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Exploration Collection and Conservation of Local Maize Germplasm of Nagaland

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ABSTRACT

An exploration and collection of local maize germplasm was conducted in different district of Nagaland and a total of 38 maize accessions were collected, evaluated and conserved for documentation. The samples were in the form of maize kernels and seeds with various colour and size. Keeping these things in view field experiment was carried out during the *kharif* and *rabi* season of 2013-2015 to evaluate the yield potential of the local collected maize germplasm. Results revealed that the all the landraces collected differed significantly from each other in yield attributes and yield parameters. In terms of grain yield, the maximum yield was recorded with maize line Merangkong local-1 (5688.8 kg ha^{-1}) and the minimum with Lampongonglak (1422.22 kg ha^{-1}). Similarly, maize germplasm *i.e.* Merangkong local-1 (8988.45 kg ha^{-1}) recorded the highest stover yield while the Lampongonglak (2247 kg ha^{-1}) recorded the lowest stover yield.

1. Introduction

The North East region has its own unique combination of living species, habitats and ecosystems, which together make up its diversity rich resource. While speaking strictly about the plant diversity, two regions of the country are termed as hot spots *i.e.* Western Ghat and North Eastern Hill Region, in which Nagaland is one of the hot spot for biodiversity. Maize (*Zea mays* L.) is one of the most important crops in the world, being one of the main sources of human food, animal feed and raw material for some industrial processes, but is also model genetic organism with immense genetic diversity. Furthermore, maize is a significant model plant for scientific community to study the phenomena such as hybrid vigour, genome evolution and many other important biological processes. It is currently produced on nearly 100 m ha in 125 developing countries and among the three most widely grown crops in 75 of those countries (FAOSTAT, 2010).

It is expected that demand for maize in the developing world will double by 2025. The maize production is expected to be the highest globally, especially in developing countries (Rosegrant *et al.,* 2009). Yet, the maize yield in many developing countries is severely limited by an array of abiotic and biotic stresses besides other factors. The diversity of several important crops including maize spread across the world is threatened by rapid urbanization and habitat erosion as well as unpredictable and extreme climatic event including increasing frequency of drought, heat and flooding. The concerted and intensive effort are required to develop the climate-change-resilient maize cultivars, while accelerating yield without which the outcome will be hunger and food insecurity for millions of poor consumers of maize. Maize landraces are genetically heterogeneous populations and typically selected by the farmers for better adaptation to the specific environment, prolificacy, flowering behaviour, yield, nutritive value and resistance to the biotic and abiotic stresses.

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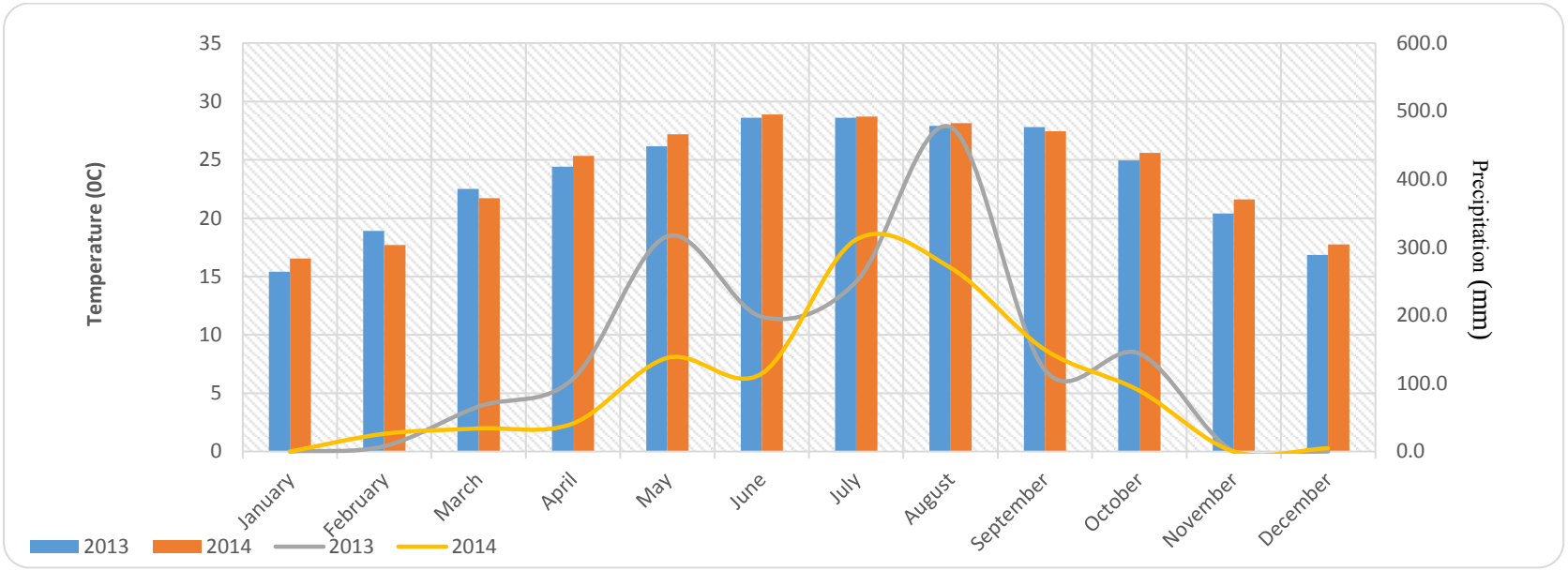
Table 1. Details of maize germplasm collected

Lines name	Village	District	Farmer's name	Altitude	Latitude	Longitude
Onglakemii local	Hupkang	Longleng	ChinglongPhom	1202	N26º28.516	E94 º 49.261
Lampongonglak local	Hupkang	Longleng	AmeiPhom	1212	N26º28.516	E94 º 49.261
Nyakmakonglak local	Hupkang	Longleng	ManjaiPhom	1223	N26º28.516	E94 º 49.261
Cheloonglak local	Hupkang	Longleng	LakhleiPhom	1208	N26º28.516	E94 º 49.261
Hupkang local	Hupkang	Longleng	EnyüPhom	1218	N26º28.516	E94 º 49.261
Jharnapani local	Jharanapani	Dimapur	Ajano	290 m	N25º45.240	E93 º 50.260
Razaphema local	Ruzaphema	Dimapur	Theja	156 m	N25º60.0	E93 º 20.
Wokha local	Wokha Village	Wokha	Shanchobeni	1113	N26º60.0	E94 º 16. 0
Kemenya local	Wokha Village	Wokha	Mhathung	1113	N26º60.0	E94 º 16. 0
Theruyie local	Wokha Village	Wokha	Senjumo	1113	N26º60.0	E94 º 16. 0
Mopungchukit local-1	Mopungchukiet	Mokokchung	Narola	1180 m	N 26^{0}39.319'	E 094^{0}39.125'
Mopungchukit local-3	Mopungchukiet	Mokokchung	Sungtinaro	1185 m	N 26^{0}36.310'	E 094^{0}26.114'
Mopungchukit local-4	Mopungchukiet	Mokokchung	Chubatemsu	1180 m	N26^{0}36.319'	E094^{0}39.125'
Khensa local-1	Khensa	Mokokchung	Bendangtemjen	1195 m	N26^{0}20.540'	E094^{0}29.791'
Khensa local-2	Khensa	Mokokchung	Sashi	1189 m	N26^{0}26.536'	E094^{0}28.783'
Khensa local-3	Khensa	Mokokchung	Nuksung	1190 m	N26^{0}24.540'	E094^{0}24.788'
Khensa local-4	Khensa	Mokokchung	Rongsen	1195 m	N26^{0}20.540'	E094^{0}29.791'
Tuli local-1	Tuli	Mokokchung	Maongla	221 m	N 26^{0}39.317'	E 094^{0}39.126'
Tuli local-2	Tuli	Mokokchung	Sosang	220 m	N 26^{0}39.310'	E 094^{0}38.129'
Mongsenyimti local	Mongsenyimti	Mokokchung	Nungshichizung	1190 m	N 26^{0}25.090'	E 94^{0}37.104'
Meyimenti local	Mongsenyimti	Mokokchung	Mentina	1195 m	N26^{0}20.098'	E094^{0}37.191'
Mapokmenti local	Mongsenyimti	Mokokchung	Mokokla	1195 m	N26^{0}20.040'	E094^{0}29.194'
Ungma local-1	Ungma	Mokokchung	Lendina	1217 m	N 26^{0}20.542'	E 094^{0}29.783'
Ungma local-2	Ungma	Mokokchung	Meren	1220 m	N26^{0}20.540'	E094^{0}29.791'
Akhoya local	Akhoya	Mokokchung	Talisenla	874 m	N26^{0}30.862'	E094^{0}40.556'
Longsa local-1	Longsa	Mokokchung	Meyilepden	1195 m	N26^{0}20.538'	E094^{0}26.781'

Longsa local-2	Longsa	Mokokchung	Apok	1190 m	N26^{0}20.528’	E094^{0}29.791’
Longsa local-3	Longsa	Mokokchung	Saku	1190 m	N26^{0}20.528’	E094^{0}29.791’
Longsa local-4	Longsa	Mokokchung	Arensenla	1192 m	N26^{0}20.540’	E094^{0}29.780’
Longsa local-5	Longsa	Mokokchung	Sentinaro	1193 m	N26^{0}20.520’	E094^{0}29.788’
Longchang local	Longchang	Mokokchung	Anungla	1195 m	N26^{0}20.540’	E094^{0}29.791’
Sungratsu local	Sungratsu	Mokokchung	Temjenmongba	1003 m	N 26^{0}23.687’	E 094^{0}33.540’
Merangkong local-1	Merangkong	Mokokchung	Olem	720 m	N 26^{0}33.483’	E 094^{0}39.424’
Merangkong local-2	Merangkong	Mokokchung	Imti	710 m	N26^{0}35. 444’	E094^{0}36.791’
Merangkong local-3	Merangkong	Mokokchung	Soalemba	700 m	N26^{0}20.540’	E094^{0}29.791’
Changki local	Changki	Mokokchung	Adangla	842 m	N26^{0}23.687’	E094^{0}33.540’
Rubber menti	Yisemyong	Mokokchung	Benjongwati	1075 m	N26^{0}23.258’	E094^{0}35.439’
Chubayimkum local	Chubayimkum	Mokokchung	Tiaienla	672 m	N 26019.837’	E 094^{0}33.331’

Figure 1. Meteorological data during the crop growing season



2. Materials and Methods

A systematic survey had been conducted during the 2013-2015 to collect the indigenous maize germplasm from different district of Nagaland. A team of expert comprising of scientist, technical officers and SRF went for the exploration programme. The team discussed with local agricultural officers and KVKs and identified important maize growing regions in the states. The team surveyed door to door and *jhum* fields for collecting the local maize germplasm. The details of germplasm collected from different places are mentioned below in Table 1. A maize landrace is mostly defined by the farmer in terms of ear characteristics; the ear type is maintained by farmers through conservative selection in spite of considerable gene flow (Louette and Smale 2000). The genetic resources, including landraces (farmer varieties) and wild relatives of crops are crucial to the global food security. Therefore, the ICAR RC for NEH Region Nagaland Centre Jharnapani, Medziphema has been undertaken exploration and collection of maize germplasm in different parts of the state under the NICRA project. A total of 38 germplasm of maize were collected from Dimapur, Wokha, Longleng and Mokokchung and farmers field. The sole objective of experiment was to document the morphological characterization and evaluation of collected accessions so as to identify the best available local maize germplasm that can adapt to the moisture stress conditions as well as to standardize the suitable high yielding germplasm for maize cultivation in the states. About 250-300 g maize seeds/2-4 cobs were collected for each sample available, tagged and packaged separately. The collection sites coordinates using Global Positioning System (GPS) and each accession were properly dried, cleaned and dispatched as voucher sample in medium term storage for future references. The other relevant information was gathered including town/state, collection site/collection centre, longitude, altitude, sample name as well as farmer's name. A set of the collected accessions were grown during *kharif* and *rabi* season of 2013-14 and 2014-15 to assess the suitable high yielding lines of maize under rainfed condition of Nagaland. The experimental site was sandy clay loam in texture, acidic in reaction (p^H=4.2), high in organic carbon (0.83%), low in available N (209.2 kg N/ha), K (127.3 kg K/ha) and moderate in P (16.9 kg P/ha). Experiment was laid out in randomized block design and replicated thrice. The healthy and bold seed of maize were sown with a seed rate of 20-25 kg/ha and spacing of 60 cm×25 cm. Recommended dose of fertilizer *viz.* 120-60-40 kg NPK ha^{-1} (100% RDF) were applied through urea, DAP and MOP.

Half doses of N and full doses of P and K were applied as basal and remaining half doses of N was applied in two equal split *i.e.* knee high and tassel emergence stage at appropriate soil moisture condition. Farm yard manures were applied as basal @ 10 t ha^{-1} along with furrow liming @ 0.5 t ha-^{1}. However, mulching was done uniformly to take care of evaporation loss and minimize weed infestation. The weather data were presented in the Fig. 1. The moistures content data were recorded with following the standards procedures and depicted in Fig. 2 and 3. The morpho-agronomic characters for both vegetative and reproductive stages were recorded. The observations were recorded on quantitative characters over five randomly selected plants and subjected to the statistical analysis to draw the valid conclusion (Gomez and Gomez, 1984).

3. Results and Discussions

The data recorded during course of investigation revealed that significant variation among the landraces of maize in terms of growth and yield characters was observed. Plant height ranged from 167-313.11 cm, the maximum plant height was recorded with maize cv. Ungma local-1 (313.1 cm) and the lowest with Jharnapani local (167 cm). The maximum number of green leaves $plant^{-1}$ at 90 DAS was recorded with maize line of Merangkong local-2 (21.03) and the lowest with Mopungchukit local (10.71). In regard to stem girth, which ranged from 2.23 to 5.67 cm, maize germplasm Hupkong local (5.67 cm) recorded the maximum while the minimum was recorded with Sangratsu local (2.23 cm). Ungma Local-1 (185.31g) recorded the highest dry matter $plant^{-1}$, while Tuli Local-2 (20.25 g) recorded the minimum. Further, data revealed that maximum dry matter production/plant of maize was recorded with Ungma local-1 (185.3 g), whereas lowest value was noted with Tuli local-2 (20.2 g). In phonological characters *viz*. days to 50% flowering, Mopungchukit local (112 days) recorded the maximum and Tuli local-2 (43 days) recorded the minimum days to 50% flowering. Similar lines of findings were noted with Pal *et al*., (2011).

In respect of yield attributes, the highest grain rows/cob (no.) was recorded with maize germplasm of Theruyie (19.4) and the lowest with Sungratsu (12.34). In regard to cob length, the maximum was recorded with Chubayimkum local (24.45 cm), whereas the lowest value was recorded with Mopungchukit local (12.34 cm). The cob $plant^{-1}$ (no.) of maize was recorded the maximum with Changki local (2.56) and whereas lowest value was associated with Nyakmakonglak (1.45).

Figure 2. Soil moisture content during the period of investigation (*kharif*)

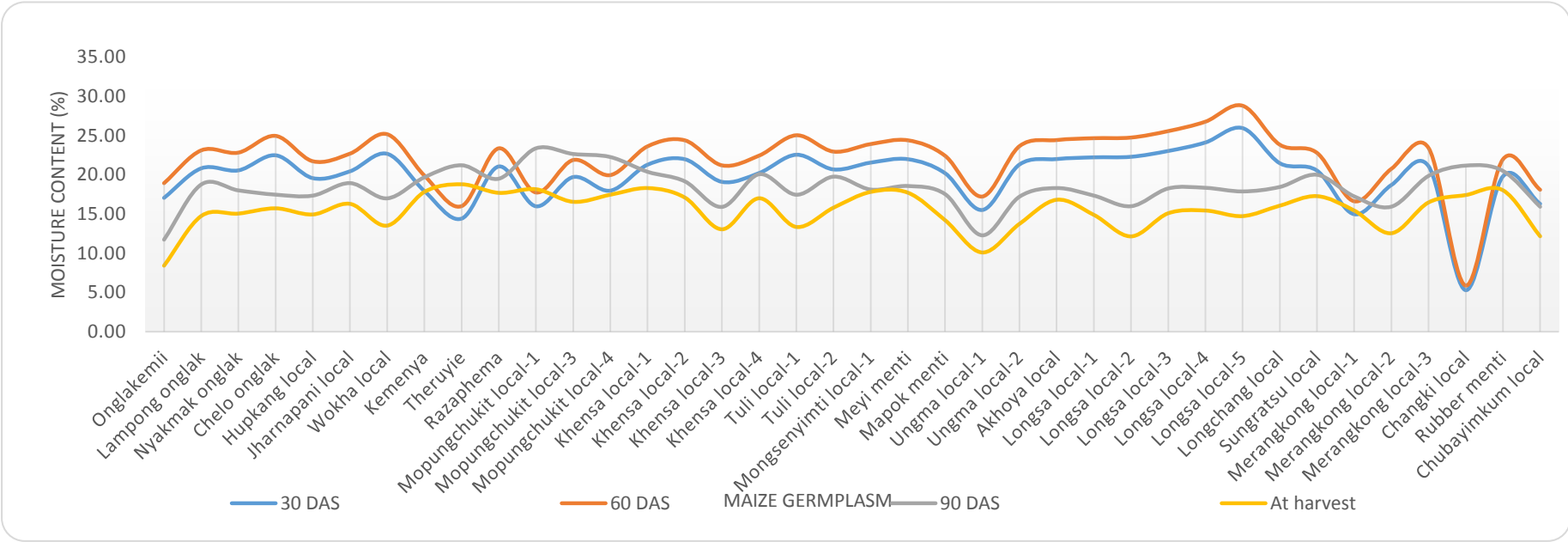


Table 2. Growth, yield attributes and yields of maize germplasm during *kharif* (Mean data of two year

Characters	Mean	SD	Minimum	Maximum	CV (%)
Plant height(cm)	231.51	7.45	167.00	313.11	4.49
Green leaves/plant	16.35	0.30	10.71	21.03	4.77
Stem girth (cm)	4.76	0.10	2.23	5.67	4.72
Dry matter/plant (g)	82.45	7.79	20.25	185.31	5.51
Days to 50% flowering	61.26	2.18	43.00	112.00	4.73
Cobs/plant	2.17	0.04	1.45	2.56	4.64
Cob length (cm)	18.66	0.48	12.34	24.45	4.57
Grain row/cob (cm)	14.18	0.30	10.45	19.45	4.57
Grains/cob row (No.)	28.66	0.60	20.10	35.90	4.62
Seed yield (kg/ha)	2836.84	170.90	1422.22	5688.89	4.53
Stover yield (kg/ha)	4482.21	270.03	2247.11	8988.45	4.53

Figure 3. Soil moisture content during the period of investigation (*Rabi* season)

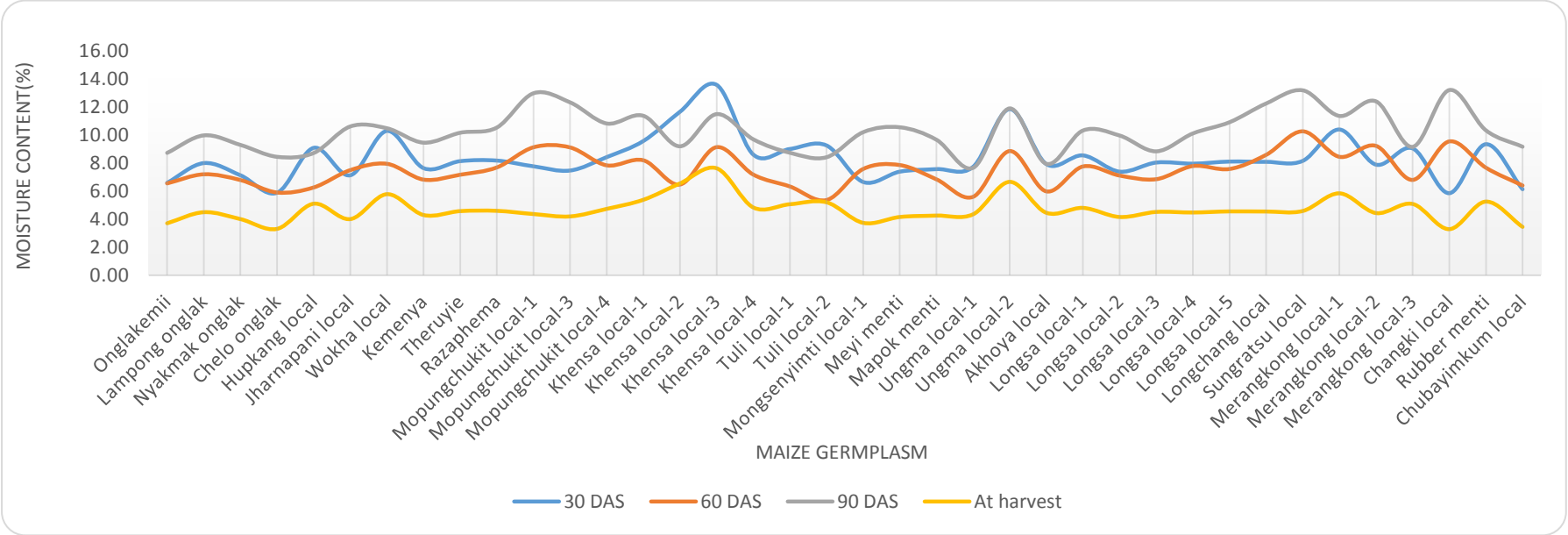


Table 3. Growth, yield attributes and yields of *maize* germplasm during *rabi* season (Mean data of two years

Characters	Mean	SD	Minimum	Maximum	CV (%)
Plant height(cm)	178.06	4.17	102.3	209.7	5.02
Green leaves/plant	15.78	0.24	12.1	19.9	5.09
Stem girth (cm)	4.28	0.07	3.4	4.99	4.91
Dry matter/plant (g)	57.72	5.45	14.18	129.72	5.10
Days to 50% flowering	88.95	1.54	78	112	5.07
Cobs/plant	1.48	0.03	1.11	2.00	4.90
Cob length (cm)	15.24	0.28	11.7	19.7	4.86
Grain row/cob (cm)	13.34	0.20	11.1	15.3	5.04
Grains/cob row (No.)	28.66	0.60	20.1	35.9	5.03
Seed yield (kg/ha)	1786.55	109.51	577.78	2933.33	5.44

In terms of grain yield, the maximum yield was recorded with maize Merangkong local-1 (5688.8kg ha^{-1}) and the minimum with Lampongonglak (1422.22 kg ha^{-1}). The maize germplasm *i.e.* Merangkong local-1(8988.45 kg ha^{-1}) recorded the highest stover yield while the Lampongonglak (2247 kg ha^{-1}) recorded lowest stover yield. It can be revealed from the experiment that the landraces collected differ significantly from each other in growth and yield attributes. Pal *et al*., (2011) also reported that distinct variation in growth and yield characters among the maize accessions. Moisture content during the experimentation were ranges from 5.29-28.87% and its values were recorded the maximum at 60 DAS, which coincides with peak vegetative growth of crop (Fig. 2). At sowing, initial moisture content were noted to be 7.59%

A similar set of the experiments were carried out during the *rabi* season of 2013-14 and 2014-15, where a total of 38 germplasm of maize were screened to assess the best suitable line in terms of higher production potential under moisture stress condition. The maximum plant height was recorded with maize Ungma local-2 (209.7 cm) and lowest with Rubbermenti(102.3 cm).The maximum green leaves $plant^{-1}$ (at 90 DAS) was recorded with the Theruyee (19.9) and the lowest with Khensa local-4 (12.1). Stem girth was recorded the maximum with maize germplasm Akhiyu local (4.99 cm) and the minimum with Yimenti local -1(3.4 cm). Dry matter production/$plant^{-1}$ of maize were recorded the maximum with Ungma local-1 (129.72 g) and whereas the lowest values with Tuli local-2 (14.18 g). In phonological characters *viz*. days to 50% flowering was recorded the maximum with Cheloonglak local (112 days) and whereas the minimum days to 50% flowering with kemeya, Razaphema, Mopungchukit Local-1 and Ungma Local-1 (78 days) (Annual Report 2013-14). In yield attributes, cob $plant^{-1}$ (no.) of maize were recorded the maximum with Ungma Local-1 (2.0) and whereas the lowest values was associated with Tuli Local-1 (1.11). Cob length of maize were recorded the higher with Longsa Local-5 (19.7 cm) and whereas lowest values was associated with Theruyee (11.7 cm). Similarly, the grain rows/cob (no.) were recorded the maximum with maize cv. Hupkang (15.3) and the lowest with Longsa Local-3 (11.1). In number of grain cob row^{-1}, the highest was observed with Kemeya (35.9) and the lowest with Hupkang (20.1). In terms of grain yield, the maximum yield was recorded with Tuli Local-2(2933.33 kg ha^{-1}) and minimum with Nayakmakonglak (577.78 kg ha^{-1}). Moisture content in soil (%) during the experimentation ranged from 3.29-13.6% and higher of its values were recorded between 60 and 90 DAS which coincides with vegetative growth and tasseling stages of crop growth (Fig. 3). At sowing, the initial moisture content was noted to be 13.59%.

Conclusion

From the site covered during the exploration and collection exercise, a wide range of maize germplasm were collected and collection is available at ICAR RC, Jharnapani, Medziphema, Nagaland. The viable lines will be screened in laboratory with proline for potential drought tolerance and also for root development, elongation intensity, energy of crown roots formation and tillering. The selected maize lines such as Merangkong local-1 (5688.8kg ha^{-1}) for *kharif* Tuli Local-2 (2933.33 kg ha^{-1}) for *rab*i season under limited moisture condition, having high yield potential thus be recommended and disseminated to drought prone areas in Nagaland as a strategy for alleviating the production constraints.

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