International Journal of Plant & Soil Science

34(20): 802-809, 2022; Article no.IJPSS.89157
ISSN: 2320-7035

Effect of Gibberellic Acid and Naphthalene Acetic Acid on Growth and Yield of Cucumber (*Cucumis sativus* L.) in Prayagraj Agro Climatic Conditions

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2022/v34i2031224

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/89157

Original Research Article

Received 29 April 2022
Accepted 03 July 2022
Published 06 July 2022

ABSTRACT

The experiment was conducted to determine the effect of gibberellic acid and Naphthalene acetic acid on growth and yield of cucumber at Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during mid March- mid June 2021. Total Nine treatments were tried and replicated three times in a Randomized Block Design. Treatments include two growth regulators having concentrations of GA_3 (15, 25, 35, 45 ppm) and NAA (75, 100, 125, 150 ppm) and Control (Water spray) were spayed at two leaf stage and four-leaf stages. The application of plant growth regulators significantly effects the vegetative as well as reproductive attributes of the crop. The treatment T_3 25 ppm GA_3 at 2, 4 leaf stage was found most effective among all the treatments in terms of Vine length at 20, 40, 60 days after sowing (39.12, 91.02, 180.32 cm) Days to first appearance of male flowers in 50% plants (32.86 days), Number of fruits per plant (12.20), Average fruit yield per plant (1870.37 g), fruit weight (153.33g) where as Days to first appearance of female flowers in 50% plants (38.93) and Days to first harvest (50.6) was observed in 35 ppm GA_3, length of the fruit (14.66 cm in 15 ppm GA_3), fruit diameter (4.28 cm in 15 ppm GA_3), Average yield (18.77 t/ha in 25 ppm GA_3). Based on these observations spraying of GA_3 25 ppm at 2, 4 leaf stages was found effective for growth and yield of cucumber compared to other concentrations of GA_3, NAA and control.

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Keywords: Cucumber; GA_3; NAA; growth; yield.

1. INTRODUCTION

Cucumber (*Cucumis sativus* L.) belongs to the family Cucurbitaceae with monoecious nature having 2n=14 as chromosome number is an important warm season vegetable crop [1]. It is cross pollinated and propagated by seed. *Cucumis hardwckii* is progenitor of present cultivating cucumber. The fruit of cucumber is said to have cooling effect, prevent constipation and check jaundice and indigestion [2]. During 2020- 2021 according to (DAC & FW) cucumber was cultivated about an area 0.109 million ha with annual production of 1.665 million tonnes (Anonymous). In cucumber staminate flowers are much more than pistillate flowers so application of optimum concentration of plant growth regulators at correct stage of crop growth modifies the morphology and physiology of plant by inhibiting or stimulating the alpha amylase enzyme which regulate the metabolism of plants in altering the sequence of flowering. Plant growth regulators can be used flexibly for the fine tuning of crops that grow uncontrollable and unpredictable environmental conditions [3]. GA_3 and NAA are the two important plant growth regulators that alter the growth and yield contributing characters of cucumber. Exogenous application of GA_3 at three leaf stage and tendril initiation stage helps in enhancing vine length, branches, promoting and better fruit setting while NAA which is a synthetic form of auxin helps in enhancement in vegetative growth, fruit and seed yield [4]. Sex expression and sex ratio in cucumber was affected by different growth regulators [5]. Inadequate data was observed on application of plant growth regulators on growth and yield of cucumber. Therefore an experiment was conducted to determine the best concentration of gibberellic acid and naphthalene acetic acid on growth and yield of cucumber.

2. MATERIALS AND METHODS

The field experiment was conducted at Horticulture Research Field, Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during mid-March 2021. The University is about 7 km away from Prayagraj city and it is geographically situated at 25.5^0 N latitude, 81.08^0 E longitudes. The altitude of this location is about 98 meter above the mean sea level. The soil of the experimental field was sandy loam with pH of 6.8.

Recommended package of cultural practices were adopted at last ploughing FYM- 2.0 kg/m^2 and half dose of nitrogen, full dose of P_2O_5 and K_2O were applied as basal and the remaining half dose of nitrogen was applied at 30 days after sowing 100:60:60 kg/ha in the form of Urea, Single super phosphate and Muriate of potash.

The field experiment was carried out as a randomized block design with three replications. Two seeds per pit were sown with a spacing of 1.5 x 0.6 m in march 2021. Plot size is 2 x 2 m^2. GA_3 (15, 25, 35, 45 ppm) and NAA (75, 100, 125, 150 ppm) solutions, control- water spray were prepared from the respective stock solutions with distilled water. The solutions were sprayed at 2 and 4 leaf stage with hand sprayer early in the morning. Irrigation, weeding, hoeing and plant protection measures were employed as per the need of the crop. For each treatment of a replication five plants were selected and observations were recorded on various parameters of growth and yield of the crop as per the planned schedule. The recorded data was analyzed statistically by ANOVA.

GA_3 - Gibberellic acid; NAA- Naphthalene acetic acid; PGR- Plant growth regulators.

3. RESULTS AND DISCUSSION

3.1 Germination Parameters

The seeds were germinated in 4-5 days after sowing among all the treatments including control. The experimental results revealed that there is no significant difference with respect to days taken to germination because the seeds were not treated with the gibberellic acid and naphthalene acetic acid. It can be affected by various environmental factors such as the difference between day and night temperature, soil moisture, light, pH of the soil in cucumber. The statistically analysed data pertaining to days to germination was presented in Table 1.

3.2 Growth Parameters

The statistical data on growth parameters in different treatments was recorded (Table 1) In the experiment the results revealed that the vine length was increased significantly with the

application of GA_3 25 ppm (39.12, 91.02, 180.32 cm) which was at par with GA_3 15 ppm (34.9, 89.76, 178.84 cm) followed by NAA 75 ppm (35.03, 86.16, 176.72 cm) while minimum was recorded in control (29.8,73.21,162.5 cm) at 20, 40, 60 days after sowing (Fig. 1). The data indicated in Table no 1 shows that application of plant growth regulators significantly reduces days taken to first appearance of male flowers in 50% plants which was recorded in T_3 GA_3 25 ppm (32.86 days) and it was at par with T_2 GA_3 15ppm (33.4 days) where as maximum days was recorded in control-water spray (39 days). This might be due to reducing the sugars there by inducing metabolic activity of cell which induces early flowering [6]. Minimum days to first appearance of female flowers in 50% plants were recorded in T_4 GA_3 35 ppm (38.93 days) which was at par with T_3 GA_3 25 ppm (39.9 days) where as maximum days was recorded under control-water spray (46.2 days) (Fig. 2). This might be due to effect of GA_3 which alters the sexual differentiation in potentially male buds to female buds that enhances female flower formation earlier. Mahala et al*.,* [7] revealed that application of growth regulators (NAA, Ethrel, CCC) has significant effect on vegetative growth as well as reproductive attributes. Chovatia et al., [8]; Sure et al., [9] showed that spraying of gibberellic acid at 25 ppm reduced the days to flowering in pumpkin. GA_3 enhances more cell division, cell wall elongation, cell wall plasticity and permeability of cell membranes, induced parthenocarpy and modify yield contributing characters of plant [10]. GA_3 increases the rate of photosynthesis, efficiency of utilization of photosynthates which results in rapid cell elongation and cell division, stimulates RNA and protein synthesis which ensures in increasing the vine length. Acharya et al*.,* [11] observed that days to first appearance of male flowers in cucumber were significantly influenced by the GA_3 50-100 ppm as compared to control. The similar results of the study were also observed by Rahman et al., [12] in cucumber; Dixit et al*.*, [13] in watermelon. The statistically analysed data pertaining to growth parameters was presented in Table 1.

3.3 Yield Parameters

In the study the exogenous application of gibberellic acid and naphthalene acetic acid at 2, 4 leaf stages shows significant difference on yield parameters as compared to control which was shown in Table 2. The results obtained in the present study shows that minimum days taken to first harvest of cucumber was recorded in T_4 GA_3 35 ppm (49.8 days) which was at par

Table 1. Effect of gibberellic acid and naphthalene acetic acid on days to germination and growth parameters of cucumber (*Cucumis sativus* L.)

Notation	Treatment	Days to germination	Vine length (cm)			Days to 1st appearance of male Flowers in 50% plants	Days to 1st appearance of female flowers in 50% plants
			20 DAS	40 DAS	60 DAS		
T_1	Control	4	29.89	73.21	162.75	39.93	46.26
T_2	GA_3 15 ppm	5	34.96	89.76	178.84	33.40	41.06
T_3	GA_3 25 ppm	4	39.12	91.02	180.32	32.86	39.93
T_4	GA_3 35 ppm	5	33.02	82.31	172.79	34.13	38.93
T_5	GA_3 45 ppm	5	32.48	79.88	170.16	36.05	44.86
T_6	NAA 75 ppm	4	35.03	86.16	176.72	37.06	45.80
T_7	NAA100 ppm	5	34.14	85.13	175.94	33.86	42.13
T_8	NAA125 ppm	5	33.28	84.15	173.79	35.26	43.73
T_9	NAA150 ppm	4	30.79	77.80	166.75	44.33	44.33
F-Test		NS	S	S	S	S	S
SE(d) ±		0.150	0.812	1.231	1.072	0.285	0.579
$CD_{0.05}$		-	1.735	2.631	2.292	0.608	1.238

S - Significant; NS - Non significant;
DAS - Days after sowing

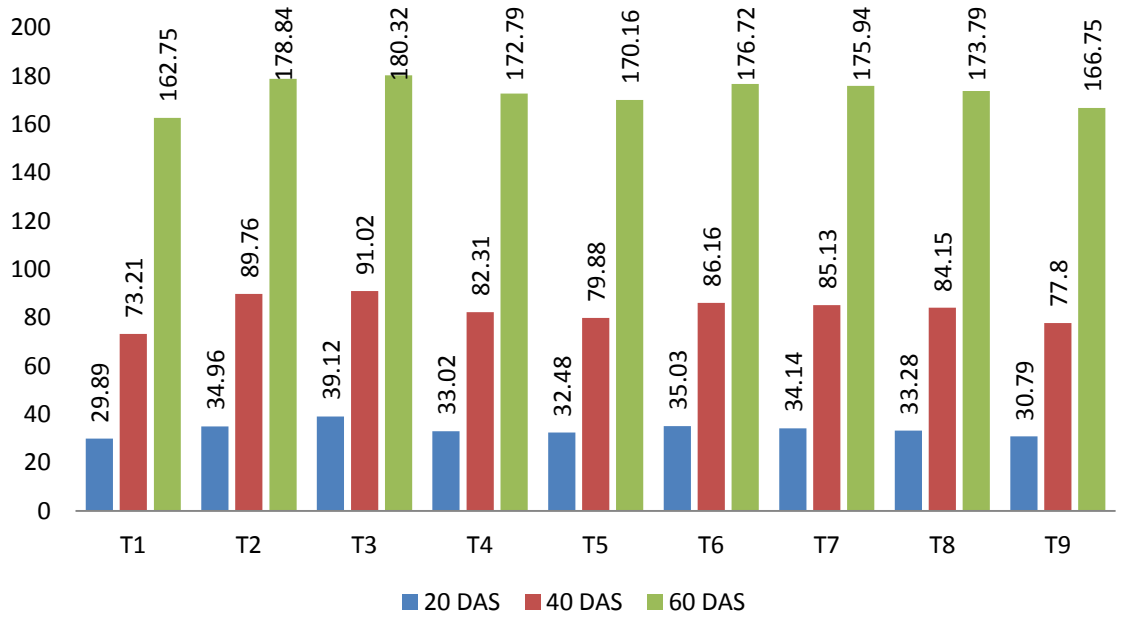

Fig. 1. Effect of Gibbereillic acid and Naphthalene acetic acid on vine length of cucumber

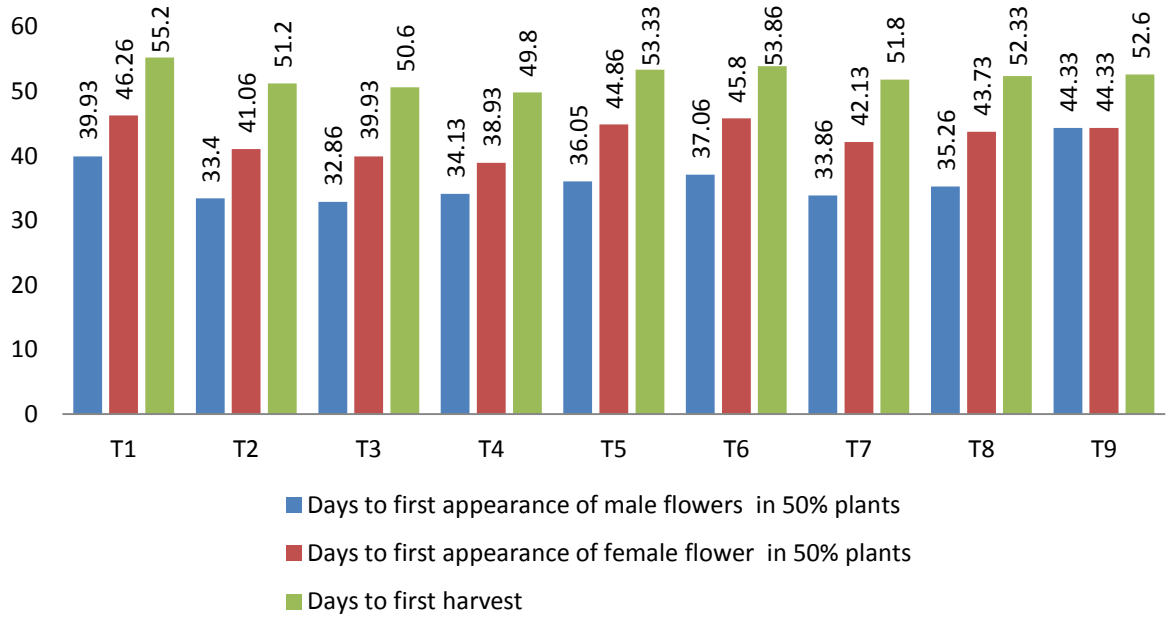

Fig. 2. Effect of Gibberellic acid and Naphthalene acetic acid on Days to first appearance of male and female flowers in 50% plants and Days to first harvest of cucumber

with T_3 GA_3 25 ppm (50.60 days), followed by T_7 NAA 100 ppm (51.80) where as the maximum days taken to first harvest was recorded control-water spray (55.2 days) Fig. 2. The treated plants are more physiologically active translocates food to develop fruits which results in early maturity of fruits. The maximum fruit weight (153.33g) was recorded in T_3 GA_3 25 ppm followed by T_2 GA_3 15 ppm (151.11g) where as minimum was recorded in control-water spray (142.90 g) shown in Fig. 3. GA_3 and NAA application increases the fruit mesocarp by increasing the cell size [14]. Jyoti et al., [15] revealed that GA_3 25 ppm increased the fruit weight in ridge gourd. The maximum length of the fruit (14.66 cm) and the maximum diameter (4.42cm) was recorded with application of GA_3 15ppm T_2 followed by T_6 NAA 75 ppm (14.23cm), (4.28 cm) and minimum was recorded

Table 2. Effect of gibberellic acid and naphthalene acetic acid on days to first harvest and yield parameters of cucumber

Notation	Treatment	Days to first harvest	Fruit weight (g)	Length of the fruit (cm)	Fruit diameter(cm)	No of fruits per plant	Average yield per plant (g)	Average yield (t/ha)
T_1	Control	55.20	142.90	12.36	3.96	8.13	1,162.36	11.61
T_2	GA_3 15 ppm	51.20	151.11	14.66	4.42	11.13	1,682.39	16.81
T_3	GA_3 25 ppm	50.60	153.33	14.12	4.25	12.20	1,870.37	18.70
T_4	GA_3 35 ppm	49.80	146.86	14.05	4.15	8.53	1,253.14	12.53
T_5	GA_3 45 ppm	53.33	145.67	13.88	4.11	8.20	1,194.58	11.94
T_6	NAA 75 ppm	53.86	149.72	14.23	4.28	10.73	1,606.73	16.06
T_7	NAA100 ppm	51.80	148.01	13.74	4.07	9.66	1,430.71	14.30
T_8	NAA125 ppm	52.33	147.79	14.19	4.26	9.26	1,369.56	13.69
T_9	NAA150 ppm	52.60	143.90	13.54	4.02	8.20	1,180.03	11.79
F-TEST		S	S	S	S	S	S	S
SE(D) ±		0.513	1.217	0.184	0.037	0.190	29.083	0.291
$CD_{0.05}$		1.131	2.602	0.394	0.080	0.407	62.184	2.515

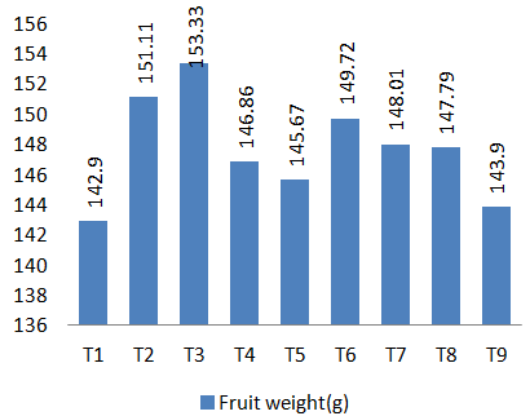

Fig. 3. Effect of gibberellic acid and naphthalene acetic acid on fruit weight of cucumber

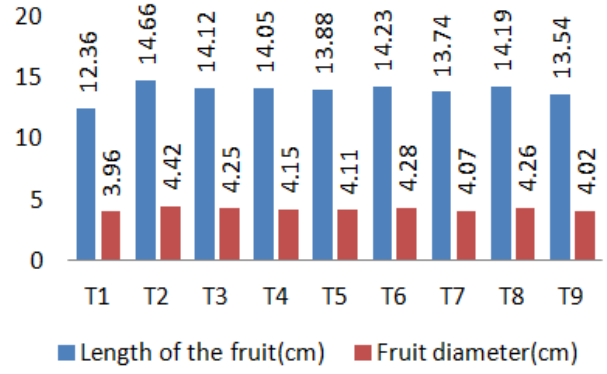

Fig. 4. Effect of gibberellic acid and naphthalene acetic acid on length and diameter of cucumber

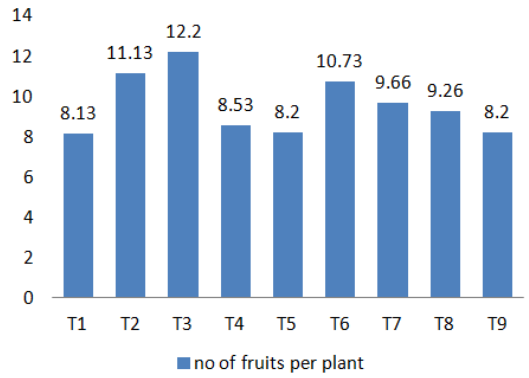

Fig. 5. Effect of gibberellic acid and naphthalene acetic acid on no of fruits per plant of cucumber

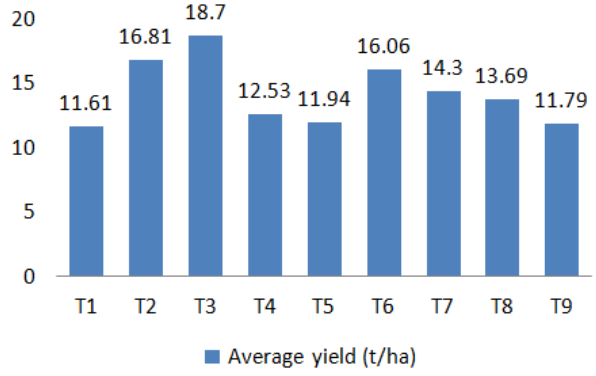

Fig. 6. Effect of gibberellic acid and naphthalene acetic acid on average yield of cucumber

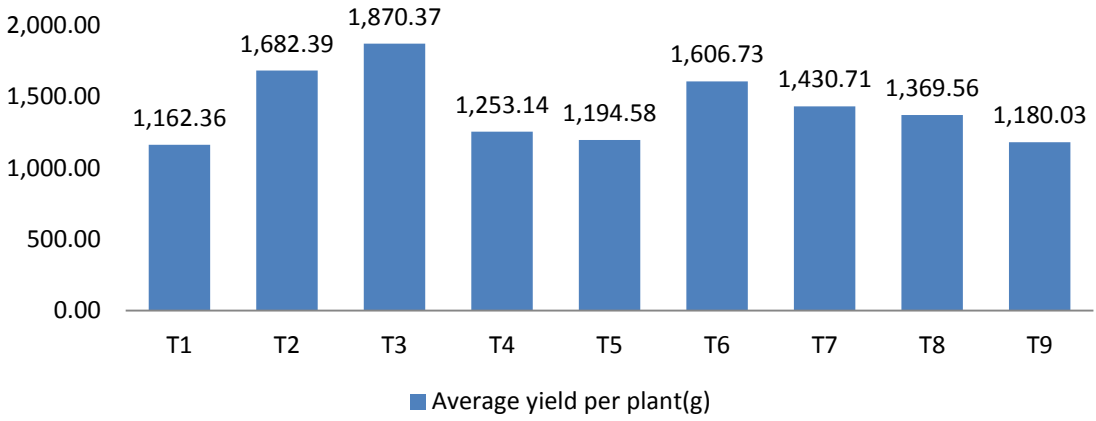

Fig. 7. Effect of gibberellic acid and naphthalene acetic acid on average yield per plant of cucumber

in control (12.36cm), (3.96cm) respectively which was shown in Fig. 4. This may be due to increasing the accumulation of carbohydrates and traslocation of food towards fruit. The results are similar with [6] showed that increasing length and diameter of the cucumber by spraying GA_3 100 ppm. The maximum number of Fruits per plant (12.2), Average yield per plant (1870.378 g)

and Average yield tonnes per hectare (18.70 t/ha) was recorded in GA_3 25 ppm where as minimum (8.13, 1162.3 g, 11.61 t/ha) was recorded in control-water spray respectively which was graphically shown Figs. 5-7. The Yield which depends on multiple factors like number of fruits per plant, fruit weight, length and diameter of the fruits. GA_3 has an effect on both vegetative as well as reproductive characters, mainly female flower formation and fruit setting which ultimately increases the number of fruits, fruit weight both combinedly increased fruit yield per plant resulted in maximum Average yield per hectare. This may be due to better enzymatic activity and the synthesis of growth regulators endogenously which was similar findings of Sure et al., [9] in pumpkin. Shirzad et al. [16] reported that application of GA_3 60 ppm increased the number of fruits per plant and yield in bittergourd. These findings were similar with [17] in cucumber, Dalai et al., [18] in cucumber [19-21].

4. CONCLUSION

It was concluded that the effect of gibberellic acid and naphthalene acetic acid on growth and yield of cucumber at 2, 4 leaf stage was found superior in T_3 - GA_3 25 ppm in terms of Vine length, Days to first appearance of female flowers in 50% plants, Days to first appearance of male flowers in 50% plants, Days to first Harvest, Fruit weight in grams (g), Length of the fruit (cm), Fruit diameter (cm), Number of Fruits per plant, Average Yield per plant (g), Average Yield (t/ha) as compared to other doses of GA_3, NAA and control.

ACKNOWLEDGEMENTS

Success is the manifestation of diligence, perseverance, inspiration, motivation and innovations It is my proud and privilege to express a deep sense of gratitude to my advisor Mr. Deepanshu, Assistant Professor, Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj, to the chairperson Dr. Pradeep Kumar Shukla, Assistant Professor, Department of Biological Sciences, SHUATS,Co-advisor Dr. Vijay Bahadur Associate Professor and Head, Department of Horticulture, Naini Agricultural Institute, SHUATS, and member Dr. Pratyasha Tripathi, Assistant Professor, Department of Mathematics and Statistics, SHUATS, for providing help in various ways and offering valuable suggestions during the course of the research work.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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