International Journal of Agriculture Sciences
ISSN: 0975-3710&E-ISSN: 0975-9107, Volume 10, Issue 6, 2018, pp.-5576-5580.
Available online at http://www.bioinfopublication.org/jouarchive.php?opt=&jouid=BPJ0000217

Research Article

PERFORMANCE OF CUCURBITS IN DRY LAND ECO-SYSTEM OF UTTAR PRADESH, INDIA

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Received: March 18, 2018; Revised: March 27, 2018; Accepted: March 28, 2018; Published: March 30, 2018

Abstract- Integrated Crop Technology (ICT) based demonstrations were conducted on cucurbits with improved technologies against farmers practices on farmer's fields during 2009-10 to 2011-12 in Hamirpur district of Bundelkhand zone of Uttar Pradesh. Full package of practices was followed. The demonstrations were conducted on bottle gourd (329), bitter gourd (254), sponge gourd (381) and cucumber (199). The results showed that improved techniques increased yield over farmers practices by the margins of 84.94 q ha^{-1} or 55.33 % in bottle gourd, 42.06 q ha^{-1} or 48.85 % in bitter gourd, 58.08 q ha^{-1} or 55.72 % in sponge gourd and 55.86 q ha^{-1} or 67.66 % in cucumber. Net profit o ₹ 73088 ha^{-1} in sponge gourd followed by ₹ 52092 ha^{-1} in bottle gourd and ₹ 45140 ha^{-1} in bitter gourd realized by farmers. Lowest of ₹ 25316 ha^{-1} net profit was increased in cucumber. There was wide technology gap, which need to bridge by promoting the scientific production and protection technologies of cucurbits crops in Hamirpur district of Uttar Pradesh.

Keywords- Cucurbits demonstrations, Cucurbits productivity and profitability, Technology gap analysis.

Citation: Khaiwal Rajiv, *et al*., (2018) Performance of Cucurbits in Dry Land Eco-System of Uttar Pradesh, India. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 10, Issue 6, pp.-5576-5580.

Introduction

Hamirpur is located at 25.95°N 80.15°E with an average elevation of 80 meters. It is one of the district of Uttar Pradesh state of India and a part of Chitrakoot division. The district occupies an area of 4,121.9 km². According to the 2011 census Hamirpur district has a population of 1,104,021 roughly equal to the nation of Cyprus. Out of 640, this gives it a ranking of 417th in India. It is the third least populous district of Uttar Pradesh, after Mahoba and Chitrakoot and has a population density of 268 inhabitants per square kilometer. Hamirpur district has a sex ratio of 860 females for every 1000 males and a literacy rate of 70.16% (Anonymous 2011) [1]. Two major rivers Yamuna and Betwa meet here. The climate of the district is intensely hot summer and a pleasant cold season. The summer season from March to about middle of June is followed by the south-west monsoon season from mid-June to the end of September. The cold season is from mid-November to February. May and the beginning of June are generally the hottest period of the year and maximum temperature in May is about 43°C and minimum about 28°C. The maximum temperature on individual days sometimes reaches 48°C or more. During the cold season minimum temperature sometimes drops down to about 2 or 3°C.

The soils consist of the well-known Bundelkhand varieties i.e. *Mar*, *Kabar*, *Parwa* and *Rakar* [Table-1]. Net sown area in the district is 290.785 thousand ha [Table-2]. The major sources of irrigation are bore wells and canals. Source wise irrigated area in Hamirpur district has been furnished in [Table-3]. Out of net cultivated area, the net irrigated and rainfed area is 35.65 % and 64.35%, respectively (Anonymous 2008) [2]. Pulses, cereals, oilseeds, fruits and vegetable crops are being cultivated [Table-4] and agriculture - animal husbandry, agriculture - horticulture - animal husbandry and horticulture - animal husbandry are the major farming systems in the district [Table-5].

The cucurbits are the emerging important crops grown in Hamirpur district of Bundelkhand zone in Uttar Pradesh. However, the productivity of these crops is much lesser than the other part of state. The major constraints in crops production are non-availability of improved varieties seed, imbalance use of fertilizers and lack in adoption of improved cultivation techniques by majority of farmers (Rajiv, 2014) [3]. Most of the farmers in the district are not aware about improved techniques of crops cultivation. If the productivity increases, the sizeable area under these crops will be increased and thus, production of cucurbits to be enhanced. Keeping these factors in view, integrated crop technology (ICT) based demonstrations were organized at several locations on farmer's fields in district Hamirpur to enhance the productivity and profitability per unit area under Diversified Agriculture Support Project (DASP).

Table-1 *Type of soils and their main characteristics in Hamirpur district*

S. No.	Soil type	Main characteristics
1.	*Parwa*	Light coloured sandy soil, found in many forms, average water holding capacity, moderately alkaline, usually less rich in organic matter but its finer texture makes it more responsive to manure and irrigation.
2.	*Kabar*	Rich dark black to light gray brown colour, poor to average water holding capacity, poor in organic carbon and extreme adhesiveness, which causes it to quickly dry & cake in to hard blocks.
3.	*Rakar*	Brown at surface, average water holding capacity, sandy loam and occurs on sloping ground, where the action of water has tended to denude the earth of all its better qualities.
4.	*Mar*	Black cotton soil varies greatly in colour, high water holding capacity, low in organic matter and slightly calcareous.

Table-2 *Land use pattern of Hamirpur district, Uttar Pradesh (average of 5 years).*

S. No.	Category	Area (in 000 ha)
1.	Area under forest	23.520
2.	Area under non-agricultural use	30.703
3.	Permanent pastures	0.432
4.	Miscellaneous tree, crops & groves	0.713
5.	Fallow area	26.699
6.	Rainfed area	187.111
7.	Net irrigated area	103.674
8.	Net sown area	290.785
9.	Net area sown more than once	33.274
10.	Gross cropped area	324.059

Table-3 *Source-wise irrigated area in Hamirpur district*

S. No.	Source	Irrigated area (in 000 ha)	Percentage area
1.	Canals	22.162	21.38
2.	Bore wells	76.840	74.12
3.	Tanks	4.646	4.48
4.	Other sources	0.026	0.02
	Total	103.674	100.0

Table-4 *Major crops/enterprise of Hamirpur district*

S. No.	Component	Major crops/enterprise
1.	Agriculture	Gram, field pea, pigeon pea, lentil, urd, moong, wheat, barley, sorghum and bajra
2.	Horticulture	Aonla, guava, cucurbits, vegetable pea, tomato, cauliflower, cabbage, okra, chillies, brinjal and onion
3.	Animal husbandry	Deshi cow, deshi buffalo, goat, sheep and back yard poultry
4.	Other	Fisheries and fruit & vegetable processing products

Table-5 *Major farming systems of Hamirpur district, Uttar Pradesh*

S. No.	Farming system	
	Cropping system	Animal
1.	Sorghum + pigeon pea	Deshi cow
2.	Fallow – pulses (gram/lentil)	Deshi buffalo/cow
3.	Sesame – pulses (gram/lentil)	Deshi buffalo/cow
4.	Moong/urd – wheat	Deshi cow
5.	Cucurbits/okra – wheat	Deshi cow + goat
6.	Cucurbits – chillies/brinjal/ tomato/cole crops/vegetable pea	Deshi buffalo/cow + goat/sheep

Methodology

The selection of farmers was done block wise with the help of block level functionaries and staff of line departments. Only interested farmers were selected for demonstrations on different crops. Large, medium and small holding size farmers were included in the study. Through preliminary discussion with selected farmers, causes for low crop yield of cucurbits were identified and prioritized. Based on the major causes, technological interventions were finalized. Under improved techniques, integrated crop technology approach was demonstrated included interventions *viz*. use of improved variety with optimum seed rate, line sowing with optimum plant stand, optimum dose of fertilizer application, use of plant growth regulator and proper weed management. Under conventional system, farmers used old varieties with high seed rate, without seed treatment, imbalance use of fertilizer application, without use of plant growth regulator and no proper weed control. Critical inputs *viz*. seed and fertilizers were supplied to the farmers. All demonstration was conducted on subsidy basis with participatory involvement of farmers. The demonstrations were conducted in form of half-field demonstration. Each demonstration had an area of 0.2 ha, in which half area (0.1 ha) was kept under conventional system and rest half (0.1 ha) under improved techniques of crop production demonstrated side-by-side. The 1163 demonstrations on cucurbits crops were conducted in whole district during three years of 2009-10 to 2011-12. Demonstrations on bottle gourd (329), bitter gourd (254), sponge gourd (381) and cucumber (199) were laid out. Yield data were recorded and analyzed economics. Technology gap, extension gap and technology index were calculated by using the following formulae as suggested by Samui *et al*., (2000), Balai *et al*., (2014) and Kikon and Angadi (2012) [4-6]:

Technology gap : Potential yield – Demonstration yield

Extension gap : Demonstration yield – Farmer's practice yield (Local check)

$$\text{Technology index (\%)} = \frac{\text{Technology gap}}{\text{Potential yield}} \times 100$$

Description of technologies disseminated and conventional system

Technologies disseminated in cucurbits demonstrations were included improved/ hybrid varieties (Swarn Purna, Swarn Shweta and Aman of bottle gourd, Kashi Harit, Kashi Urvashi and Vivek of bitter gourd, Pusa Supriya, Harita and Chetak of sponge gourd and Pusa Sanyog, Rani and Kalyanpur Green of cucumber), seed soaking in 0.05 % solution of carbendazim before sowing (6 hours, 24 hours, 6 hours and 4 hours for bottle gourd, bitter gourd, sponge gourd and cucumber, respectively), integrated nutrient management (20 ton FYM + NPK @ 80-100:60-80:60-80 kg ha^{-1}), weed management (Pendimethalin @ 3.3 liters ha^{-1} as pre emergence + 1 hand weeding at 45 days after sowing), IPM practices and *machan* technique. The bottle gourd and bitter gourd crops were sprayed with M.H. @ 50 ppm and Cycocel @ 250 ppm, respectively and sponge gourd and cucumber crops with Ethrel @ 100 ppm twice at 2 and 4 true leaf stages. All demonstrations were sown during *kharif* season between end of the June to mid-July by using seed @ 5 Kg ha^{-1} for open pollinated variety & 2 Kg ha^{-1} for hybrid variety in bottle gourd and bitter gourd, 4 Kg ha^{-1} for open pollinated variety & 2 Kg ha^{-1} for hybrid variety in sponge gourd and 3 Kg ha^{-1} for open pollinated variety & 1.5 Kg ha^{-1} for hybrid variety in cucumber with crop geometry of 2.0-3.0 x 1.0-1.5 m, 1.5-2.5 x 0.6-1.2 m, 2.0-2.5 x 0.6-1.2 m and 1.5-2.0 x 0.6-0.7 m, respectively. On the other hand, farmers were using without treated local variety seed with imbalance nutrients (NPK @ 125:40:0 kg ha^{-1}) and without herbicide, plant growth regulator, IPM practices and *Machan.* The seed rate used by the farmers was high as 7 Kg ha^{-1} in bottle gourd and bitter gourd, while 5.5 Kg ha^{-1} in sponge gourd and 4 Kg ha^{-1} in cucumber with dense crop geometry of 1.5 x 1.0 m, 1.5 x 0.5 m, 1.5 x 0.5 m and 1.2 x 0.5 m, respectively.

Results and Discussion

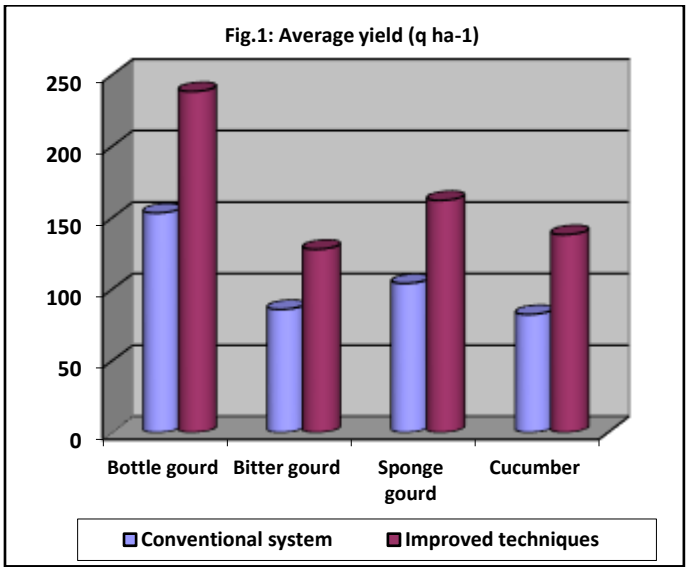
Yield analysis

Remarkable change on yield parameter was observed [Table-6] & [Fig-1]. Technological interventions in terms of improved varieties, integrated nutrients management, integrated pest management, weed management, etc. made a difference on cucurbits yield. The possibility of increasing yield of bottle gourd, bitter gourd, sponge gourd and cucumber per unit area was found in the area at significant level. Maximum increase in yield due to improved techniques over conventional system was recorded in cucumber followed by sponge gourd and bottle gourd, while lowest yield increase was seen in bitter gourd. On mean basis, bottle gourd, bitter gourd, sponge gourd and cucumber increased 55.33%, 48.85%, 55.72% and 67.66% yield, respectively, over conventional system [Table-7]. It might be mainly due to region specific improved/hybrid variety with optimum seed rate, soaking of seeds in carbendazim solution before sowing, proper spacing, optimum fertilizer application, plant growth regulator spray, IPM practices, proper weed control and *Machan* technique. All these improved techniques had a great impact on cucurbits and lead to high yield. The spray of plant growth regulators helps a lot in modifying sex ratio and increased fruit set in cucurbits. Under conventional system, local or old variety with high seed rate, dense spacing, imbalance use of fertilizer, no or imperfect plant protection measures and no proper weed control are the main reasons of poor yield. During the period of study, it was also observed that in cucurbits, farmers use their own seed year after year, which lead to poor yield. Proper improvement in these inputs might have increased the cucurbits yield with improved techniques over conventional system. These results are in conformity with the findings of Balai *et al.* (2014), Singh *et al.* (2014), Dhaka *et al.* (2010), Kumar *et al.* (2010), Hiremath and Nagaraju (2009) and Mishra *et al*. (2009) [5,7-11] on different crops. The demonstrations conducted on lentil with improved varieties and technologies showed a yield advantage of about 33% over local check in Bundelkhand zone of Uttar Pradesh as reported by Kokate *et. al.* (2013) [12].

Table-6 *Year wise yield (q ha-1) of cucurbits in Hamirpur district, Uttar Pradesh*

Crop	Years of demonstration						Mean	
	2009-10		2010-11		2011-12			
	Conv.	Imp.	Conv.	Imp.	Conv.	Imp.	Conv.	Imp.
Bottle gourd	144.10	222.88	160.14	250.38	156.32	242.12	153.52	238.46
Bitter gourd	78.62	118.04	91.04	135.08	88.64	131.36	86.10	128.16
Sponge gourd	99.02	154.12	108.52	168.56	105.18	164.28	104.24	162.32
Cucumber	74.74	126.14	88.78	147.86	84.16	141.26	82.56	138.42

Conv.- Conventional system ; Imp.- Improved techniques



Economic analysis

Cost of cultivation of cucurbits has been raised due to higher rates of inputs per unit area. Increase in expenditure due to improved techniques over farmer's practices was lowest of ₹13786 ha^{-1} in cucumber to highest of ₹19840 ha^{-1} in sponge gourd. The use of improved techniques increased net economic gain from all cucurbits under demonstrations considerably. Maximum increase of ₹73088 ha^{-1} in net profit was observed in sponge gourd followed by bottle gourd with ₹ 52092 ha^{-1} and bitter gourd with ₹ 45140 ha^{-1} net profit, while lowest of ₹ 25316 ha^{-1} net profit was found in cucumber [Table-8]. The percent yield increase due to improved interventions was highest in cucumber but net profit was lowest. It might be attributed to lowest sale price of cucumber. Return per rupee invested on improved techniques was worked out highest of ₹4.68 in sponge gourd followed by ₹ 4.28 in bottle gourd and ₹ 3.51 in bitter gourd, while lowest of only ₹ 2.84 in cucumber. These results showed that investment on improved cultivation techniques is more profitable on sponge gourd and bottle gourd in Hamirpur district of Bundelkhand. In case of chillies, Singh (2000) [13] has also reported almost similar results on farmers' fields studied in Baran district of Rajasthan. Chaturvedi *et al.* (2014), Rajiv and Singh (2014), Tomar (2010) and Singh *et al.* (2004) [14-17] have reported almost similar results of demonstrations on different crops earlier.

The increase in crop profitability (₹ha^{-1}day^{-1}) due to improved techniques of bottle gourd, bitter gourd, sponge gourd and cucumber was recorded by ₹441.46, ₹399.47, ₹676.74 and ₹ 294.37, respectively. The crops, which give higher profitability, are economically beneficial. Kokate *et. al.* (2013) [12] reported a net return of ₹34400 ha^{-1}, which was 46% higher to local check in lentil in Bundelkhand zone of Uttar Pradesh.

Technology gap analysis

The data depicted in [Table-7] and [Fig-2] revealed that the bottle gourd, bitter gourd, sponge gourd and cucumber produced average yield of 238.46 q ha^{-1}, 128.16 q ha^{-1}, 162.32 q ha^{-1} and 138.42 q ha^{-1} under demonstrations as against the potential yield of 290 q ha^{-1}, 160 q ha^{-1}, 200 q ha^{-1} and 165 q ha^{-1}, respectively. Thus, there was a wide gap found between the demonstration yield and potential yield. The highest technology gap of 51.54 q ha^{-1} was recorded in bottle gourd followed by sponge gourd (37.68 q ha^{-1}) and bitter gourd (31.84 q ha^{-1}), while minimum gap was found in cucumber (26.58 q ha^{-1}). There was highest gap existed between the potential yield and demonstration yield (improved technologies) in bottle gourd followed by sponge gourd and bitter gourd, whereas lowest was in cucumber. However, demonstrations were conducted under close supervision of field staff but the technology gap was found there. It might be due to varied agro-ecosystems of the area. In addition, it was also observed that the reasons responsible for the technology gap were lack of adoption of complete or thoroughly recommended package of practices at demonstration fields under improved technologies due to non-availability of some important inputs at the time of requirement, high cost of inputs and insufficient technological advice.

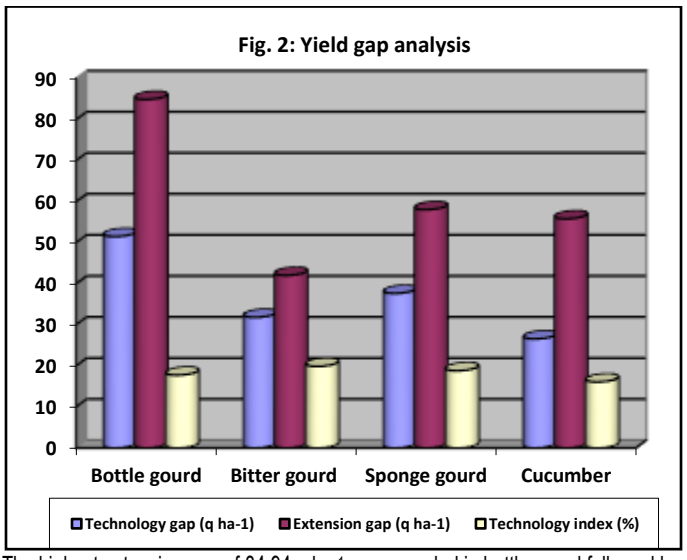
Table-7 *Yield and gap analysis of cucurbits in Hamirpur district, Uttar Pradesh*

Crop	No. of demo.	Potential yield (q ha^{-1})	Average yield (q ha^{-1})		% increase in yield over conv.	Technology gap (q ha^{-1})	Extension gap (q ha^{-1})	Technology index (%)
			Conv.	Imp.				
Bottle gourd	329	290	153.52	238.46	55.33	51.54	84.94	17.77
Bitter gourd	254	160	86.10	128.16	48.85	31.84	42.06	19.90
Sponge gourd	381	200	104.24	162.32	55.72	37.68	58.08	18.84
Cucumber	199	165	82.56	138.42	67.66	26.58	55.86	16.11

Demo. – Demonstrations; Conv.- Conventional system ; Imp.- Improved techniques

Table-8 *Economic analysis of cucurbits in Hamirpur district, Uttar Pradesh*

Crop	Increase with improved techniques over conventional system in					
	Yield (q ha^{-1})	Gross income (₹ ha^{-1})	Expenditure (₹ ha^{-1})	Net profit (₹ ha^{-1})	Return per rupee invested	Crop profitability (₹ ha^{-1}day^{-1})
Bottle gourd	84.94	67952	15860	52092	4.28	441.46
Bitter gourd	42.06	63090	17950	45140	3.51	399.47
Sponge gourd	58.08	92928	19840	73088	4.68	676.74
Cucumber	55.86	39102	13786	25316	2.84	294.37



The highest extension gap of 84.94 q ha^{-1} was recorded in bottle gourd followed by sponge gourd (58.08 q ha^{-1}) and cucumber (55.86 q ha^{-1}) whereas lowest was in bitter gourd (42.06 q ha^{-1}) which indicates that there was a gap existed between the yield of demonstrations and local check/farmers practice. In comparison between the improved technologies and conventional system, it was observed that the farmers did not use balance nutrients, herbicide, plant growth regulator and plant protection measure properly, local varieties were sown without seed treatment and optimum plat population, which was not maintained under conventional system. Thus, the farmers were failed to adopt recommended package of practices under conventional system and lead to extension gap. The extension gap in the yield indicates that there is big scope to increase the yield of cucurbits on farmer's fields by adopting the recommended package of practices. Therefore, to bridge the extension gap, there is a need to give more emphasis on transfer of improved technologies and management practices of bottle gourd, sponge gourd and cucumber as compared to bitter gourd through strengthening of extension network. The extension gap for all cucurbits was higher as compared to the technology gap, which also indicates that there is need to train and educate the farmers about improved technologies.

Technology index was minimum in cucumber (16.11%) compared to bottle gourd (17.77%), sponge gourd (18.84%) and bitter gourd (19.90%). Technology index shows the feasibility of the demonstrated scientific technological interventions on farmer's field [18]. Therefore, technology index ranging from 16.11 to 19.90 % indicates of higher scope for further improvement in productivity of cucurbits in Bundelkhand zone of Uttar Pradesh. Similar findings were also observed by Singh, *et al*., 2014, Chauhan, 2012 and Katare, *et al*., 2011 [7,19,20] on yield gap analysis of field pea, gram and rapeseed-mustard, respectively under front line demonstrations.

Conclusion

Demonstrations conducted on bottle gourd (329), bitter gourd (254), sponge gourd (381) and cucumber (199) were performed better. The results showed that improved techniques increased average yield over farmers practices by the margins of 84.94 q ha^{-1} or 55.33 % in bottle gourd, 42.06 q ha^{-1} or 48.85 % in bitter gourd, 58.08 q ha^{-1} or 55.72 % in sponge gourd and 55.86 q ha^{-1} or 67.66 % in cucumber. The farmers realized net economic gain of ₹ 52092 ha^{-1} in bottle gourd, ₹45140 ha^{-1} in bitter gourd and ₹ 73088 ha^{-1} in sponge gourd. Lowest of ₹ 25316 ha^{-1} net gain was increased in cucumber. There is wide technology gap, which need to be bridged by promoting the scientific production and protection technologies in varied condition. Major attention on district and area specific technology modules should be developed for enhancing the productivity of cucurbits in varied conditions and agro-eco systems of Hamirpur district of Uttar Pradesh. Capacity building programme of extension functionaries and farmers is an urgent need.

Application of research: The farmers of adopted villages are aware and convinced of the benefits of the improved techniques of cucurbits cultivation. Improved techniques increased productivity over farmers' practices by the margins of 48.85 to 67.66 %. The cropping intensity increased under dry land eco-system and raised income of the farmers.

Research Category: Dissemination and diffusion, improved agro-techniques.

Abbreviations

ICT: Integrated Crop Technology
Conv.: Conventional system
Imp: Improved techniques
Demo: Demonstrations

Acknowledgement / Funding: Author thankful to Diversified Agriculture Support Project (DASP), Government of U.P., Chandra Shekhar Azad University of Agriculture & Technology, Kanpur, 208002, Uttar Pradesh. Author thankful to Dr R.K. Tomer, Nodal Officer, PIU, Horticulture, Lucknow for their continued support throughout the study.

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Research project name or number: Diversified Agriculture Support Project (DASP), Government of Uttar Pradesh

Author Contributions: All author equally contributed
Author statement: All authors read, reviewed, agree and approved the final manuscript

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

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