Effect of sources of *kusum* (*Schleichera oleosa* (Lour) Oken) seed, its size and tree attributes on seed quality and seed germination

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Summary

Kusum tree is considered to be the best lac host and is distributed throughout the country. The germination of *kusum* seeds is very much erratic. To through light on this erratic behavior, three experiments were conducted in Randomized Block Design on different aspects of seed germination and viability during 2014-18. It was found that higher seed viability test weight (61 g) and healthy seeds with lesser discolored/ infected seed per cent (40.1) were found in the year having higher rainfall (i.e. 2014 receiving 844 mm rainfall) during the growth and development period of fruits. Thus 104 mm higher rainfall could increase test weight 36 per cent and produce 47 per cent lesser infected seeds. Diurnal variation in temperature impacted quality seed production. Experimental findings also suggested that when seed weight was more than 700 mg, it performed better with higher germination per cent (13 and 46 per cent, respectively). Experimentation also suggested that better quality of *Kusum* seeds can be obtained from trees having higher ranges of tree exposure to sunshine (40-90 per cent), higher branch length (2.9-6.1 m) and several consecutive unpruned seasons (3.6-8.8).

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INTRODUCTION

Kusum tree (*Schleichera oleosa* (Lour) Oken) is much known for lac cultivation. Phloem sap of *Kusum* contains the highest essential/ non-essential amino acid ratio which could be one of the reasons for its being an excellent host plant.[23] But, besides lac cultivation, it is known for other uses also. Villagers eat the fruits and seeds are used for the extraction of industrial oils. Dhyani et al. 2015[7] emphasized that *Kusum* tree can meet the requirement of biofuel to a great extent. The tree produces good timber, which is used for making implements used for many agricultural operations. Saha et al. (2010)[17] explained elaborately different uses of *Kusum* tree including lac cultivation, industrial uses, medicinal uses and other uses. A thin-layer chromatography study revealed that it contains many coloured phytochemicals having different Rf values in different solvents. The presence of these phytochemicals particularly phenols and flavonoids could be the reason why it is used as ethnomedicines for curing many diseases.[13, 18] In Jharkhand *Kusum* trees are available with 66.6% of farmers and its utilization per cent for lac cultivation is 22.4%.[14] A *kusum* tree can produce as high as Rs 3312/- compared to Rs 163.4 and Rs 418.3 for *palas* and *ber*.[15] In general, the tree grows very slowly and moreover, the germination per cent of seed is unpredictable. It is the need of the hour to identify the reasons why the germination percentage varies in different years. There could be so many factors governing germination.[10, 19] Thapliyal & Tiwari (2011)[21] came up with the finding that *Kusum* seed germination increases up to 92 per cent when it is stored dry for two months in ambient temperature conditions compared to 15 per cent if sown during maturation. Scientists from Dehradun, India discussed that *Kusum* seeds collected from lower altitudes (250-500 m) perform the best in terms of fruit/ seed size and germination per cent. Other important factors could be rainfall pattern, summer temperature, tree size, tree spacing, pruning time, branch length, age of seed *etc* and many more. In some years fruiting behaviour is very scanty, while in others, profuse fruiting takes place. There has been a consensus among scientists that the effect of global warming is being prominent day by day.[6] Global climate change might play a significant role in influencing all these factors. It is not possible to consider all the factors while framing an experiment. Therefore, a study encompassing some common factors was framed to see the effect of site, seed size and tree attributes effecting on seed germination of *Kusum*.

Materials and Methods

The following experiments were conducted during 2014-18 to study factors responsible for the low germination per cent of *kusum*.

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a) Source of *Kusum* seed affecting germination

Kusum seeds were collected from two sources *i.e.* Jhalda, Purulia and Institute Research Farm (IRF), Namkum. Sowing was done in August 2014 and 2015 on prefilled poly tubes. The germination per cent was recorded in September. The sample was drawn randomly from both the lots of seed and different seed attributes were noted down minutely to infer the effect of year and location on seed quality. Rainfall received in the growth period in these two years was 848 mm and 744 mm, respectively. April/May months were recorded to be harsher in the case of 2015 as the difference in minimum and maximum temperatures were 15-16°C. The same values for 2014 were 12-14 °C.[3,4]

b) Effect of seed size on *Kusum* seed germination

Kusum seeds were collected from Institute Research Farm (IRF), ICAR-IINRG, Namkum. Seeds were broadly classified into two groups *i.e.* small (0.40-0.70 g) and big (0.80-1.20g). Further sowing was done on prefilled poly-tubes to study its effect on germination. Seeds of both categories were sown in August to determine how seed germination is affected due to seed size. One hundred seeds from each category (10 seeds per row X 10 rows) were taken for the study.

c) Tree attributes affecting seed quality and germination

Eleven *kusum* trees were selected in 2018 to study different tree and fruit or seed attributes to examine if any relationship exists between these attributes. Trees were selected based on some uniqueness regarding their positional status, which facilitated these plants to enjoy the different magnitude of exposure/ average shoot length/ number of un-pruned seasons as presented in Table 2. Fruits/ seed attributes including germination per cent were estimated based on a random sampling of fruits. A germination study was conducted on soil mixture (soil: sand: Farm Yard Manure: 2:1:1) filled polythene tubes. A hundred seeds were taken from each tree (10 seeds per row X 10 rows). All these experiments were conducted in Randomized Block Design. ANOVA was prepared manually with the help of MS-Excel.

Results and Discussion

Source of *kusum* seed affecting germination

Test weight and infected seed per cent data affected by the collection site is presented in Table 1. Average test weights in two different sites pooled over two years were similar *i.e.* 52.9. However, the values for the same collection in 2014 (*i.e.* 61.0) were much higher than that collected in 2015 (*i.e.* 44.80). There was a 36% increase in values, which touched the significance level.

The general growth and development period of *kusum* fruit takes place from February to July months. Higher rainfall received in 2014 during the period and lower diurnal variation in temperature during April/ May as stated in the Material and Methods section could be the reason for higher seed set and seed development in 2014. This could be the reason why the test weight of seeds collected in 2014 was much higher than that collected in 2015. Several citations are available in support of this view. Chebrolu et al. (2016)[5] discussed that heat-tolerant genotype seeds (at 36°C temperature) of soybean were having higher concentrations of anti-oxidant compounds (as compared to 28°C temperature). They also discussed that this heat-tolerant capability of seeds is attenuated by higher concentrations of ascorbate precursors, flavonoids and tocopherols which protect seeds from heat-induced ROS damage at seed maturity. It was further reported that severe seed wrinkling along with reduced germination was noticed in soybean when the temperature was raised from 28°C to 42°C.[5,8]

The percentage of discoloured/ infected seeds actually indicates the nutrition received during the growth and development period. Usually, such seeds are very low in oil percentage. Seeds collected from Purulia were found to have a lesser percentage of infected/discoloured seeds (55%). The same value for IRF collected seed was 73% in the same year. Similarly, values for the same in the years 2014 and 2015 were 40 and 87% respectively. It indicated that seeds collected in 2014 were of better quality. Similarly, seeds from Jhalda, Purulia were superior in quality.

Trees situated in the IRF is maintained under a plantation where spacing is limited (6mx6m) and pruning is done at regular interval; as a result, trees face much competition for space, light and nutrition. However, those situated in Jhalda are distributed in a much-scattered way (>50m spacing). Scattered trees receive better nutrition. This led to better growth and development of Jhalda-located trees. Similarly, seeds collected in 2014 also received better nutrition due to the high rainfall received in that year. Therefore, the discoloured/ infected seed percentage was higher in 2015.

Infected seeds were black in colour, while discoloured seeds were whitish in colour. Ideally, seed kernels are yellowish in colour due to the oil deposit. Due to poor nutrition, either due to unfavourable rainfall or lower spacing or impaired growth due to repeated pruning, adequate oil deposit did not take place in seeds. As a result, the seeds looked white. These seeds were prone to fungal/ microbial infection especially when kept in bad storage conditions. It could be the reason behind good quality seed in Jhalda condition and also in 2014.

Germination of *Kusum* seeds affected by their size.

Kusum seeds collected from IRF were screened for bold and small sizes in 2016. For the characterization of these two categories of seeds, the weight of individual seeds was measured. It was found that 48 and 52 per cent of seeds were under the small and bold categories.

Germination per cent was recorded from time to time and the final value was reported after one and a half months.

Small-sized seeds recorded a germination per cent of 13.8% and bold-seeded ones recorded 46.3% and the difference observed touched the level of significance (Fig. 1). The study suggested that seed size is a very important attribute, which should be considered with due importance. Bold seeds are usually rich in oil per cent and the cotyledons have a good storage of sugar/ starch (Fig. 2 & 3). As a result, germinating seeds can supply proper nutrition to the embryo. Small seeds cannot meet up the requirement of the growing embryo on many occasions. Therefore, higher germination per cent was recorded in the case of big-sized seeds. Very scanty references are available on this topic on *Kusum*. However, Smith et al. (2008)[20] came up with the result that larger seeds germinate more effectively than medium and smaller seeds in the case of grassy species. Adji et al. (2022)[1] confirmed similar results in the seeds of a member of the Fabaceae family. They also confirmed that such seeds could adapt to climate change better. Similar observations were reported on sandal wood[2] and *Myrtus communis*.[11]

Host tree attributes affecting seed quality and germination

Variation in seed germination per cent was examined as affected by different *kusum* host trees. The effort was also done to determine whether there is any relationship between host tree attributes and its location *i.e.* exposure of trees to sunshine, average shoot length and number of consecutive seasons without pruning operation. A perusal of the data revealed that higher values of fruit fresh weight and seed fresh weight were recorded at T2 and T8. The difference was significant (Table 2). Corresponding values of tree exposure (65-75%), average branch length (5.2-7.5m) and the number of consecutive unpruned seasons (6.2-8.8) were also higher with these trees only. The picture of trees giving lower fruit fresh weight and seed weight was quite different. Lower values of fresh fruit weight and seed weight were recorded at T3 and T10 trees and corresponding ranges of exposure, branch length and number of unpruned seasons were (40-90%), (2.9-6.1m) and (3.6-8.8) respectively. The cumulative effect of all these factors is supposed to play a role. Thus, a tree can yield inferior seeds if it receives more exposure but lesser branch length and unpruned seasons and *vice-versa*.

The phenomenon can be explained in light of the source-sink relationship. Grain yield is governed by changes in a source-sink relationship.[12] Here the exposure, branch length and several unpruned seasons act as sources and seeds may be considered as sinks. Tollenaar & Daynard (1978)[22] affirmed that the rate of accumulation of photosynthate could vary in different individuals. The reason could be attributed to kernel sink strength. It is very much clear from the study that seed weight and fruit weight increased significantly when the exposure of trees to sunshine, average branch length and the number of unpruned seasons increased. The most important character *i.e* the germination per cent is directly related to seed weight (Table 2). Similar observations were reported by many authors in other genera also.[20, 1, 2, 11] Therefore, it can be concluded that to achieve higher germination per cent of *kusum* seeds, the mother trees should maintain enough spacing by which the trees get good exposure to sunshine. Higher branch length and more unpruned seasons can ensure a higher amount of stored assimilate which can supply proper nutrition to fruits and it ultimately results in the production of seeds with satisfactory germination per cent.

Table 1: Test weight and damaged seed per cent over location and year

Factors	Test wt (g)	Discoloured/ infected seed %
Purulia	52.9	54.5
IRF	52.9	72.8
CD	1.5	6.4*
Year 2014	61.0	40.1
Year 2015	44.8	87.2
SEM±	0.62	2.59
CD (0.05)	1.5*	6.4*

*Significant at 5% level

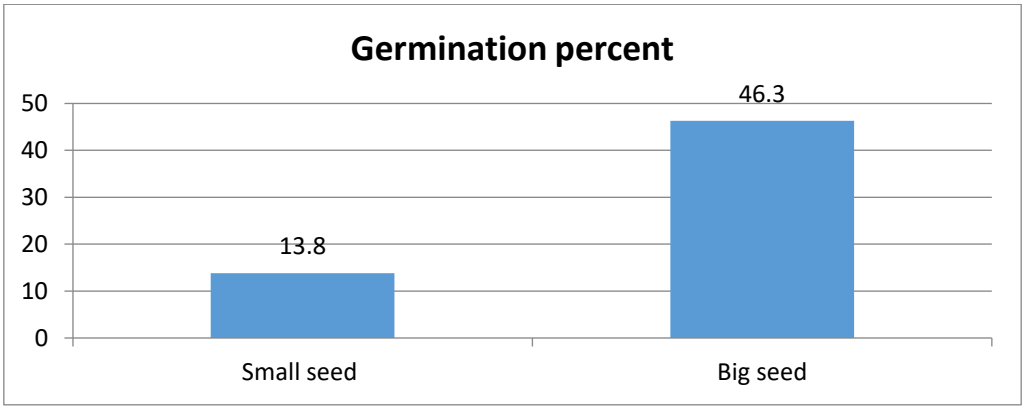

Fig 1: Germination percent of *kusum* seed affected by seed size

Table 2: Variation in different attributes of seed characters due to different tree sources of seed

Tree No	Tree exposure (%)	Av shoot length (m)	No of unpruned seasons	Fruit Fresh wt (g) 2018	Seed fresh wt (g) 2018	Germination %
T1	25	4.05	8.2	5.5	1.0	66.7
T2	65	7.5	8.8	6.1	1.1	8.3
T3	40	6.1	8.8	3.9	0.8	8.3
T4	35	4.0	6.4	4.8	1.0	41.7
T5	40	5.4	7.4	4.4	1.0	25.0
T6	60	4.05	6.6	4.9	1.0	33.3
T7	20	2.25	4	2.7	0.7	16.7
T8	75	5.25	6.2	6.0	1.3	66.7
T9	50	4.35	6.5	4.7	1.1	66.7
T10	90	2.9	3.6	4.7	0.9	58.3
T11	10	2.1	5.2	0.0	0.0	0.0
SEM±	--	--	--	0.16	0.03	13.6
CD (0.05)	--	--	--	0.39*	0.07*	31.9*
STD	24.4	1.6	1.8	1.7	0.3	24.2
Mean	46.4	4.4	6.5	4.3	0.9	39.2
CV%	52.6	37.5	26.9	39.7	37.5	61.9

*Significant at 5% level

Fig. 2: Good quality seeds rich in oil

Fig. 3: Poor quality seed produced in adverse climate

Conclusion

It can be concluded that higher rainfall received during Feb-July could produce better seeds with higher germination. The year when diurnal temperature variation in April/ May was 12-14°C, seed test weight was found to be 36 percent higher than that when the variation was 15-16°C in same months. Bold seeds with more than 700 mg weight were actually suitable for good germination. Suitable trees for seed production should have 40-90 percent exposure to sunshine and longer branches (2.9-6.1 m).

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Declaration of interests
The authors have no conflict of interest to declare.

Data sharing
All relevant data are within the manuscript.

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