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Biannual Seed Yield, Viability and Germination in *Commiphora wightii* (Arnott) Bhandari

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Abstract: *Commiphora wightii* is an important medicinal tree of arid and semi-arid regions of India. It is commonly known as Guggal and belongs to family Burseraceae. The slow growing poor viable seed producer plant, moreover, excessive destructive tapping for oleogum resin (known as guggul) put this plant under critically endangered categories by IUCN. This plant produces two types of seeds viz. black highly viable seed and white non-viable seeds. Therefore, Present study was carried out with the aim to estimate seed production in summer and winter and their viability ratios (Black: White) which will be helpful in raising nursery and large-scale plantation of Guggul. The mature seeds were collected from 647 guggal plants (10 years old) from Deesa, Gujarat, India in summer (March–July, 2017) and winter (November–December, 2017). There is no significant difference in percentage of plants bearing mature seeds but number of mature seeds per seed producing plant was significantly higher in winter (72.51 seeds) as compared with summer (10.19 seeds). The proportion of black seed in summer and winter was almost opposite i.e. in winter 70.9% seeds were black whereas in summer only 30% black seeds were found. Seed germination data revealed that black seeds collected in winter showed higher seed germination (13.6%) than summer (2.1%). No germination was recorded in summer collected white seeds whereas very low seed germination was observed in winter (1.2%) white seeds.

Keywords: apomixis; viable black seed; guggal; dioecious plant

1. Introduction

Commiphora wightii is slow growing, endangered, medicinally important plant and commonly known as Guggal. It is a perennial, dioecious and small to medium size thorny plant belongs to family Burseraceae. The population is dominated by female with extremely rare male and hermaphrodite plants. In the scarcity of male plants, it produces seeds through apomixis [1,2]. The plant remains leafless most of time. Leaves are present only in rainy season which are small, sessile with irregularly toothed edges and aromatic in nature [3]. The flowers are small and red in colour. The fruits are oval in shape, pulpy in nature, green when immature, pinkish when partially mature and become red at maturity [4]. It is mainly distributed in arid and semi-arid area of Rajasthan and Gujarat, and also occur in some areas of Pakistan and Bangladesh [5]. Plant is valued for oleogum resin exudate produced from its bark, known as guggul. It has been used in Ayurvedic medicine to treat arthritis Inflammation, hypercholesterolemia, cardiovascular diseases, cancerous diseases and to improve hepatic antioxidant defense system [6,7].

This plant is categorized as critically endangered in IUCN [8] due to excessive destructive harvesting to obtain oleogum resin, poor regeneration and seed germination. Previous literature on guggal seeds reported that these seeds are apomictic [2], black and white seeds with significantly

different seed viability [9]. Because of above reason raising nursery and plantation is serious problem for forest department and developing agrotechniques for domestication of this species. The flowering and fruiting are highly asynchronous in this plant [10]. Earlier, Prakash at el. [11] collected *C. wightii* seeds in February-March and calculated seed weight, seed viability, seed germination percentage and percentage of polyembryony. In 2014, [10] reported two peaks for both flowering and fruiting intensity in *C. wightii*. But they included both mature and immature seeds in their study and results were based on relative score. Present studies were carried out on actual seed yield (mature seeds only) with an aim to compare seed production in summer and winter along with black and white seed ratio and their germination. This study is essential to develop any agro and nursery techniques.

2. Materials and Methods

Surveys were carried out in different guggal growing areas. The ten years old four plantation, having 647 plants from Ranpur Forest nursery, Datiwada (Deesa, Gujarat), India were selected for seed collection being well protected and maintained. It is situated between 24°17′ N (Latitude) and 72°12′ E (Longitude). The spacing between plants were 3 × 3 meter in all four fields.

Mature red fruits and seeds without epicarp and mesocarp from individual plant were collected from four fields at Deesa, Gujarat. Seeds from individual plant were kept in separate brown paper bag and maintain their identity by marking plant number. These fruits were de-pulped by manually rubbing in cloth and washed with fresh water then dried in shade.

Guggal seeds were collected from Deesa, Gujarat in in summer (March–July, 2017) and winter (November–December, 2017). Pooled seed data of March, May and July (summer) and November and December (winter) were used to estimate the seed yield, average number of mature seeds per plant.

Seed ratio and seed weight in summer (July, 2017) and winter (November–December, 2017) were calculated by counting the black and white seeds of each plant and then weighed them. Seed weight (1000 seed) is calculated by following method: -

(Total seed weight of all the seeds of a plant/number of seed in that plant) × 1000

Total 3000 Seeds (1500 black and 1500 white seeds) collected in summer and 25738 seeds (19816 black and 5922 white seeds) collected in winter were sown in root trainer filled with fine sand, coarse sand and compost in 3:2:1 ratio in March month which were kept in polyhouse condition (35.9 ± 0.12 °C temperature and 53.8 ± 0.24% humidity) of AFRI. The germination medium was kept moist with regular watering or misting. Criteria for germination was emergence of plumule above the germination medium. Seed germination was recorded after four weeks.

3. Results

3.1. Total Mature Seed Production

The percentage of plants bearing mature seeds is not much varied in summer (50.6%) and winter (53.0%). However, the intensity of seed production per seed producing plant was greatly influenced by the season (Figure 1). Number of seeds per seed producing plant was higher in winter (72.5 seeds) as compared with summer (10.2 seeds). In winter, higher average number of seeds per seed producing plant was observed in field ‘C’ (105.3 seed) and lowest in field ‘D’ (13.9 seeds).

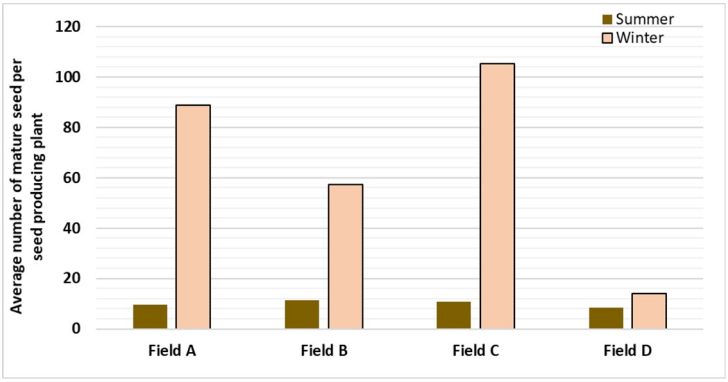

Figure 1. Effect of season on mature seed yield in C. wightii.

3.2. Black and White Seed ratio and Seed Weight

The ratio of black and white seeds changed with season. In summer, guggal plant produced more white seeds (70%) than black seeds (30%) whereas in winter black seed (70.9%) was higher than white seed (29.1%). The black and white seed ratio in summer and winter was almost opposite in all four fields (Figure 2). It appears that higher tempearture is not favourable for seed maturity and viability as well.

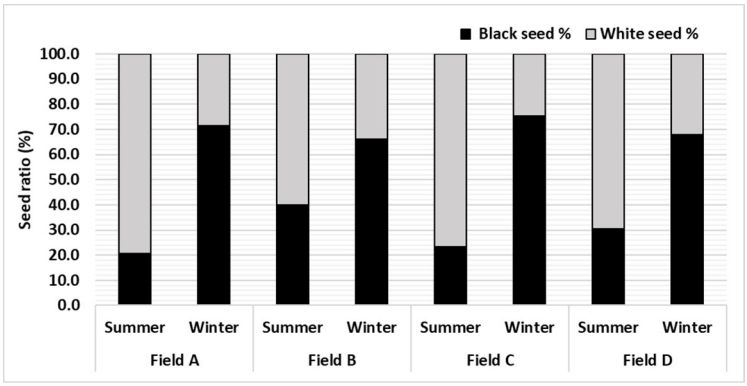

Figure 2. Effect of season on seed ratio in four fields of C. wightii.

Comparison of black and white seed weight in summer and winter showed that black seed weight was almost similar both in summer and winter (39.6 and 40.0, respectively) but higher than white seed weight (summer 25.8 g and winter 26.1 g,). Black seed weight was highest in field C (43.5 gm) whereas in winter higher black seed weight was found in field D (42.87 gm; Figure 3).

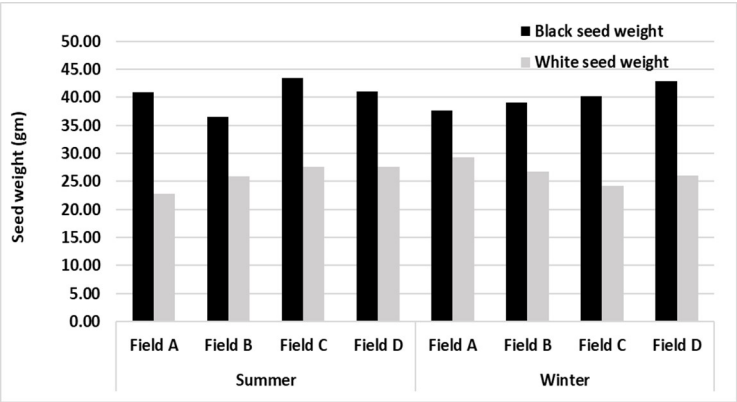

Figure 3. Effect of season on seed weight in four fields of C. wightii.

3.3. Seed Germination

Overall germination (about 1%) was very poor in the summer collected seeds. In summer black seed germination percentage was 2.1% and white seeds failed to germinate (zero percent). Whereas, winter collected black seeds germination was relatively higher (13.6%) and few white seeds also germinated (1.2%; Figure 4). The amount of total mature seed collected in winter was almost seven times higher as compared with summer.

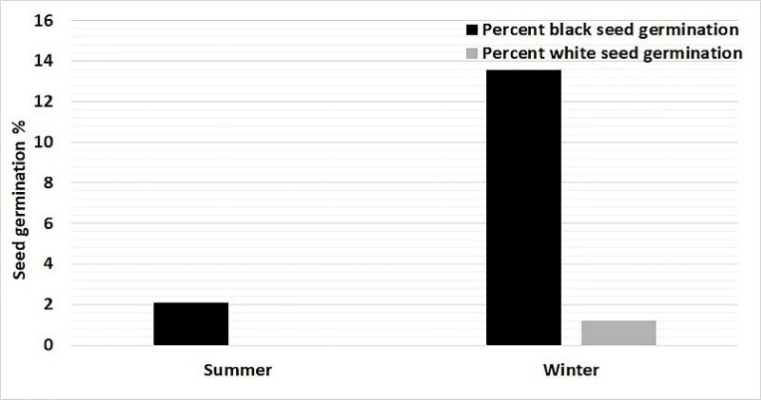

Figure 4. Effect of season on seed germination of *C. wightii.*

4. Discussion

Seed maturation and viability is influence by several environmental factors as well as by species genetic structure. In 2005, [12] reported effect of higher temperature and lower relative humidity causes lower seed yield in *Helianthus annuus*. Prasad et al. [13] investigated that higher temperature in *Sorghum bicolor* resulted in low seed set and seed yield. Similarly, we found that higher temperature in summer greatly influence total mature seed yield in *C. wightii*. In summer, lower availability of water and nutrient caused lower conversion of flowers to mature fruits. Whereas temperature during October to December is ideal for ripening of fruits in *C. wightii*. Earlier, Singhal et al. [10] reported that maximum flowering and fruiting intensity in *C. wightii* in April and May months, respectively. In their study they have considered all fruits (mature red and immature green). They have also reported smaller peak of fruits intensity in winter. They have not studied the fully mature fruit yield. It may be possible that immature seeds remain attached with plants and require longer period (four to six months) for seed maturation which results in higher mature seed yield in winter.

Time of seed maturation affect the germination efficiency in *Portulaca oleracea* [14], *Prosopis juliflora* [15]. Similarly, germination of *C. wightii* seeds also affected by time of seed maturation. The high temperature during seed maturation cause seed dormancy in Soya bean [16] and *Thlaspi arvense* [17]. In *Portulaca oleracea* [14] and *Arabidopsis thaliana* [18], exposure of mother plant to short day during seed development and maturation reported to increase in seed germination. According to Evenari et al. [19] the higher germination in seed mature under shorter day than long day mature seed was due to their greater ability to imbibe water during germination. Similarly, in our case both low temperature and short day are characteristic of winter season which may be the main reason behind high seed germination in winter matured seeds.

In the present work it was found that the ratio of black and white seeds was greatly influenced by the season. Winter season supported more viable black seed production. Miralles et al. [20] reported that high temperature and low relative humidity had adverse effect on pollen viability and pollen quality which resulted in empty and sterile achenes (seeds). This could be another reason in case of *C. wightii* also. Seed weight denotes the presence of mature embryo inside the seed coat. Higher the seed weight means fully developed embryo and light seed weight means deteriorate embryo or empty seed. In present study, black seeds have higher seed weight both in summer and winter as compared with white seeds.

5. Conclusions

Winter is the right harvesting time for guggal seeds. Seed screening is necessary to remove white seed and seeds having low seed weight. This study is useful to stakeholders who are interested in raising large scale plants of Guggul through seeds.

Author Contributions: U.K.T. conceived and designed the experiments; M.C. and S.B. performed the experiments and wrote the paper; M.C. and U.K.T. analyzed the data; U.K.T. edited and finalized the manuscript for submission. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest: "The authors declare no conflict of interest."

Abbreviations

The following abbreviations are used in this manuscript:
IUCN International Union for Conservation of Nature
AFRI Arid Forest Research Institute

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