The impact of the climate change of the seed resources

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Abstract

Mongolia is located at the central part of Eurasia, landlocked, located far from oceans, surrounded by high mountain ranges with average altitude is 1500 m a.s.l. and due to these specific conditions, Mongolia has extreme terrestrial, harsh climate. Main peculiarities of Mongolian climate is the large seasonal and diurnal fluctuations, especially of the air temperature, less precipitation and strong effects of altitude and latitude. Dry and short summer continues June-August, cold winter continues November-April, and the duration of fall and spring season fluctuates year to year.

Total amount of the precipitation is less and the amount of precipitation differs by regions and are not same due to location of mountains and altitude. For instance, regions of Khangai, Khuvsgul, and Khentii has biggest rivers along these mountain ranges amount of annual precipitation varies between 250-390 mm, in Altai mountain range varies 90-130 mm and steppe and plain areas accounts as180-280 mm.The amount of precipitation decreases as southward and the smallest amount of precipitation (70-150 mm) accounts for Gobi desert region (Division of Climate change and resource of Institute of Meteorology, Environment and Hydrology, 2017). This extreme climate condition of Mongolia shows large impacts on the flowering, seed ripening, and seed yields of woody plants.

Keywords: seed stands, larch, pine, seed, germination, weight of 1000 seeds

Introduction

A total forest resource in Mongolia is estimated to 1245.4 million.m3 and which includes larch (78.5%), Scotch pine (4.9%), pine Siberian cedar (9.4%), spruce (0.23%), fir (0.02%), birch (6.17%), aspen (0.18%), poplar (0.05%), elm (0.007%), willow (0.27%), populous diversifolia (0.002%) and Saxaul (0.14%) forests (MNE, 2017).

Forest resources in Mongolia have been continuously degraded over the past few years due to improper exploitation for timber and fuel wood, forest and step fires (Tsogtbaatar, 2004), insects/pests and diseases, mining, uncontrolled grazing, and inadequate management. During last decades, Mongolia lost approximately 4 million ha of forests, averaging to 40 000 ha annually. But between 1990 and 2000, the rate of deforestation has increased to 60,000 ha/year. As a result of ongoing loss and degradation, only 13 million ha of closed canopy forests remained in relatively remote area. Much of the other 5.3 million ha of forests are fragmented and degraded (World Bank, 2002)

Reforestation activity in Mongolia has been started since 1968. During 1980 to 2000, reforestation was carried out in 72.132 ha areas, 50% of which was replanted by seedlings. Although some positive results have been shown, fires, disease infection and grazing by the livestock have caused damage to some of the planted areas. Up to year 2002, an area of about 98,000 ha has been reforested (MNE, 2000, 2002, 2006). Reforestation success was very low, and survival rate of planted seedlings ranged from 30 to 60% (seldom reaching 50%). Consequently, the total area that has been successfully replanted represented only 5% of the total forest lost, mostly due to low survival rates of the seedlings (World Bank, 2002).

Success of plantation and reforestation depends on many factors, including seed and seedling quality, site-species compatibility, and appropriate silvicultural practices (Udval., Batkhuu, 2013). Seed quality plays a major role in the production of high quality plants. Many factors, climate, both biological and environmental, influence the quality of seed produced by a given tree under natural conditions.

The main objectives of this study are 1) to determine seed quality of diverse seed stands, 2) to study climate impact on seed yield and seed quality.

Study area and data sources

The locations of fourteen different populations of *P. sylvestris* in the three northern provinces namely, Khentii, Khuvsgul, and Selenge, Mongolia listed in Table 1. Four popuations from Khentii, 8 populations from Selenge, one population from Khuvsgul provinces were selected for this study.

Table 1. Description of populations used in this study

№	Provinces	Soum name	Population name	Latitude	Longitude	Altitude, m
1	Khentii	Binder	Uvur-huurt	N48^{0}38’18.0”	E110^0 25’ 33,7”	1198
2	Khentii	Binder	Yangiin Ar	N48^{0}38’41.5”	E110^0 28’ 38,0”	1084
3	Khentii	Dadal	Shanagan tolgoi	N48^{0}57'14.6"	E111^0 37' 04,0"	1064

4	Khentii	Norovlin	Dev nars	N48^{0}44’09.9”	E111^0 30’ 08,6”	957
5	Selenge	Selenge	Gun nuur	N50^{0}15'36.5"	N106^{0}38'11"	671
6	Selenge	Selenge	Togos uul	N50^{0}03'12.6"	E106^{0}35'06.5"	773
7	Selenge	Javhkhlant	Yargait	N49.41	106.41	706
8	Selenge	Bugant	Ikh ulunt	N49^{0}25'17.0"	E107^{0}20'44.7"	882
9	Selenge	Altanbulag	Tsaram	N50^{0}05'69.5"	E106^{0}05'69.5"	761
10	Selenge	Selenge	Khuder	N49^{0}46'28.3"	E107^{0}13'57.9"	893
11	Selenge	Shariin gol	Monostoi			
12	Selenge	Khond	Mukhar Dukhum	N50^{0}11'17.2"	E106^{0}37'30.2"	701
13	Khuvsgul	Khuvsgul	Tsagaan nuur			

Methodology

Methodology developed by N. P. Anuchin (2004) is used for the establishment of sample plots and measurements of tree growth parameters.

Collection of cones was carried out at the of March, 2018. Thirty (30) representative trees of the approximately with same age from the natural populations of *P. sylvestris* were subjected to cone collection and selected trees were located minimum 50 m apart and thirty cones with three replications were collected per individual tree (in total 900 cones). The variation in cone, seed and seed quality characteristics were measured.

Laboratory tests of seed quality were conducted by the International Rules for seed Testing (ISTA, 1999). Seeds were examined for their qualities by purity, weight of 1000 seeds, germination test. Laboratory tests of seed traits were conducted by the Seed Testing Laboratory of the Ministry of Nature and Environment of Mongolia.

The parameters were analyzed by One-way analysis of variance (ANOVA) followed by Duncan’s multiple range test.

Results and discussion

Results of studies conducted in Khuvsgul, Khentii and Selenge aimags where we are evaluated of seed yield and forecasting using classification by A.A.Korchagin. The results showed that the Siberian larch forests scored 0, which means they didn’t have seed yield for 2017 growing season. Multiple factors affect seed yield, including, climatatic condition during flowering, pollination, seed ripening, moisture condition of the vegetation period, soil fertility, age of the trees, and growth condition of the stand etc.

Table 1. Evaluation of seed yield for the Scots pine (Pinus sylvestris L) seed stand

№	Province	Tree species	Seed yield score
1	Selenge province	*Pinus sylvesris* L.	3/medium
2	Khentii province	*Pinus sylvesris* L.	2/low
3	Khovsgol province	*Pinus sylvesris* L.	2/low

Evaluation results of seed yields for Scotch pine seed stands shows seed yield score between 2 and 3, which means expecting medium amount of seed yield for 2017. In the Scotch pine plantations, trees have lagged growth, high loss of biomass in the crown, and loss of needles due to lack of silvicultural treatment activities. Also trees have reached the age to produce flowers, pollinate and produce seeds, however no seed production is observed. One-way-factoral analysis of variance (ANOVA) was carried out to test seed yield in the stands, and it showed statistically significant (*p=0.001*) different seed yield amongst the stands.

Seed morphological characteristics. Seed morphological traits such as seed length (*SL*), seed width (*SW*), seed wing length (*SWL*), seed wing width (*SWW*), and seed wing area (*SWA*) among provinces and populations.

Table 2. ANOVA for seed morphological characteristics of studied provinces of *P. sylvestris* (n=900)

Source	DF	*SL*, mm	*SW*, mm	*SWL*, mm	*SWW*, mm	*SWA*,
Province	2	5.86**	0.72ns	18.22***	87.38***	44.24***
Seed stands	12	3.16***	1.15ns	22.22***	23.94***	27.42***

Table 3. ANOVA for seed morphological characteristics of studied populations of *P. sylvestris* (n=900)

Province	SL, мм	SW, мм	SWL, мм	SWW, мм	SWA,	Rank
Khentii	4.57a	2.58b	14.56a	5.38b	79.06a	II
Selenge	4.61a	2.76a	14.57a	5.64a	82.51a	I
Khovsgol	3.98b	2.34c	11.96b	4.62c	55.97b	III

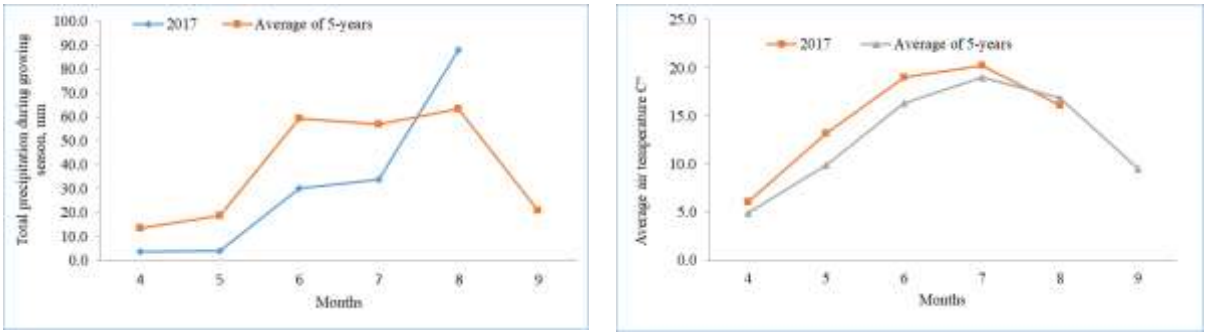
The average seed length and seed width were 4.54±0.04 mm, 2.86±0.19 mm, longer seeds (4.61±0.02 mm) was observed in from Khentii province, while shorter seeds (3.98±0.04 mm) were originated from Khuvsgul province. In case of variation at the population level, Dadal-Shanagan population had longer seeds (5.01±0.51 mm) and population of Javhglant-Yargait had wider seeds (2.91±0.04 mm), while shorter and narrow cones (3.98±0.04 mm and 2.34±0.02 mm) were originated from Tagaan-Uul population, Khuvsgul province.

Seed germination characteristics. Seed quality testing, including germination energy (*GE*, %), germination capacity (GC, %), and 1000-seed weight was examined by the State Forest Seed Testing Laboratory, Ministry of Environment and Tourism, Mongolia and Laboratory of Forest Genetics and Ecophysiology, National University of Mongolia.

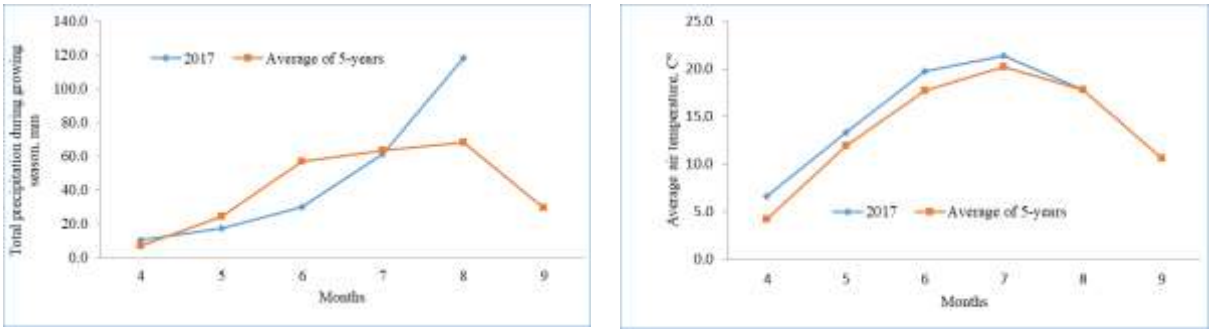
Table 4. Seed quality

No	Provinces	Population	Seed germination energy, %	Seed germination capacity, %	1000-seed weight, gr	Seed quality category
1	Khentii, Binder	Ovor khuurt	74.0	74.8	5.2	III
2	Khentii, Binder	Yangiin ar	80.8	81.0	5.4	II
3	Khentii, Dadal	Shanagan tolgoi	50.5	51.0	5.3	NS
6	Khentii, Norovlin	Dev nars	66.3	69.0	6.2	III
4	Selenge, Altanbulag	Gun nuur	78.5	79.8	6.9	III
5	Selenge, Altanbulag	Togos uul	76.3	76.5	7.1	III
8	Selenge, Altanbulag	Yrgait	-	-	-	-
9	Selenge Bugant	Ikh Olont	70.5	71.5	5.6	III
11	Selenge, Altanbulag	Tsaram	69.0	70.0	6.1	III
12	Selenge, Khuder	Dohom	57.8	59.5	4.6	NS
13	Selenge, Shariin gol	Monostoi	74.8	78.3	6.6	III
14	Selenge, Khond	Mukhar tohom	54.0	55.5	5.7	NS
15	Khovosgol, Tsagaan Uur	Ongonii nars	-	-	-	
Average			**68.41**	**69.65**	**5.88**	

The overall mean germination capacity (*GE*) and germination energy (*GC*) were 68% (varied from 20% to 81%) and 69% (varied from 51% to 81%), respectively. Highest germination value was shown by population Yangiin Ar, Khentii province (*GE*=80.8% and GC=81%). Whereas lowest germination value (*GE*=50.5% and GC=51%0) was revealed by population Dadal-Shanagan tolgoi. The mean weight of 1,000 seeds was 5.88 g (Figure 14). The heaviest seed (7.1 g) was found in population Togos Uul, Selenge prvince and the lightest one (4.6 g) was in population Khuder, same from Selenge province.

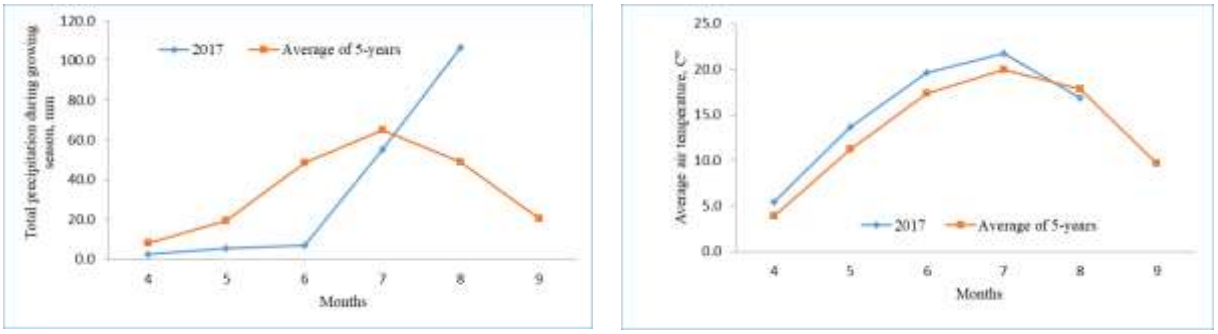


Graphic 1. According to data of 2017 provided by Murun meteorological station in Khuvsgul aimag, total precipitation during vegetation period has reduced by 15mm in May, and29.3 mm in June, and average air temperature increased by3.3^{0}in May, and 2.7^0 in June.



Graphic 2. According to data for 2017 provided by Sukhbaatar meteorological station in Selenge aimag, total precipitation

during vegetation period has reduced by 7.3mm in May, and26.9 mm in June, and average air temperature increased by1.4^{0}in May, and 2.0^0 in June.



Graphic 3. According to data for 2017 provided by Undurhaan meteorological station in Khentii aimag, total precipitation during vegetation period has reduced by 13.7 mm in May, and 41.6 mm in June, and average air temperature increased by 2.4^{0}in May, and 2.3^0 in June.

**Source: Agency of meteorology and environmental monitoring*

Total precipitation and air temperature during of 2017 vegetation period of three provinces were compared to 5-year annual average values and comparative results showed that air temperature was higher and precipitation was lower and occurred drought in springs season in 2017 compared to multi-year average (Graphics 1-3). During late May and early June when Siberian larch produces flowers, the precipitation was low and air temperature was high, therefore, due to dry condition Siberian larch trees did not yield seeds for 2017 in all provinces.

Conclusion

1. There is a strong correlation between weather condition at given year and flowering, germinating process of pine seed. According to the study findings, high altitude temperature and lower annual precipitation than the long-term average in the study field have had negative influence on seed yield.

2. We observed slow decreasing tendency of seed quality indicators, growth process and the mean weight of 1000 seeds due to climate change and other environmental factors.

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Research results on flowering and production of seeds Scotch pine shows that maximum production of flowering occurs in 30 days starting from late May through early June, and seeds ripen after 18 months starting in late February and early March of the following year (Bazarsad, 1996; Udval, 2014). Evaluation of seed yield forecasting and evaluation of seed crop was conducted in each provinces and shown in the following Table 5.

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