The Pharma Innovation Journal 2022; 11(3): 2325-2330

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; 11(3): 2325-2330
© 2022 TPI
www.thepharmajournal.com
Received: 01-12-2021
Accepted: 08-01-2022

S Sony
PG Scholar, Department of Seed Science and Technology, College of Agriculture, OUAT, Bhubaneswar, Odisha, India

S Mohanty
ASRO, Seed Technology Research, AICRP on Seed Crops, OUAT, Bhubaneswar, Odisha, India

S Das
ASPO, AICRP on Vegetable Crops, OUAT, Bhubaneswar, Odisha, India

BC Das
Assistant Professor, College of Horticulture, OUAT, Chiplima, Odisha, India

JK Beura
Technical Assistant, Seed Technology Research, AICRP on Seed Crops, OUAT, Bhubaneswar, Odisha, India

Corresponding Author:
S Mohanty
ASRO, Seed Technology Research, AICRP on Seed Crops, OUAT, Bhubaneswar, Odisha, India

Enhancing seed yield and quality of chilli by application of plant growth regulators

S Sony, S Mohanty, S Das, BC Das and JK Beura

Abstract

An investigation was undertaken in the Department of Seed Science and Technology, Odisha University of Agriculture and Technology, Bhubaneswar, during *kharif* 2019 to study the role of plant growth regulators as foliar spray on seed yield and quality of chilli. The experiment was laid out in RBD with three replications and ten treatments, *viz*., NAA 25 ppm, NAA 50 ppm, NAA 75 ppm, GA_3 30 ppm, GA_3 40 ppm, GA_3 50 ppm, 2,4-D 2 ppm, 2,4-D 4 ppm, 2,4-D 6 ppm and untreated Control. Foliar sprays were done at 30, 60 and 90 DAT. Observations on various plant growth parameters, yield attributing characters, seed yield and quality were recorded. Seeds harvested from each treatment in three replications were stored in cloth bags for a period of six months to study the storability of seeds. Results revealed that there was increase in plant height over Control in all the treatments. Plants of the Control plot took least number of days for flower initiation in 50% plants (51.18) and number of days to maturity (105.52), as compared to other treatments. Foliar spray of GA_3 50 ppm recorded maximum plant height at maturity, number of primary and secondary branches, followed by GA_3 40 ppm, while lowest values were recorded in Control. Spraying of NAA 50 ppm resulted in higher fruit set, maximum number of fruits per plant, fruit yield per plant, fruit yield per hectare, seed yield per plant and seed yield per hectare (46.45%, 109.29, 322.70 g, 230.14 q, 8.24 g and 607.98 kg, respectively), while the Control recorded lowest values for the same parameters (41.87%, 94.12, 270.20 g, 197.65 q, 6.79 g and 493.82 kg, respectively). The seed yield from NAA 50 ppm was 23.12% higher over Control. Highest 1000-seed weight (5.624 g) was recorded in NAA 75 ppm, followed by NAA 50 ppm (5.527 g), while lowest 1000-seed weight was recorded in Control (4.994 g). Treatment with NAA 75 ppm recorded maximum (90.5%) germination, which was closely followed by NAA 50 ppm (89.7%), while the Control recorded lowest germination (86.6%). Similar was the trend regarding the seed vigour indices. During storage, there was gradual increase in moisture content after 2 months storage, while there was gradual decline in seed germination after 1 month storage. Highest germination percentage was recorded in NAA 75 ppm (90.5% and 85.6%) whereas lowest was observed in case of Control (86.6% and 65.7%) at initial stage and after six months of storage, respectively. Similar trend was observed for seed vigour indices. Thus, it may be concluded that foliar spray of NAA 50 ppm played important role in improving the fruit yield, seed yield attributing parameters and seed yield, while NAA 75 ppm improved seed quality in chilli seeds. Foliar spray of the above two treatments can be considered as a suitable technique for improving seed yield and quality of chilli, as well as reducing qualitative loss during seed storage.

Keywords: Chilli, seed yield, quality, storability, plant growth regulator, NAA, GA_3, 2, 4-D

Introduction

Chilli is an important commercial crop of India as it is profusely consumed as green and dry red chillies, as well as in powder form. The production of chilli is governed not only by inherent genetic yield potential of the cultivars but also is greatly influenced by several environmental factors and cultivation practices. Flower and fruit drop are major constraints in production of chilli, which are caused by physiological and hormonal imbalance in the plants particularly under unfavourable environments, such as extremes of temperature, i.e. too low or high temperatures (Erickson and Makhart, 2001) [12]. Plant growth regulators (PGRs) are chemicals, produced naturally by plants to regulate their growth and development. In chilli, PGRs are used to enhance plant growth and improve yield by increasing fruit number, fruit set and size (Batlang, 2008 and Serrani *et al*., 2007) [4, 22]. Studies on the effect of plant growth regulators in chilli had revealed that the application of some of the plant growth regulators were effective in reducing the flower and fruit drops, thereby enhancing production of chilli per unit area and per unit time (Balraj *et al*., 2002; Chaudhary *et al*., 2006; Sultana *et al*., 2006) [3, 8, 30]. Seed is the basic and crucial input in agriculture. The quality of seed, either for seed multiplication or for commercial cultivation, depends on several factors which influence the planting value of seed.

The high seed quality in terms of viability and vigour are essential factors which determine seedling development in nursery and plant establishment in the field in order to get higher yield of quality seeds (Doijode, 1988) [11].

Although plant growth regulators have great potential for growth improvement but their application has to be planned sensibly in terms of optimal concentration, stage of application and proper application method. Information on influence of foliar spray of PGRs on seed yield and quality in chilli is very scanty. The present study was conducted to investigate the effect of PGRs on plant growth, seed yield, quality and storability of chilli.

Materials and Methods

The research work was conducted in the Department of Seed Science and Technology, Odisha University of Agriculture and Technology, Bhubaneswar, during *kharif* 2019. Foliar sprays of PGRs at various concentrations were given to chilli seed crop cv. Utkal Abha. The experiment was laid out in RBD with three replications and ten treatments, *viz*., NAA @ 25 ppm (T_1), NAA @ 50 ppm (T_2), NAA @ 75 ppm (T_3), GA_3 @ 30 ppm (T_4), GA_3 @ 40 ppm (T_5), GA_3 @ 50 ppm (T_6), 2,4-D @ 2 ppm (T_7), 2,4-D @ 4 ppm (T_8), 2,4-D @ 6 ppm (T_9), Control (T_{10}). The foliar sprays were done at 30 DAT, 60 DAT and 90 DAT. In Control, equal quantity of water (without any PGR) was sprayed as in case of the treatments. Observations on various plant growth and yield attributing characters were recorded. After harvest of the crop, the seeds were dried, cleaned and graded and used for recording the seed yield and quality parameters. Seed of each treatment were stored in cloth bags in three replications for a period of six months to study the storability of seeds.

Results and Discussion

The effect of plant growth regulators on seed yield and quality of chilli was studied and the observations presented in Tables 1 and 2. Significant differences in plant height were noticed among the treatments. There was an increase in plant height over Control in all the treatments. Among the treatments, GA_3 @ 50 ppm produced tallest plant at maturity (55.19 cm), followed by GA_3 @ 40 ppm (54.72 cm), while lowest plant height was recorded in Control. Chandiniraj *et al*. (2016) [7] in chilli reported maximum plant height (75.60 cm) was recorded in GA_3 60 ppm treated plants. Natesh *et al*. (2005) in chilli found that application of GA_3 100 ppm recorded maximum plant height (85.7 cm).

With regards to the days to flower initiation in 50% plants, though plants of the Control plot took least number of days (51.18) to flower initiation in 50% plants compared to other treatments, the differences among the treatments being statistically non-significant. Similarly, minimum number of days to maturity (105.52) was taken by the plants of the Control plot, followed by NAA 75 ppm (106.16) and NAA 50 ppm (106.92), while maximum number of days to reach maturity was recorded in 2, 4-D @ 6 ppm (111.19). Chandiniraj *et al*. (2016) [7] in chilli reported minimum number of days to flowering in 75 ppm NAA. Sharmin (2019) [24] in chilli also reported that the minimum number of days from transplanting to 50% flowering (90.17 days) was found from NAA 40 ppm treatment, while the maximum days (103.67 days) was attained from Control. Mahindre *et al*. (2018) [16] in chilli recorded the minimum (41.13) days to 50% flowering in 50 ppm NAA compared to Control. Similarly, Tapadiya *et al*. (2018) [31] reported minimum days to 50% flowering (39.00) in NAA @ 20 ppm in chilli while maximum was observed in untreated Control (45.67). Improvement in chilli growth under GA_3 and NAA application was observed. This might be ascribed to more efficient utilization of food for reproductive growth (flowering and fruit set), higher photosynthetic efficiency and enhanced source to sink relationship of the plant, reduced respiration, enhanced translocation and accumulation of sugars and other metabolites. The plants sprayed with NAA and GA_3 remained physiologically more active to build up sufficient food reserve for developing flowers and seed.

Significant differences in number of branches per plant were noticed with the application of plant growth regulators at different concentrations. Among the treatments, 50 ppm GA_3 recorded significantly higher number of primary branches (5.90) followed by 40 ppm GA_3 (5.85) over Control (water treatment) which recorded minimum (5.52) number of primary branches per plant. Likewise, maximum number of secondary branches per plant (13.82) was recorded in case of 50 ppm GA_3, followed by 40 ppm GA_3 (13.69), while least number of secondary branches (13.04) were obtained in Control. The results of the present study are in conformity with those reported by Kannan *et al*. (2009) in peperika hot pepper, Sreenivas *et al*. (2017) [29], Natesh *et al*. (2005) and Veishnav *et al*. (2012) [32] in chilli. Biradar (1999) [5] in chilli recorded the maximum number of primary branches (8.02) with 100 ppm GA_3 which was on par with 50 ppm GA_3 (7.60) and minimum number of primary branches in water spray. Similar findings were reported by Abdul *et al*. (1988) in pepper, Patel *et al*. (2016) [17] and Singh and Singh (2019) [27] in chilli. This may be due to the blocking of the plant system which provided active gibberellins to the growth mechanism and reduced apical dominance in the plants, thereby increasing dry matter due to the increased carbohydrate accumulation resulting from a more efficient photosynthetic activity brought about by the anatomical modifications (Saleh and Abdul, 1980) [20].

Highest fruit set percentage (46.45%) was recorded in application of NAA 50 ppm while the least fruit set percentage (41.87) was recorded in Control. Maximum number of fruits was found in plant growth regulators (NAA) treated plants compared to Control. Spraying of NAA 50 ppm resulted in production of maximum number of fruits per plant (109.29), followed by NAA 75 ppm (108.06), while the Control recorded minimum number of fruits per plant (94.12). The findings of the present investigation were in agreement with that of Dod *et al*. (1989) [9] and Balraj *et al*. (2002) [3] in chilli. Fruit set in crops can be increased by applying plant growth regulators to compensate the deficiency of natural growth substances required for its development (Singh and Choudhury, 1966). Similar beneficial effect of NAA on fruit setting percentage were reported in chilli by Doddamani and Panchal (1989) [10], Patil *et al*. (1985) [18], Yamgar and Desai (1987) [33], Mahindre *et al*. (2018) [16] and Tapadiya *et al*. (2018) [31]. Gare *et al*. (2017) [13] in chilli reported the highest fruit setting (84.2%) and lowest flower drop (15.8%) was recorded in the treatment of NAA @ 60 ppm and the Control recorded lowest fruit setting percent (61.3) and the highest flower drop (38.8). According to Sarker *et al*. (2009) [21] in chilli reported maximum fruit set percent (81.49%), lowest flower abscission (18.51%) in 40 ppm NAA as compared to 0 ppm NAA, which recorded 53.67% and 46.33%, respectively.

The growth regulators like NAA, GA_3 are known to be involved in inhibition of cellulose and pectinase activities and abscissin production which might have reduced the premature flower drop apart from involvement in ovary development during seed filling process (Revanappa *et al.*, 1998) [19] in chilli.

Highest fruit yield per plant (322.70 g) was reported from NAA 50 ppm, while the lowest (270.20 g) was observed from Control. Similarly, highest fruit yield per hectare (230.14 q/ha) was observed from NAA 50 ppm treatment, while the lowest yield per hectare (197.65 q/ha) was recorded from Control. These results are in conformity with Sarker *et al.* (2009) [21] in chilli wherein maximum green fruit yield per plant (439.50) was recorded in NAA @ 40 ppm compared to 0 ppm NAA (245.70). Tapadiya *et al*. (2018) [31] in chilli reported that fruit yield per plant (430.60) showed increase in foliar spray of NAA 40 ppm than all other treatment including Control. Mahindre *et al*. (2018) [16] in chilli reported that application of NAA @ 40 ppm recorded maximum fruit yield per plant (440 g). Singh *et al*. (2017) [26] reported maximum that NAA @ 60 ppm recorded maximum fruit yield per plant (1.67 kg) in capsicum.

NAA at 50 ppm recorded maximum seed yield per plant (8.24 g), followed by NAA 75 ppm (8.11 g). Similarly, regarding seed yield per hectare, application of NAA had significant effect on seed yield per hectare. NAA 50 ppm recorded maximum seed yield per hectare (607.98 kg) compared to other treatments, while lowest seed yield per hectare (493.82 kg) was obtained in case of Control. The seed yield from NAA 50 ppm was 23.12% higher over the Control. These results are in conformity with the results of Shamsheer (2007) [23] in chilli who reported that application of 40 ppm NAA recorded significantly highest seed yield per plant (12.77g) and lowest in Control (water treatment). Similarly, Patel *et al.* (2016) [17] in chilli reported that maximum seed yield per plant (8.30 g) was obtained by spraying of NAA @ 40 ppm as against Control. Similar results were reported by Kar *et al.* (2016) [15] in chilli where highest seed yield (951.85 kg/ha) was obtained with application of NAA 40 ppm.

With regards to 1000-seed weight, highest 1000-seed weight (5.624 g) was observed in NAA @ 75 ppm, followed by NAA @ 50 ppm (5.527 g), while lowest 1000-seed weight was recorded in Control (4.994 g). Similar results were observed by Shamsheer (2007) [23] in chilli wherein application of 40 ppm NAA recorded significantly the highest 1000 seed weight (5.92 g) as compared to Control. Beneficial effects of GA_3 with respect to 1000-seed weight were also reported by some authors. Natesh *et al*. (2005) in chilli wherein maximum 1000-seed weight was recorded by GA_3 @ 100 ppm (5.24 g).

Seed quality parameters recorded after harvest revealed that seed moisture content and seed germination was found to be non-significant. Lowest seed moisture content (6.60%) was recorded in Control (6.50%) and the maximum seed moisture content (6.79%) in NAA @ 75 ppm followed by NAA @ 50 ppm (6.73%). Treatment with NAA @ 75 ppm recorded maximum (90.5%) germination, which was closely followed by NAA @ 50 ppm (89.7%), while Control recorded lowest germination (86.6%). Maximum seed vigour index-I (1609) was observed in case of treatment with NAA @ 75 ppm and the lowest (1472.9) was recorded in case of Control. Similarly, maximum seed vigour index-II (30.11) was recorded in NAA @ 75 ppm and least in Control (27.56). Similar beneficial effects of growth regulators on seed quality enhancement are in conformity with Biradar (1999) [5] in chilli.

During storage, the seed moisture content was found to be non-significant up to two months of storage. However, it was found to vary significantly from the third month of storage up to end of storage period, i.e., six months. There was gradual increase in moisture content over 6 months of storage under ambient condition. Among the treatments, highest seed moisture content of 6.53% was recorded in 2, 4-D @ 6 ppm at initial stage and 7.32% after six months of storage. Also, the seed germination was found to be non-significant up to one month storage under ambient conditions. However, it was found to vary significantly from the second month of storage up to end of storage period, i.e., six months. Seed germination declined progressively over the period of storage for six months of storage as compared to the initial germination recorded at harvest. Among the treatments, highest germination percentage was recorded in NAA @ 75 ppm (90.5% and 85.6%) whereas lowest was observed in case of Control (86.6% and 65.7%) at initial and after six months of storage, respectively. According to Singh and Lal (1995) [25] spraying with NAA (10 to 80 ppm) at 40 and 60 DAT reported the highest seed germination (66.1%) with 20 ppm NAA compared to water spray (56.1%) in chilli. Balaraj (1999) [2] reported that chilli sprayed with NAA 10 to 20 ppm at 35 and 50 DAT recorded highest germination percentage (93.49) as compared to Control (86.13%).

Table 1: Effect of foliar spray of plant growth regulators on growth and yield attributing characters and seed yield of chilli cv. Utkal Abha

Treatments	Days to flower initiation in 50% plants	Number of primary branches per plant	Number of secondary branches per plant	Plant height at maturity (cm)	Days to maturity	Fruit set (%)	Number of fruits per plant	Fruit yield per plant (g)	Fruit yield per hectare (q)	Seed yield per plant (g)	Seed yield per hectare (kg)	1000-seed weight (g)
T_1 - NAA 25 ppm	52.23	5.68	13.28	53.12	107.45	45.47	107.12	310.81	222.85	7.30	568.04	5.410
T_2 - NAA 50 ppm	51.96	5.70	13.34	53.34	106.92	46.45	109.29	322.70	230.14	8.24	607.98	5.527
T_3 - NAA 75 ppm	51.60	5.70	13.45	53.39	106.16	46.35	108.06	319.88	228.92	8.11	591.77	5.624
T_4 - GA_3 30 ppm	52.02	5.78	13.54	54.13	107.02	43.79	100.53	291.02	210.63	7.27	531.86	5.210
T_5 - GA_3 40 ppm	52.22	5.85	13.69	54.72	107.45	44.14	102.11	295.11	213.17	7.37	539.33	5.252
T_6 - GA_3 50 ppm	52.28	5.90	13.82	55.19	107.56	44.23	101.81	296.14	213.80	7.39	541.21	5.263
T_7 - 2,4-D 2 ppm	53.00	5.66	13.24	52.96	109.05	43.53	99.74	287.98	208.74	7.20	526.30	5.179
T_8 - 2,4-D 4 ppm	53.57	5.63	13.17	52.70	110.23	43.09	98.21	282.96	205.62	7.09	517.13	5.127
T_9 - 2,4-D 6 ppm	54.04	5.59	13.28	52.33	111.19	42.48	96.26	276.04	201.30	6.93	504.48	5.055
T_{10} – Control	51.18	5.52	13.04	52.01	105.52	41.87	94.12	270.20	197.65	6.79	493.82	4.994
Mean	52.42	5.70	13.75	53.39	107.86	44.15	101.48	295.28	213.28	7.37	542.19	5.264
S.Em(±)	0.227	0.058	0.076	0.199	0.402	0.454	0.897	2.076	1.344	0.190	4.317	0.0315
$CD_{0.05}$	0.674	0.171	0.226	0.592	1.193	1.349	2.665	6.168	3.993	0.564	12.825	0.0936

Table 2: Effect of foliar spray of plant growth regulators on seed quality after harvest and after six months storage in chilli cv. Utkal Abha

Treatments	Seed moisture content (%)			Seed germination (%)			Seed vigour index – I			Seed vigour index – II		
	After harvest	After 3 months	After 6 months	After harvest*	After 3 months*	After 6 months**	After harvest	After 3 months	After 6 months	After harvest	After 3 months	After 6 months
T_1 - NAA 25 ppm	6.66	6.71	6.76	88.7 (9.42)	83.3 (9.13)	78.2 (62.16)	1547.8	1419.1	1300.0	28.96	22.94	19.14
T_2 - NAA 50 ppm	6.73	6.86	7.00	89.7 (9.47)	87.0 (9.33)	84.3 (66.65)	1581.4	1497.3	1416.5	29.59	24.21	20.86
T_3 - NAA 75 ppm	6.79	6.86	6.92	90.5 (9.51)	90.0 (9.49)	85.6 (67.70)	1609.1	1563.8	1451.1	30.11	25.28	22.36
T_4 - GA_3 30 ppm	6.54	6.57	6.61	87.1 (9.33)	77.3 (8.79)	68.5 (55.89)	1490.7	1291.7	1118.5	27.90	20.88	16.47
T_5 - GA_3 40 ppm	6.56	6.88	7.19	87.4 (9.35)	78.5 (8.86)	70.5 (57.10)	1502.6	1317.7	1154.7	28.12	21.30	17.00
T_6 - GA_3 50 ppm	6.57	6.59	6.62	87.5 (9.36)	78.8 (8.88)	71.0 (57.41)	1505.6	1324.3	1163.9	28.18	21.41	17.14
T_7 - 2,4-D 2 ppm	6.52	6.88	7.25	86.8 (9.32)	76.3 (8.74)	67.1 (55.01)	1481.8	1272.5	1091.9	27.73	20.57	16.08
T_8 - 2,4-D 4 ppm	6.52	6.83	7.15	86.9 (9.32)	76.7 (8.76)	67.6 (55.30)	1484.7	1278.9	1100.7	27.78	20.68	16.21
T_9 - 2,4-D 6 ppm	6.53	6.92	7.32	87.0 (9.33)	76.8 (8.76)	67.8 (55.45)	1486.2	1282.1	1105.1	27.81	20.73	16.27
T_{10} – Control	6.50	6.55	6.60	86.6 (9.30)	75.4 (8.69)	65.7 (54.16)	1472.9	1253.5	1065.9	27.56	20.27	15.69
Mean	6.59	6.77	6.94	87.8 (9.37)	80.0 (8.94)	73.0 (59.03)	1516.3	1350.1	1203.6	28.37	21.83	17.72
S.Em(±)	0.128	0.068	0.062	0.076	0.100	1.306	3.58	6.44	8.28	0.485	0.595	0.582
$CD_{0.05}$	NS	0.201	0.184	NS	0.297	3.881	10.64	19.14	24.59	1.442	1.767	1.730

Figures in the parenthesis are *square root / **arc sine transformed values

Significant variations with respect seed vigour index-I and seed vigour index-II was observed among the treatments in all months of storage. A gradual decline in these parameters was noticed with advancement in storage period. At initial month, high seed vigour index-I (1609.1) and seed vigour index-II (30.11) were recorded in treatment NAA @ 75 ppm, which declined to 1451.1 and 22.36, respectively, at the end of storage period of six months. Similar beneficial effects of NAA on chilli seed storability were reported by Biradar (1999) [5], Singh and Lal (1995) [25] and Balaraj (1999) [2].

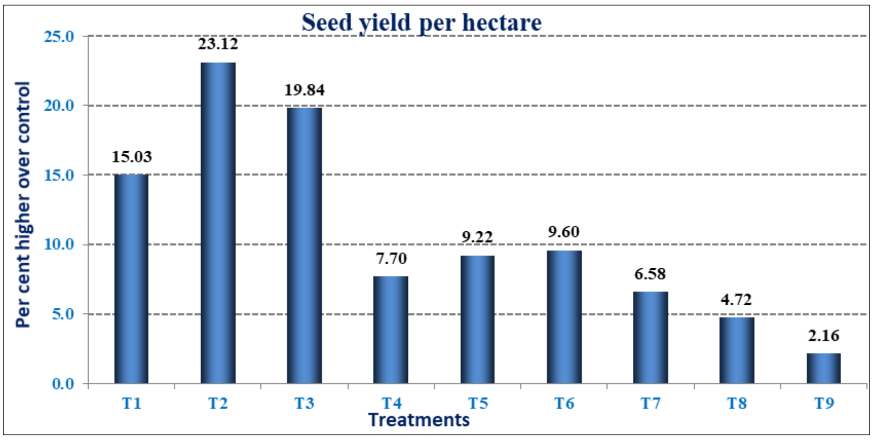

Fig 1: Per cent increase over Control in the seed yield per hectare in seed crop of chilli cv. Utkal Abha as influenced by foliar application of growth regulators

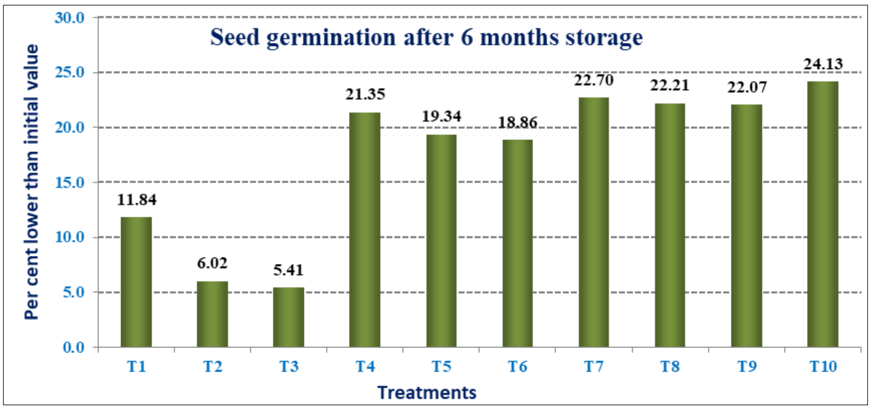

Fig 2: Per cent decrease in germination after six months storage of chilli seeds cv. Utkal Abha as influenced by foliar application of growth regulators during seed production

Considering the additional return per each additional Rupee invested, foliar spraying with NAA @ 50 ppm was found to be economically most effective as it gave maximum additional return for each additional Rupee invested (Rs 80.47). This was due to higher yield (114.16 kg/ha) over Control. Also, foliar spraying with NAA @ 75 ppm was economically effective compared to other treatments. Least additional return per additional Rupee invested was observed in foliar application of 2, 4-D @ 6 ppm (Rs 6.32).

Conclusion
In general, treatments with foliar spray of plant growth regulators proved to be more effective in comparison to the Control. A critical analysis of the results will reveal that in chilli, application of GA_3 was found to improve the plant growth such as plant height, number of primary branches and number of secondary branches compared to other treatments. Yield attributing parameters, as well as seed yield and quality were found to be better with application of NAA compared to other treatments. It was observed that a couple of treatments gave promising results with regards to maintenance of seed quality during storage. In the present investigation, played an important role in improving the fruit yield, seed yield attributing parameters and seed yield, while NAA @ 75 ppm (T_3) improved seed quality in chilli seeds. The treatments with plant growth regulators can be considered as a suitable cost-effective technique to improve seed yield and quality and reduce qualitative loss during storage, resulting in better quality seed for farmers. Economic analysis revealed that foliar spray of NAA @ 50 ppm (T_2) appeared to be the best for achieving the higher yield and economic benefit from chilli seed production.

References

1. Abdul KS, Saleh MMS, Omer SJ. Effect of gibberellic acid and cycocel on the growth, flowering and fruiting character of peppers, Iraqui J of Agril. Sci., ZANCO. 1988;6(2):17-18.
2. Balaraj R. Investigators on seed technological aspects in chilli (*Capsicum annuum* L.), Ph.D. thesis, University of Agricultural Sciences, Dharwad, Karnataka (India), 1999.
3. Balraj R, Kurdikeri MB, Revanappa. Effect of growth regulators on growth and yield of chilli (*Capsicum annuum* L.) at different pickings, Indian J Hort. 2002;59(1):84-88.
4. Batlang U. Benzyladenine plus gibberellins (GA4+7) increase fruit size and yield in greenhouse-grown hot pepper (*Capsicum annuum* L.), Journal of Biological Science. 2008;8(3):659-662.
5. Biradar BR. Investigations of seed technology aspects in chilli (*Capsicum annuum* L.), Ph.D. Thesis, Uni. Agric. Sci., Dharwad, Karnataka (India), 1999.
6. Chand KP, Channakeshava BC, Narayanareddy AB. Effect of interaction due to plant growth regulators and fruit retention on crop growth, seed yield and quality in okra cv. Arka Anamika, J of Indian Hort. 2014;3(1-2):10-18.
7. Chandiniraj A, Holebasappa K, Hore JK, Chattopadyay N. Growth and yield of chilli as influenced by different growth regulators, The Bioscan An International Journal of Life Science. 2014, 2016;11(1):385-388.
8. Chaudhary BR, Sharma MD, Shakya SM, Gautam DM. Effect of plant growth regulators on growth, yield and quality of chilli (*Capsicum annuum* L.) at Rampur, Chitwan. J Inst. Agric. Anim. Sci. 2006;27:65-68.
9. Dod VN, Kale PB, Ranotokar RS. Effect of foliar application of auxins and micronutrients on growth and yield of chilli, Punjabrao Krishi Vidyapeeth Res. J. 1989;13:29-33.
10. Doddamani MB, Panchal YC. Effect of plant growth regulators on growth and yield of Byadagi chilli (*Capsicum annuum* L.) var. accuminatum, Karnataka J Agric. Sci. 1989;2:329-332.
11. Doijode SD. Studies on vigour and viability of seeds as influenced by maturity in chilli (*Capsicum annuum* L.), Haryana J Hort. Sci. 1988;17(1-2):94-96.
12. Erickson AN, Makhart. Flower production, fruit set and physiology of bell pepper during elevated temperature and vapour pressure deficit, J Amer. Soc. Hort. Sci. 2001;126(6):697-702.
13. Gare BN, Raundal PU, Burli AV. Effect of plant growth regulators on growth, yield and yield attributing characters of rainfed chili, Advanced Agricultural Research & Technology Journal. 2017;1(2):195-197.
14. Kannan K, Jawaharlal M, Prabhu M. Effect of plant growth regulators on growth and yield parameters of chilli Paprika cv. KtPl-19, Agricultural Science Digest. 2009;29:157-162.
15. Kar B, Patra C, Padhiary AK, Mohanty SK. Effect of different level of potassium and plant growth regulators on different yield attributes of chilli, International Journal of Science, Environment and Technology. 2016;5(5):3147-3159.
16. Mahindre PB, Jawarkar AK, Ghawade SM, Tayade VD. Effect of different concentration of plant growth regulators on growth and quality of green chilli, Journal of Pharmacognosy and Phytochemistry. 2018;SP1:3040-3042.
17. Patel VP, Plal E, John S. Comparative study of the effect of plant growth regulators on growth, yield and physiological attributes of chilli (*Capsicum annuum* L.) cv. Kashi Anmol, Int. J of Farm Sci. 2016;6(1):199-20.
18. Patil UB, Sangale PB, Desai BB. Chemical regulation of yield and composition of chilli (*Capsicum annuum* L.) fruits, Curr. Res. Rep. 1985;1:39-43.
19. Revanappa B. Influence of growth regulators on fruit parameter, yield and parameter in green chilli cultivars, Karnataka J Agric. Sci. 1998;12(1):122-126.
20. Saleh MM, Abdul KS. Effect of gibberellic acid and CCC, on growth of tomato plants, Mesopotamia J Agric. 1980;15(1):137-166.
21. Sarker P, Hossain T, Mia MA, Islam R, Miah MNA. Effect of NAA on growth yield and quality of chilli (*Capsicum frutescence*), Bangladesh Research Publication Journal. 2009;2(3):612-617.
22. Serrani JC, Fos M, Atare’s A, Garcı’a-Martı’nez JL. Effect of gibberellin and auxin on parthenocarpic fruit growth induction in the cv Micro-Tom of tomato, J Plant Growth Regul. 2007;26:211-221.
23. Shamsheer A. Effect of growth regulators and stages of fruit harvest on seed yield and quality in paprika chilli (*Capsicum annuum* L.) cv. Kt-PT – 19, M.Sc (Agri.), Thesis, Univ. Agri. Sci., Dharwad, Karnataka (India), 2007.
24. Sharmin I, Mostarin T, Khatun K, Haq ME, Soniya IA, Akhter S, *et al*. Growth and yield of chilli as influenced by plant growth regulators and its method of application, Asian Journal of Research in Botany. 2019;2(4):1-10.
25. Singh DK, Lal G. Effect of plant growth regulators on the fruit set, yield and quality of chilli (*Capsicum annuum* L.) cultivars, Adva. Hortic. Forest. 1995;4:133-141.
26. Singh P, Singh D, Jaiswal DK, Singh DK, Singh V. Impact of naphthalene acetic acid and gibberellic acid on growth and yield of capsicum, *Capsicum annuum* (L.) cv. Indra under shade net conditions, International Journal of Current Microbiology and Applied Sciences.

2017;6(6):2457-2462.
27. Singh S, Singh T. Effect of gibberellic acid on growth, yield and quality parameters of chilli (*Capsicum annuum* L.), Journal of Pharmacognosy and Phytochemistry. 2019;8(2):2021-2023.
28. Singh SN, Choudhury B. Effect of various plant growth regulators and their method of application on quality of tomato fruits, Indian J Hort. 1966;23:156-157.
29. Sreenivas M, Sharangi AB, Raj AC. Evaluation of bio-efficacy and phytotoxicity of gibberellic acid on chilli, Journal of Crop and Weed. 2017;13(3):174-177.
30. Sultana W, Fattah QA, Islam MS. Yield and seed quality of chilli (*Capsicum annuum* L.) as affected by different growth regulators, Bangladesh. J Bot. 2006;35(2):195-197.
31. Tapadiya GH, Gawande PP, Ulemale PH, Patil RK and Naware MS. Effect of growth regulators on quantitative characters of chilli (*Capsicum annuum* L.), International Journal of Current Microbiology and Applied Sciences. 2018;6:2151-2157.
32. Veishnav N, Singh BK, Singh AK. Effect of NAA on growth and yield of chilli (*Capsicum annuum* L.), Env. & Eco. 2012;30(4):1261-1263.
33. Yamgar VT, Desai VT. Effect of NAA and planofix on flowering, flower and fruit drop and fruit set in chilli, J Maha. Agril. Univ. 1987;12(1):34-38.