani (2015) in okra.

The effect of different growth regulators on seedling vigour index (length) and seedling vigour index (mass) was observed significant during both the years of experiment (*kharif* 2015 and

2016) (Table 2). Seeds treated with GA_3 150 ppm (T_3) recorded significantly the highest seedling vigour index (length) of 1374.14 and 1325.28 during *kharif* 2015 and *kharif* 2016, respectively. Significantly the lowest seedling vigour index (length) (909.38 and 900.93) was recorded by the seeds soaked in distilled water (T_{10}) during both the years of experimentation. Similarly, seeds treated with GA_3 150 ppm (T_3) recorded significantly the highest seedling vigour index (mass) with a value of 2754.92 and 2707.75 during *kharif* 2015 and 2016, respectively. Significantly the lowest seedling vigour index (mass) (1836.75) was recorded by seeds soaked in NAA 100 ppm (T_8) in the first year of experimentation, while during second year, it was recorded significantly the lowest by seeds soaked in NAA 50 ppm (T_7) (1799.17). The highest germination percentage, maximum seedling length and seedling dry weight recorded by the treatment GA_3 150 ppm (T_3) resulted in the highest seed vigour index (length as well as mass). The results are in agreement with those of Omran *et al.* (1980), Ahmed and Tahir (1996) and Ravat and Makani (2015) for seedling vigour index (mass) in okra.

Seed viability test was significantly affected by different growth regulators as seed treatments (Table 2). Seeds treated with GA_3 150 ppm (T_3) recorded significantly the highest seed viability (100 %) and it was at par with IBA 50 ppm (T_4) (98.50%), NAA 150 ppm (T_9) (98.50%), GA_3 50 ppm (T_1) (98.25%), NAA 100 ppm (T_8) (97.50%) and GA_3 100 ppm (T_2) (97.33%) during *kharif* 2015, while during *kharif* 2016, seeds treated with GA_3 150 ppm (T_3) recorded significantly the highest seed viability (100 %) and it was at par with GA_3 50 ppm (T_1) (99.50%), GA_3 100 ppm (T_2) (98.00%), IBA 50 ppm (T_4) (97.00%), NAA 150 ppm (T_9) (97.00%) and NAA 100 ppm (T_8) (96.75%). Significantly the lowest seed viability (85.67 % and 86.50 %) was recorded by control treatment (water soaking) (T_{10}) during both the years of experimentation. The reason behind significantly the maximum seed viability (100 %) was recorded by the seeds treated with GA_3 150 ppm (T_3) during both the years of experiment (*kharif*2015 and 2016) is that gibberellic acid enhances the metabolic activity of the seeds and induces substrate mobilization within short period of seed treatment.

CONCLUSION

From results of seed quality parameters, it can be concluded that seeds treated with GA_3 150 ppm (T_3) was found most effective treatment, as improved the seed germination and seedling vigour.

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Table 1: Analysis of variance for experimental design (CRD) for seed quality parameters in okra during *kharif*.

Source of Variation	d. f.	Germination Percentage	Seedling Length (cm)	Seedling Dry Weight (mg)	Seedling Vigour Index (Length)	Seedling Vigour Index (Mass)	Seed Viability Test (%)
2015							
Treatments	9	74.16**	3.97**	12.53**	67454.03**	221085.03**	48.97**
Error	20	2.37	0.30	0.92	2045.80	7660.37	5.08
2016							
Treatments	9	67.57**	3.34**	12.78**	55405.44**	210372.22**	47.60**
Error	20	5.70	0.28	1.62	2859.61	11857.16	5.86

*** Significant at 1 per cent levels of significance, respectively*

Table 2: Effect of seed treatment with growth regulators on viability and vigour of okra during *kharif* .

Treatments	Germination Percentage		Seedling Length (cm)		Seedling Dry Weight (mg)		Seedling Vigour Index (length)		Seedling Vigour Index (mass)		Viability Test (%)	
	2015	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2016**	**2015**	**2015**	**2016**	**2015**
T_1	88.33	86.67	13.74	13.97	24.50	23.42	1213.65	1209.67	2164.42	2027.92	98.25	99.50
T_2	83.00	84.33	14.17	14.07	25.33	24.42	1176.11	1187.73	2103.33	2059.25	97.33	98.00
T_3	93.67	93.67	14.67	14.14	29.42	28.92	1374.14	1325.28	2754.92	2707.75	100.00	100.00
T_4	82.67	83.00	11.60	11.62	22.75	22.42	958.97	964.30	1881.33	1860.33	98.50	97.00
T_5	82.67	82.33	12.27	12.44	23.00	23.58	1014.36	1024.20	1900.33	1939.58	96.13	94.00
T_6	81.67	81.67	12.38	12.63	25.42	26.83	1011.07	1031.54	2076.50	2193.00	95.00	92.33
T_7	79.33	80.00	11.90	12.02	23.50	22.50	944.03	961.03	1863.00	1799.17	94.67	94.50
T_8	77.33	78.00	12.48	12.69	23.75	23.83	965.08	989.36	1836.75	1855.83	97.50	96.75
T_9	77.33	77.00	12.69	12.78	26.58	25.42	981.32	983.56	2055.50	1958.83	98.50	97.00
T_{10}	82.00	81.67	11.09	11.03	23.33	23.17	909.38	900.93	1913.50	1893.25	85.67	86.50
Mean	82.80	82.82	12.70	12.74	24.76	24.45	1054.81	1057.76	2054.96	2029.49	96.16	95.56
S. Em ±	0.89	1.38	0.32	0.30	0.53	0.55	26.11	30.87	50.53	62.87	1.30	1.40
CD at 5 %	2.62	4.07	0.93	0.90	1.57	1.63	77.04	91.08	149.07	185.46	3.84	4.12
C. V. %	1.86	2.88	4.32	4.14	3.73	4.11	4.29	5.08	4.26	5.37	2.34	2.53

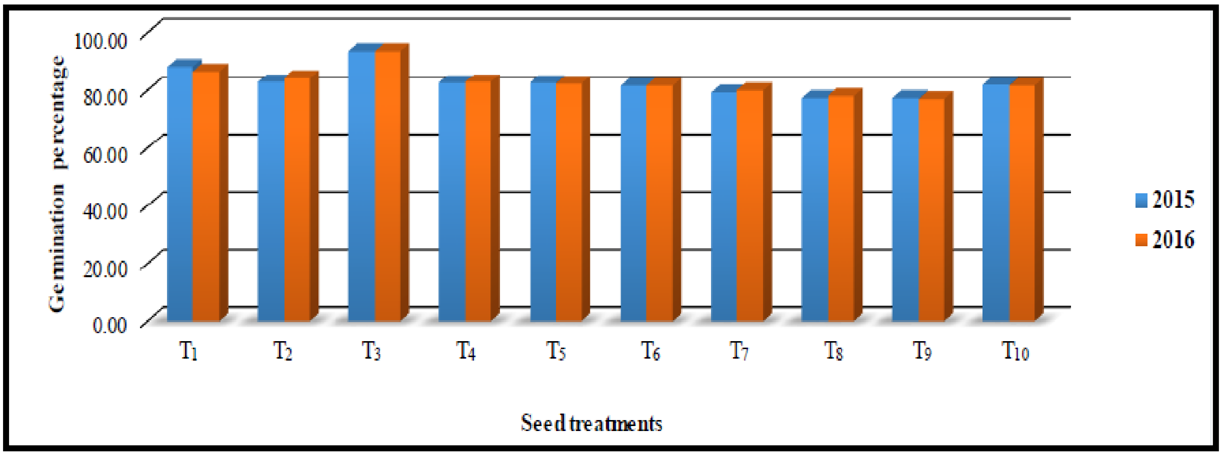

Fig. 1: Effect of seed treatment with growth regulators on germination percentage of okra during kharif.

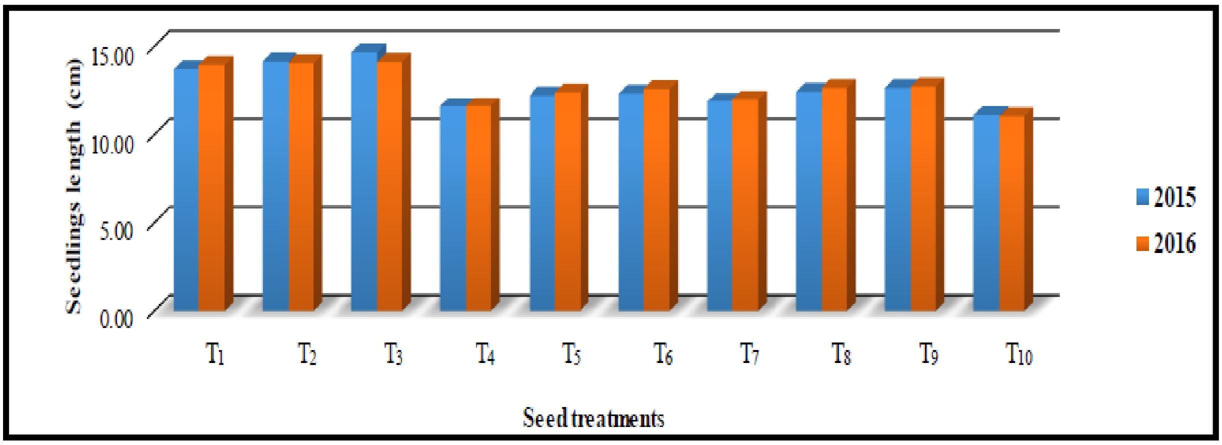

Fig. 2: Effect of seed treatment with growth regulators on seedling length (cm) of okra during kharif.

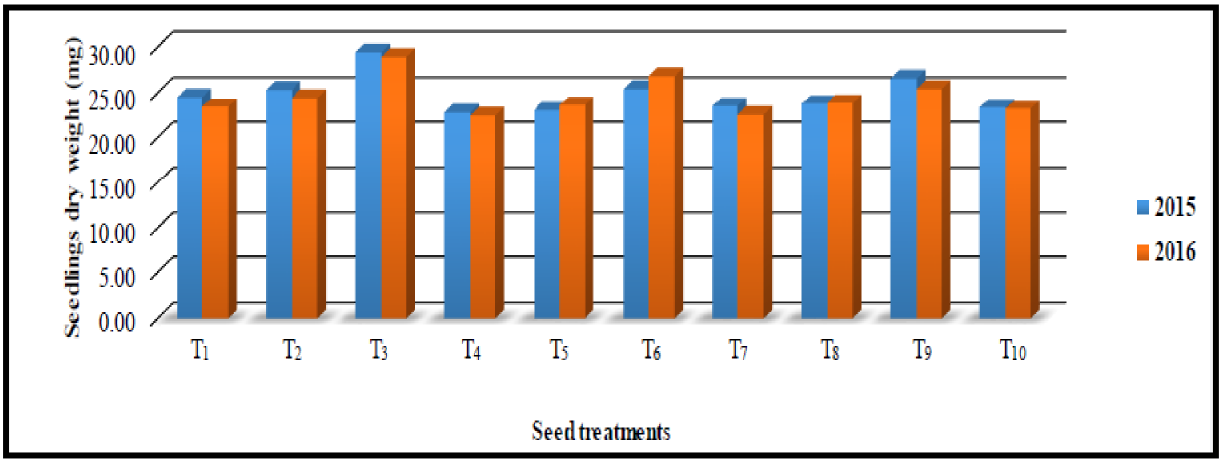

Fig. 3: Effect of seed treatment with growth regulators on seedling dry weight (mg) of okra during kharif.

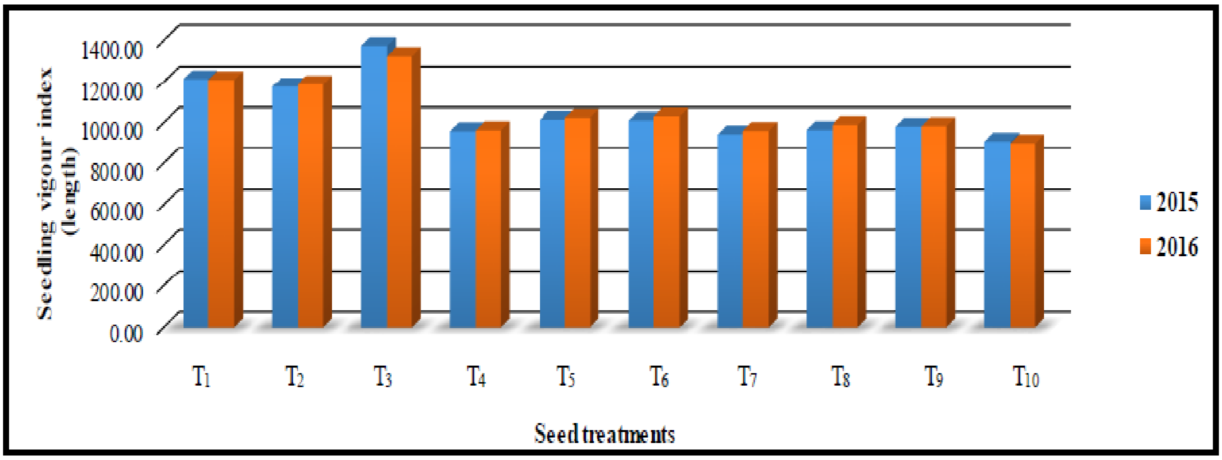

Fig. 4: Effect of seed treatment with growth regulators on seedling vigour index (length) of okra during kharif.

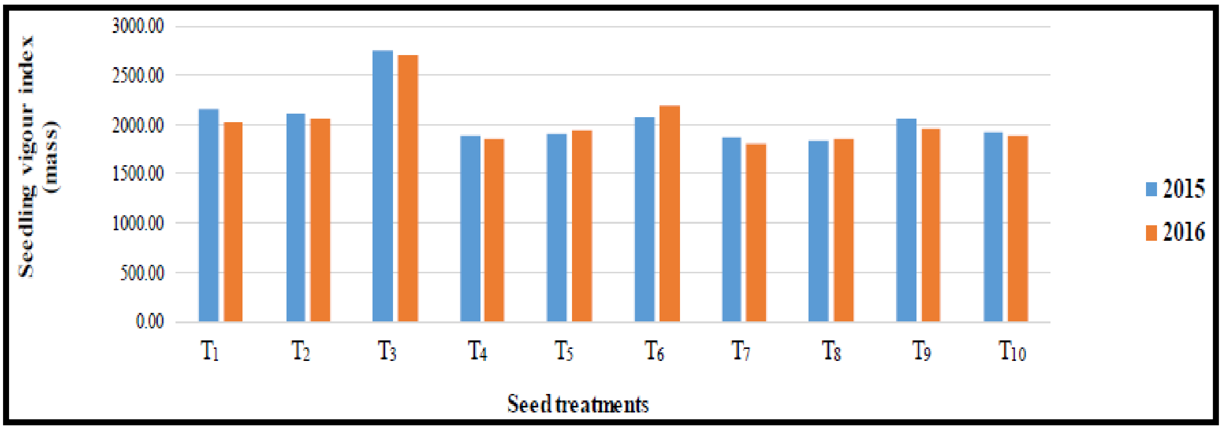

Fig. 5: Effect of seed treatment with growth regulators on seedling vigour index (mass) of okra during kharif.

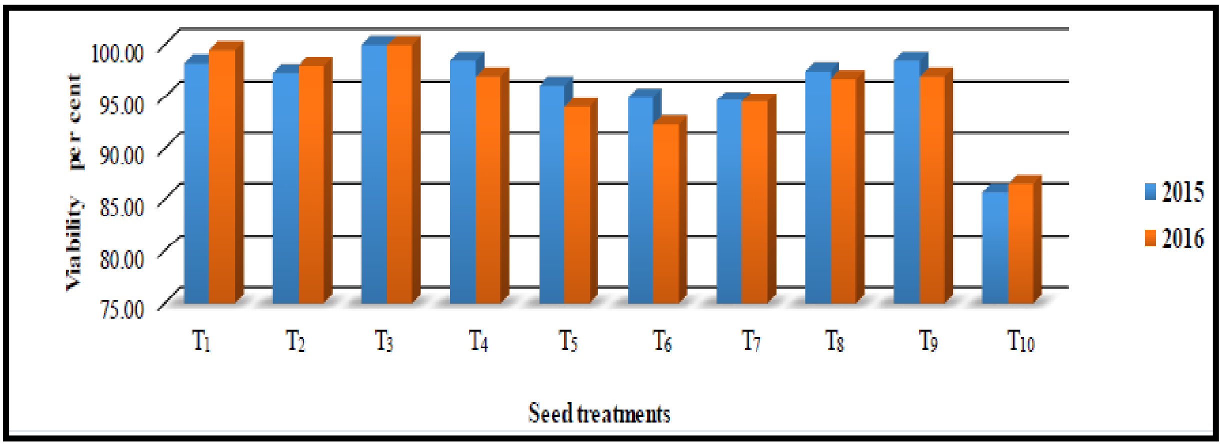

Fig. 6: Effect of seed treatment with growth regulators on seed viability per cent of okra during kharif.

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