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Effect of Musical Note ('Shuddha Swar') on the Germination and Growth of *Triticum aestivum*

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Abstract- Indian classical music is known for very fine thoughts on '*Swar*' (Musical Note). The present study is focused on the effect of '*Shuddha Swar'* on the growth of *Triticum aestivum* L. (wheat). The percentage of germination was found to be highest (96%) in samples treated with *'Sa'*'*Ga'*,'*Ma'* and '*Dha'* and lowest in the sample treated with *'Pa'*(64%).

The longest root length (23.6 cm) was observed in sample treated with *'Pa'* whereas shortest (3 cm) was recorded in *'Ga'* treated sample. Shoot length was found to be highest in the sample encountered with '*Pa*' (21.4 cm) and shortest shoot length was noted in *'Dha'* (0.6 cm) reacted samples. Post germination percentage of mortality found in sample treated with *'Pa'* (0%) and highest is recorded in control (54.54%). The farmer could prevent at least (21.21%) post germination death of plants.

Key words- Indian Classical Music, *Shuddha Swar*, Plant growth, Germination, Wheat plant

I. INTRODUCTION

India is well known for its rich heritage. The Indian classical music is one of the ancient heritages which are globally accepted which considers three basic components of the music as *'Swar'*, *'Taal'* and *'Lay'*. The twelve *'Swar'* (Musical Note) are also classified in to three type i-e '*Shuddha Swar'*(7)-(Natural notes- (*Sa', 'Re', 'Ga', 'Ma', 'Pa', 'Dha', 'Ni'*); *'Komal Swar'*(4)-(*'Re', 'Ga', 'Ma', 'Dha'*) and '*Tivra Swar'*(1)-(*'Ma'*). The micro change in the frequency range of note is known as '*Shruti'* (Tones) which are twenty two. The *'Sa'* and *'Pa'* are *'Sthayi swar'* and have no *'Shruti'*. *The 'Shuddha Swar'* is encircled with *'Shruti'* having different frequency [1].

The 'Tanpura'/ 'Tambora' is the principal instrument used in Indian classical music regardless of styles, which is constantly taken as reference throughout.

The Classical music has flourishing effect on plants while rock music has withering effect [2]. Plants responded positively to every type of music except acid rock and rock music [3]. Plants treated with '*Vedic chants'* or '*Indian classical music'* observed to have higher growth with respect to control and 'Western classical' or 'Rock music' treated plants [4].

Combination of overtones of each instrument (although of the same category) is different and therefore their sounds are different for the same note. The plants showed positive sonotropic movement towards the source of music [5].

The music influences the plant growth by increasing the concentration of Sugar, Phenols and Starch [6]. Each musical note being the frequency is constant. The oscillations per second for seven shuddha swar are - Shadja (*Sa*)-240, Rishabh (*Re*)-270, Gandhar (*Ga*)-300, Madhyam (*Ma*)-320, Pancham (*Pa*)-360, Dhaivat (*Dha*)-400 and Nishad (*Ni*)-450 [7].

The music will enhance the plant growth but preferred frequencies from the music (if any) having most pronounced effect are unknown [8, 9, 10].

Background- Most of living beings responds to sound waves. The mood swings are observed in animals after playing certain type of music with change in their behaviour. Since long, plants are supposed to respond music and also to have mood swings, which could not be observed immediately like in animals. In this scenario, it is needed to check, 'Does plants show effect of music on germination and growth?

Material and Methods-

The healthy seeds were selected, washed and taken to the acoustic chamber. The same water supply and sunlight was given to each sample. The seeds were sown and taken to sound-proof chamber. All the samples were treated with '*shuddha swar'* of Kali-1(C#) scale generated on electronic Taanpura/Tambora (Make- Swarangini Digital Electronic Tanpura) for fifteen minutes each for eight days. The control was also maintained at the same conditions without supply of fertilizers [3].

Result and Discussion- The germination percentage **(Table -1)** found to be highest in sample treated with *'Sa'* (96%), *'Ga'* (96%), *'Ma'* (96%) and '*Dha'* (96%). The 8% rise in the seed germination was recorded with respect to control.

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The Indian classical ragas act as plant growth stimulant as it enhances seed germination, early seed germination and healthy seedling growth [1]**.** The increased germination is recorded in the samples treated with low frequency notes, which is co-relating with the findings of [11].

The control had 88% germination while sample treated with *'Ni'* had 84%, which indicated the decrease in the germination when treated with high frequency. The high frequency/decibel sound treatment leaded to the damage of cells [12]. Musical sound had a highly statistically significant effect on the number of seeds sprouted compared to the untreated control [13]**.**

The average of the total length of treated samples is 29.91cm. The overall higher growth was observed in the samples treated with '*Re'*(30.78cm)*, 'Ga'* (30.94cm) and '*Ma'*(30.7cm) while lowest was found in the *'Dha'* (28.20cm) treated sample. The Control was observed to have (27.57cm)**.**The germination percentage found to be highest in sample treated with *'Sa'* (96%)*, 'Ga'* (96%)*, 'Ma'* (96%) and '*Dha'* (96%). The 8% rise in the seed germination was recorded with respect to control. The Indian classical ragas act as plant growth stimulant as it enhances seed germination, early seed germination and healthy seedling growth [1]**.** The increased germination is recorded in the samples treated with low frequency notes, which is co-relating with the findings of [11].

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Table 1- Germination and Root-Shoot length

Sr.no	Pure Note	% Germination	Longest Shoot (cm)	Shortest Shoot (cm)	Longest Root (cm)	Shortest Root (cm)	Average total length (cm)	Average of the Average total length (cm)
1	*'Sa'*	96	19.7	4	21.9	4	29.6	29.91
2	*'Re'*	88	21.2	2.1	20	3.4	30.78	
3	*'Ga'*	96	20.5	1.8	19.7	3	30.94	
4	*'Ma'*	96	21	8.8	19.5	9	30.7	
5	*'Pa'*	64	21.4	1.3	23.6	3.7	29.33	
6	*'Dha'*	96	18.3	0.6	22.2	9.6	28.20	
7	*'Ni'*	84	19.8	8.8	21.5	4.1	29.88	
8	Control	88	20.2	3.4	18.7	8.3	27.57	

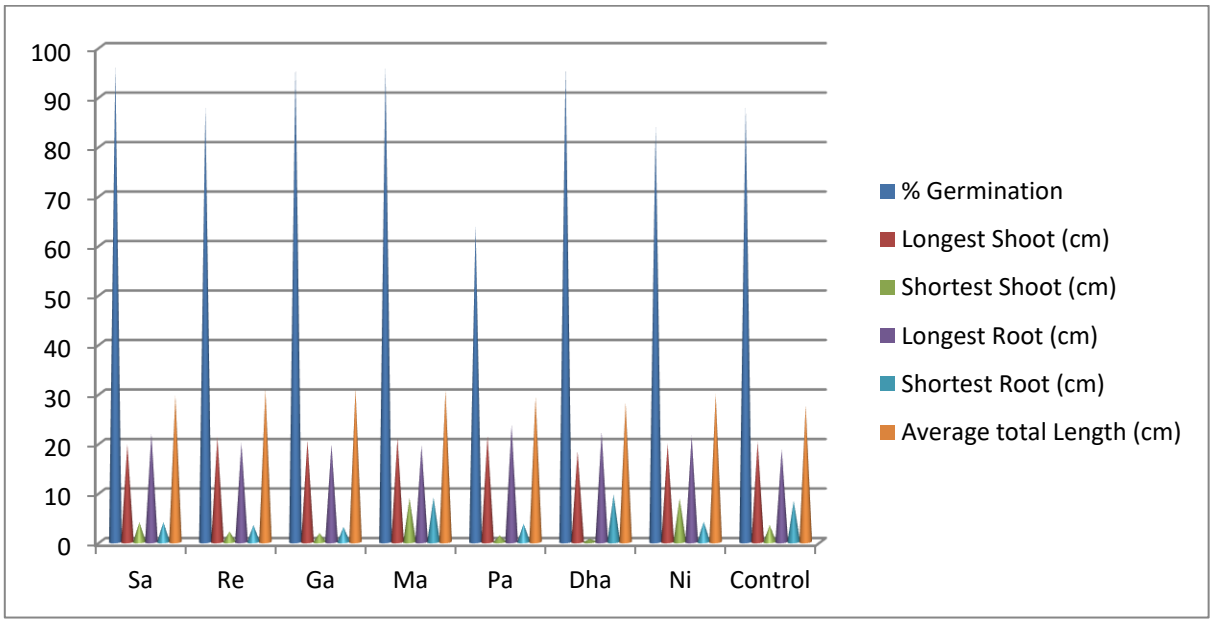

Table-1 Graphical - Germination and Root-Shoot length

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(Table-2) Percent number of individuals grown above average shoot length was recorded highest in '*Ga' followed by 'Ma', 'Sa', 'Re', 'Pa' and ' Ni'*. Percent number of individuals grown below average shoot length are also less than control. It is concluded that shoots show positive response to music. Similarly percent number of individuals having root length above average are *'Ga', 'Dha' 'Pa',* and *'Re'*. Percent number of individuals grown below average root length are higher than control. The roots are observed to be negatively sensitive to sound waves.

Table 2- % Number of individuals grown above / below average root-shoot length

Sr.no	Pure Note	% Number of individuals grown above average shoot length	% Number of individuals grown below average shoot length	% Number of individuals grown above average root length	% Number of individuals grown below average root length
1	*'Sa'*	70.5	29.41	52.94	35.29
2	*'Re'*	70	30	65	35
3	*'Ga'*	77.77	28.5	77.7	22
4	*'Ma'*	76.47	23.5	64.7	35
5	*'Pa'*	62.5	37.5	68.75	31
6	*'Dha'*	43.75	43.75	75	25
7	*'Ni'*	62.5	25	43.75	50
8	Control	40	60	80	20

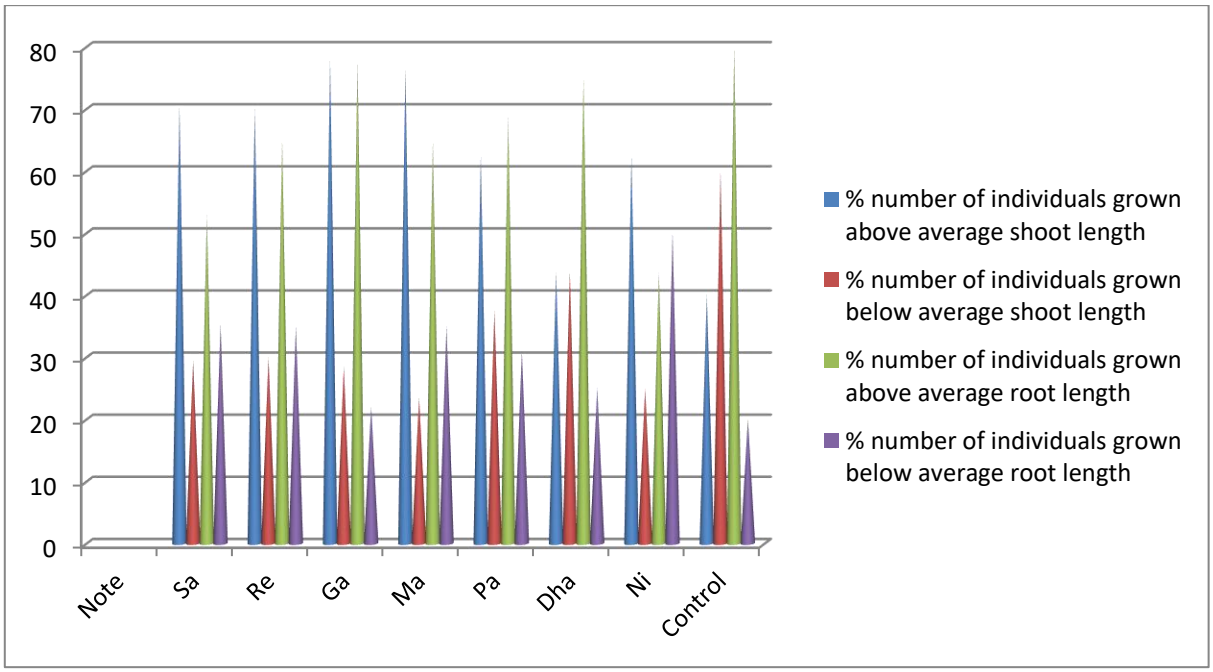

Table -2 Graphical- % Number of individuals grown above / below average root-shoot length

(Table-3) Minimum 50% (*Dha*) to maximum 72.2% (*Ga*) percent number of individuals grown above average total length and maximum *Pa*(28%) percent growth was recorded above average total length. Whereas decrease in the growth was also observed with respect to control in (4.65%) *Ni* and (0.55%)*Ma*. It is noted that any *'Shuddha Swar'* treated sample grown 10% to 32% more in number above the control.

Minimum 27%(Ga) to maximum 50%(Dha) percent number of individuals grown below average total length with respect to control and maximum (Pa)(47.5%) to minimum (Ni)(22.95%) percent growth of individuals observed below average total length with respect to control.

The '*Re'*(29%), '*Ga'*(31.5%) '*Pa'*(33.7%) percent number of shoots grown above the average shoot length. The '*Sa'*(17.2%), '*Ga'*(17.6%),'*Pa'*(26.45%),'*Dha'*(21.33%) percent number of roots grown above the average root length.

The '*Sa'*(29.36%), '*Re'*(43.1%) percent number of shoots grown below average shoot length. The '*Re'*(20.68%) '*Ga'*(23.3%) '*Pa'*(28%) are having percent total growth above average. Sound waves significantly increased the

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yield of wheat, spinach, sweet pepper, lettuce, cucumber, tomato cotton and rice similarly the average yield, Starch, protein and fat content of wheat was observed to be increased when exposed to plant acoustic frequency technology (PAFT) generator [14]. Low-frequency sound waves were used to stimulate more than 50 kinds of crops, and achieved remarkable effects [11]. Sound waves may also strengthen plant immune systems. Late blight, aphids, sheath blight of rice, Spider mite, viral disease of tomatoes (grown in the greenhouse) and gray mould observed to be decreased by sound wave treatment [14].

Table-3-% Number and % root/shoot growth above and below average

Sr.no	Pure Note	% Number of individuals grown above average total length	% Number of individuals grown below average total length	% Growth above average total length	% Growth below average total length	% Number of roots grown above average root length	% Number of roots grown below average root length	% Number of shoots grown above average shoot length	% Number of shoots grown below average shoot length
1	*'Sa'*	70.5	29.4	18.8	31.4	17.2	24.83	28.3	29.36
2	*'Re'*	65	35	20.68	30.85	12.9	26.28	29	43.1
3	*'Ga'*	72.2	27.7	23.3	36.66	17.6	33.22	31.5	73
4	*'Ma'*	64.7	35.29	17.4	25.05	13.36	16.48	21.22	52.66
5	*'Pa'*	62.5	37.5	28	47.5	26.45	38.4	33.7	53.5
6	*'Dha'*	50	50	21.33	32.6	21.33	30.95	19.36	52.82
7	*'Ni'*	62.5	37.5	13.3	22.95	15.68	21.1	22.6	35.3
8	Control	40	60	17.95	29.7	15.75	24.6	30.5	59.4

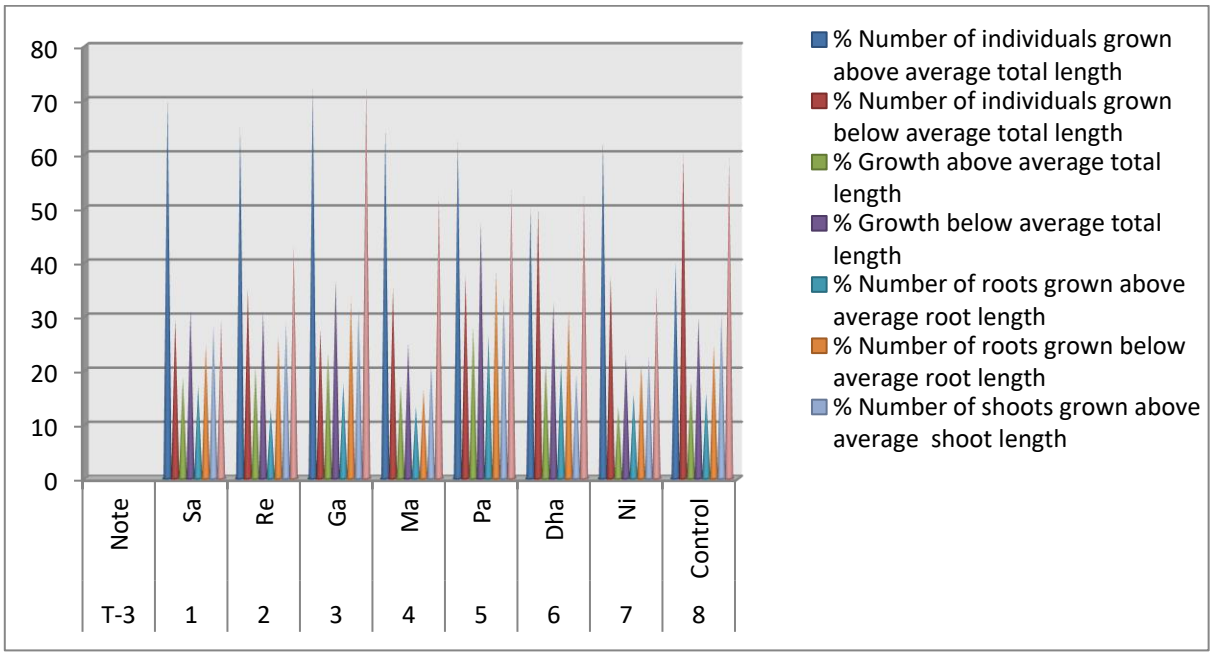

Table- 3 Graphical- % Number and % root/shoot growth above and below average

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(Table-4) *'Re'* (52%) and *'Ga'* (52%) *'Ma'* (44%) were observed to be grown above average total length. *'Re'* (52%) *'Sa'*(40%), *'Dha'*(28%)found to have higher growth of shoots above average. The highest root length above the average was recorded in *'Dha'* (44%). The *'Ga'*(20%), *'Ma'*(24%), *'Pa'*(24%) and *'Ni'*(24%) found growing below average total length. The *'Ga'*(20%), *'Ma'*(20%), *'Pa'*(20%) and *'Ni'*(12%) found growing below average shoot length. The *'Ni'*(52%), *'Re'*(48%), *'Ma'*(40%), *'Ga'*(32%), *'Pa'*(32%), *'Sa'*(28%) and *'Dha'*(20%) found growing below average root length. The synchronized sound waves in the form of '*Indian classical ragas*' act as potent plant growth stimulant and protectant[1]**.** The change in amplitude causes change in pressure that makes the air molecules to move forth and back and create brushing action on the leaf and removes the film of moisture and helps in transpiration and results in overall development [10].

Table 4- % Number above / below root-shoot length

Sr. No.	Pure Note	% Number of individuals grown above average of the total length	%Number above average shoot length	%Number below average shoot length	%Number above average root length	% Number below average root length	% Number below average total length
1	*'Sa'*	0	40	0	36	28	0
2	*'Re'*	52	52	0	0	48	0
3	*'Ga'*	52	0	20	0	32	20
4	*'Ma'*	44	0	20	0	40	24
5	*'Pa'*	0	0	20	24	32	24
6	*'Dha'*	0	28	0	44	20	0
7	*'Ni'*	0	0	12	12	52	24
8	Control	0	0	0	0	0	0

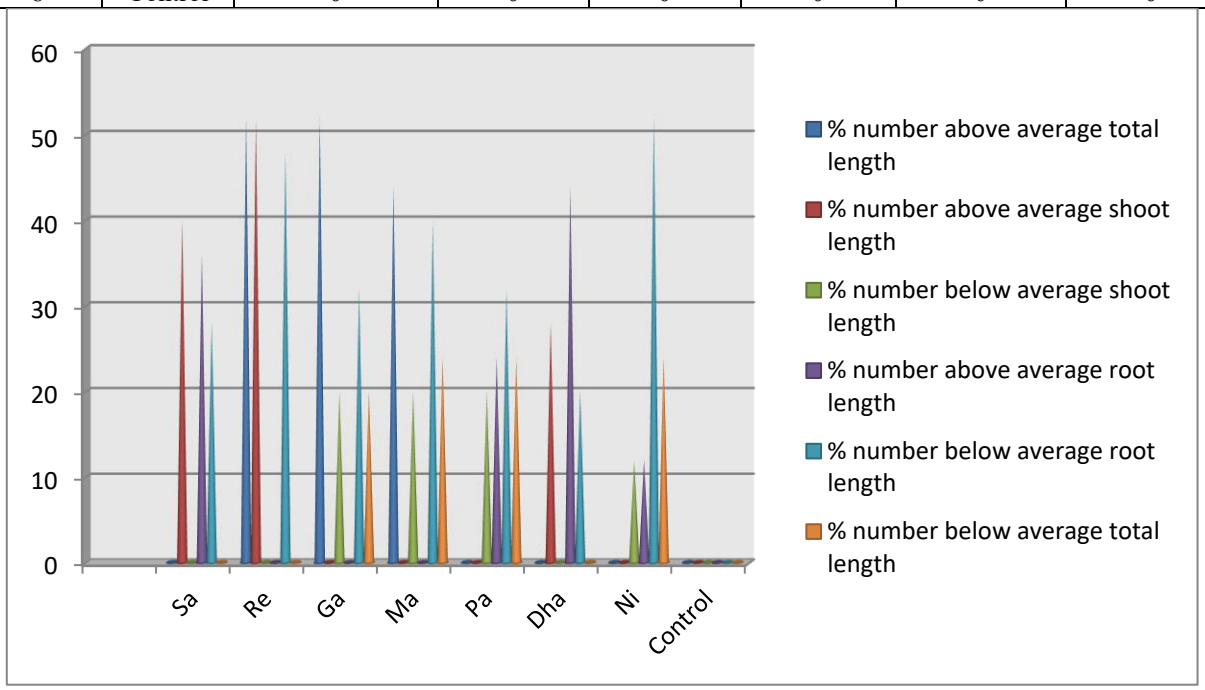

Table- 4 Graphical - % Number above / below root-shoot length

(Table -5) In *'Re'* treated samples 90.9% individuals found alive till the end of experiment, whereas only 45.45% individuals found alive till the end of experiment in control.

The *'Pa'* found to have 100% individuals alive till end but is having 24% less germination with respect to control, which is not feasible to agriculturist.

The control was recorded to have 45.45% post germination death. It is noted that- any *'Shuddha Swar'* treatment is better option for the higher survival of plants after germination. *'Re'* suited the most with 90.9 % post germination survival in *Triticum aestivum* L. Music, sound and healing energy have a significant impact on germination of grains [15].

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It is noted that, lowest growth *'Dha'*(66.66%) recoded in '*Shuddha Swar'* treated sample is also higher than control, which proves that, any *'Shuddha Swar'* (pure Note) treatment is beneficial for the plant growth, whereas few *'Shuddha Swar'* are more beneficial for the same.

Table 5- Post germination % mortality

Sr. No.	Pure Note	% Number of individuals alive till the end of experiment	% Number of individuals died after germination
1	*'Sa'*	70.83	29.16
2	*'Re'*	90.9	9.09
3	*'Ga'*	75	25
4	*'Ma'*	70.83	29.16
5	*'Pa'*	100	0.0
6	*'Dha'*	66.66	33.33
7	*'Ni'*	76.19	23.80
8	Control	45.45	54.54

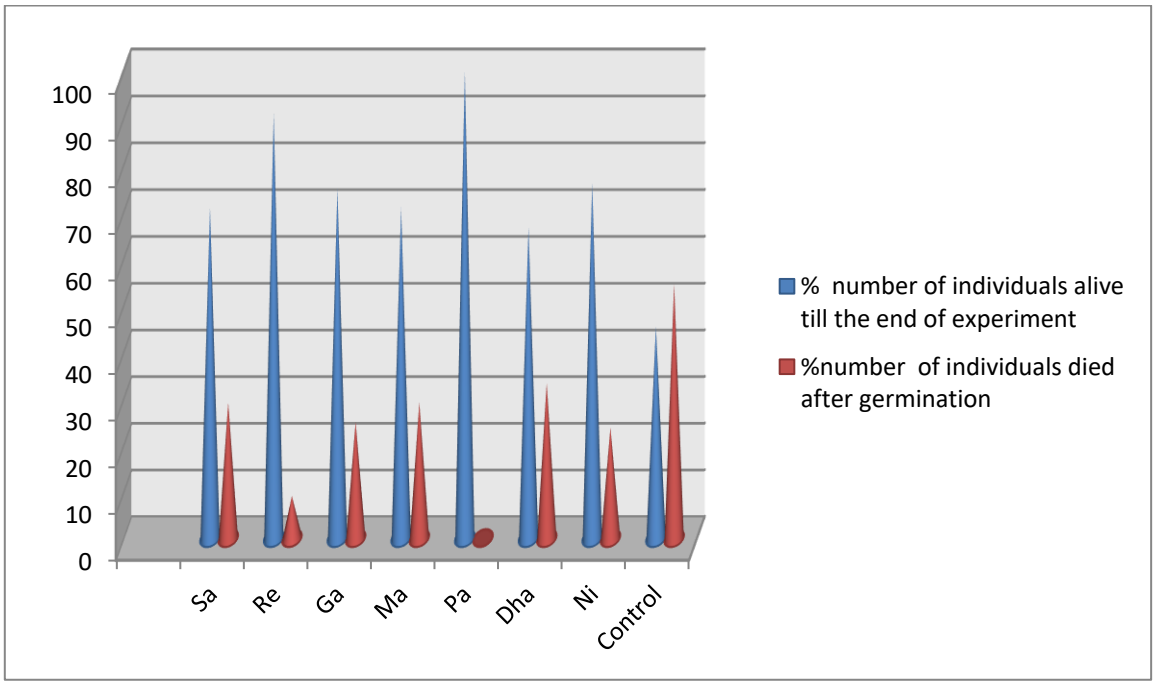

Table- 5 Graphical - Post germination % mortality

The average root length in treated samples is 16.75cm. The longest root length found in sample treated with *'Pa'* (23.6 cm) whereas shortest was in *'Ga'* (3cm). The control longest root was (18.7cm) and shortest (8.3cm.) (Table-1).

The average shoot length in treated samples was recorded 15.46cm. Highest shoot length was recorded in '*Pa*' (21.4cm) and shortest shoot length was observed in *'Dha'* (0.6cm). In control highest shoot was (20.2cm) and lowest shoot was (3.4cm) (Table-1).

Average higher root development was recorded in *'Dha'* and the average higher shoot development was also recorded in *'Sa'*. The roots of *Zea mays* were reported to bend toward sound with a frequency of 100-300 Hz among the tested frequencies of 0-900 Hz in the hydroponic system [16].

Highest post germination death (54.54%) is recorded in control. No post germination death of plants is observed in *'Pa'* treated samples but same is having lowest germination rate (64%). Post germination death (9.09%) was recorded in *'Re'* and is having (88%) germination(Table -1), which is equal to germination in control (88%) (Table-1). It reflects that, though the percentage of germination is same in '*Control*' and *'Re'* (Table -1) but the control seeds are having exactly six times more post germination death with respect to *'Re'* treated samples (Table -5).

It is observed that at least (21.21%) post germination death could be prevented with respect to control and ultimately yield could be increased by treating the sample with any *'Shuddha Swar'*.

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'Re' '*Ga*' and '*Pa*' are observed to be the best suited *'Shuddha Swar'* for *Triticum aestivum* germination and post germination growth (Table-5). Plant growth in music treated plants was better than control plants especially showing increased level of various metabolites [6]**.** QGWA-03 plant audio apparatus treated (frequency range: 100-2000Hz), tomato's yield increased by 13.2%, and its disease of grey mould decreased by 9.0% [11]. The effect of music on plants varies with species [17]**.** The music therapy grown medicinal plants can give very good health benefits [18]. Music such as rock and acid rock has negative effect on plants while classical, jazz and Indian classics are supportive for plant growth [19]**.** Musical sound regulate the synthesis of phytohormones Indole3-acetic acid and Gibberellic acid [20,24]. There is phenomenon of spontaneous sound in plants. When the frequency between external vibration and plants spontaneous sound are consistent, the resonance will occur, thus promoting plants growth [21]**.** Increased photosynthetic ability has been observed in strawberry and rice in response to sound treatment [22, 23]**.** Sound waves can decrease the requirements of chemical fertilizer and pesticide by 50% [25].

CONCLUSION

The treatment of '*Shuddha Swar'* is found to be effective to have increased germination. The farmer can prevent the post germination death by treating the crop with '*Shuddha Swar*' which in turn will enhance the crop production.

Future scope- It is observed that wheat plants are having effect of music. The same treatment could be given to various plants species to see the effect.

The need to provide costly fertilizers could be decreased and ultimately financial expenses could be reduced.

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