

Collection of Multi-crop Germplasm from Nagaland, India and their Range of Diversity

S.K. SINGH* A.K. MISRA

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ABSTRACT

Exploration and collection trips were undertaken at Dimapur, Kohima Mokokchung and Tuensang districts of Nagaland to collect crop germplasm diversity. A total of 306 multicrop germplasm accessions were collected randomly from the unexplored pockets of the surveyed areas, and their crop group wise break up is as follows; cereals 141, pseudocereals 14, grain legumes 59, vegetables 22, oilseeds 45, spices 19 tuber crop 04 and fruits 02. Characterized germplasm included rice (88 accs.), maize (50 accs.), rice bean (14 accs.), rapeseed and mustard (29 accs.) and *Perilla* (10 accs.). This paper discusses the pattern of variability of collected germplasm and the observations on field evaluation. The promising genotypes were also identified. Local indigenous technical knowledge of conservation of seed by the farmers was also recorded during exploration.

Keywords: Germplasm collection, Nagaland, Variability

INTRODUCTION

The North eastern region of India is considered as one of the hotspot of biodiversity for crop genetic resources. The North eastern hill (NEH) region is situated between 22-30° N latitude and 80-97° E longitude. The NEH region extended between Bhutan and Tibet in north, Burma in east and Bangladesh in south, has a total geographical area around 25.50 m ha. The Nagaland state borders with Myanmar in the east, Assam in the north-west, Arunachal Pradesh in the north-east and Manipur in the south. It is situated in between 25°6 and 27°4 N latitudes and 93°20 and 95°15 E longitudes, covering an area of 16579 sq. km. The forest cover is 8629 sq. km i.e. 52.04% of total area (NEC 2002). The state has subtropical to temperate climate, June to September, being the main rainy season with an annual precipitation ranges from 1050-2000 mm. The state is divided into the eleven districts, of these four districts namely; Dimapur, Kohima, Mokokchung and Tuensang were covered for

germplasm collection. Surveyed area had a rich cultural heritage with tribal traditions, and these tribes are mostly dependent on forests and practice terrace and shifting (*jhum*) cultivation. These *jhums* also form the rich reservoir of various crop diversities of the state. The important cash crops of the state are sugarcane, pineapple, orange, tea, and passion fruit.

A total of 306 multicrop germplasm accessions were collected randomly from the unexplored pockets of the surveyed areas. Crop group wise break up of collection was as follows; cereals 141, pseudocereals 14, grain legumes 59, vegetables 22, oilseeds 45, spices 19 tuber crop 04 and fruits 02. Out of all the collected germplasm, NBPGR, Umiam station characterized rice (88 accs.), maize (50 accs.), rice bean (14 accs.), *Perilla* (10 accs.) while NRC on Rapeseed and Mustard, Bharatpur characterized rapeseed and mustard (29 accs.). Further, an attempt was also been made to observe variability of quantitative traits in some of the collected crops to identify the promising genotypes.

MATERIALS AND METHODS

Collection site

Two exploration tours were undertaken in Nagaland; the first tour was conducted in collaboration with the Directorate of Rapeseed Mustard Research, Bharatpur (Rajasthan, India), during the month of February-March and second tour was undertaken by National Bureau of Plant Genetic Resources (NBPGR) Regional Station, Umiam during the month of November in 2005 and 2006. In both these exploration tours, areas confined to Dimapur, Kohima, Mokokchung and Tuensang districts of Nagaland were covered.

Dimapur and Kohima are two westernmost districts of the state and Mokokchung and Tuensang are two remotest area of the state. The explored area lies between the altitudes from 100 to 1500 meter above msl. The dominant tribes of the surveyed area in Nagaland are *Sema*, *Angami* and *Chakesang*. The important food crops of the surveyed area were rice, maize, beans, taro, pumpkin, chilli, leafy brassica and other vegetables. Out of these crops, some of the underutilized crops like rice bean and *Perilla* were also popular among the tribal people. For the collection of germplasm, standard practice and procedure developed by NBPGR was followed (Pareek et al. 2000). The collection of germplasm was concentrated in the remote and unexplored area where the possibilities of maximum diversities are available depending upon the local informations. Sampling was done from household store and crop fields. Sampling from the market was also made as per the availability of diversity. Passport data on each accession was recorded at the time of collection following the standard procedure. Altitude, longitude and latitude co-ordinates were determined by a handheld GPS system and recorded. The trip yielded 306 germplasm accessions of diverse agri-horticultural crops. After completion of a tour, all germplasm accessions were properly dried, cleaned and deposited in the National Gene Bank, NBPGR, New Delhi as a voucher sample, for ultimate storing in medium term module.

Rice, maize, rice bean and *Perilla* germplasm were characterized at NBPGR Regional Station, Umiam and mustard germplasm was characterized by the Directorate of Rapeseed and Mustard, Bharatpur (Rajasthan) during 2006-07 and 2007-08. All the germplasm were sown in Augmented

Complete Block Design. Standard agronomic package of practices and plant protection measures was adopted for all the germplasm. Randomly tagged five plants were selected at appropriate growth stages to record observations on morphological traits. The oil and protein content for mustard crop was analyzed by Near Infrared Reflectance Spectroscopy (Dickey-John, Instalab 600). The observation data was recorded as per the minimal descriptors of agri-horticultural crops (Mahajan et al. 2000). Range, mean, coefficient of variations were computed using standard statistical methods as suggested by Gomez and Gomez (1984).

RESULT AND DISCUSSION

A considerable diversity was observed in all the characterized germplasm. The preliminary characterization data for various traits on range, mean and CV is presented in Table 1. Hore and Sharma (1993) and Barua et al. (2006) reported the extent of variability in rice, maize, millets, grain legumes, cucurbits, oilseeds, tuber crops and fruit plants collected from Nagaland. However, this survey route is different and the collection was intensive without any duplication. The result on the observation on collected genotypes in the present study is summarized in Table 1.

Rice (*Oryza sativa* L.)

Rice is one of the essential foods in the surveyed areas, and almost all the local tribal people preferred sticky rice. A total of 88 accessions of rice were collected in these trips. The maximum plant height was recorded for IC524601 (168 cm) followed by IC540198 (148.2 cm) while the minimum for IC524582 (58.8 cm), and the CV was 19.0%. The number of tillers showed wide variation among the germplasm; it was maximum (60) for accession IC524632 and minimum (3.4) for IC524507. The maximum leaf length was recorded for IC524530 (56.8 cm) while the minimum for IC524567 (17.8 cm) the CV was calculated 21.3%. Maximum leaf width 2.5 cm was observed for IC540240 and minimum 1.0 cm for IC540264 with the CV of 18.9%. The mean panicle length was observed 23.7 cm having CV of 14.5%. Maximum panicle length (33.8 cm) was observed in IC524531 and minimum (14.2 cm) in IC 540195. The grain length width ratio was also having a wide variation; it was highest

Table 1: Variability in quantitative characters observed in the collected germplasm

Crop	Characters	Range	Mean	CV (%)
Rice	Plant height (cm)	58.8 - 168.0	118.7	19.0
	No. of tillers/plant	3.4 - 60.0	13.9	100.2
	Leaf length (cm)	17.8 - 56.8	29.4	21.3
	Leaf width (cm)	1.0 - 2.5	1.8	18.9
	Panicle length (cm)	14.2 - 33.8	23.7	14.5
	Grain length width ratio (mm)	1.7 - 4.5	2.7	17.6
	No. of panicle/plant	2.0 - 18.6	13.9	22.8
	No. of seeds/panicle	43.0- 321.8	237.6	29.7
	5 panicle wt (g)	2.9- 35.5	18.6	40.0
	100 Seed weight (g)	1.2 - 3.4	2.4	20.1
Maize	Cob length (cm)	6.5 - 29.2	15.9	31.3
	Cob diameter (cm)	2.3 - 6.1	4.2	20.2
	No. kernel rows	6.0 - 20.0	13.4	30.8
	No. of kernal/rows	15.0 - 58.0	30.8	30.3
Rice bean	100 seed wt (g)	8.2 - 51.2	24.2	42.4
	Days to 50% flowering	67.0 - 80.0	72.2	4.8
	Plant height (cm)	58.5 - 99.3	83.0	14.5
	Branches/plant	2.7- 4.7	3.4	17.0
	Stem thickness (cm)	0.7 - 1.4	1.0	15.7
	Seeds/pod	3.0 - 8.7	6.8	21.3
	Pod length (cm)	5.9 - 13.3	9.9	17.3
	Grain length (mm)	7.7 - 14.5	10.0	22.3
	Grain diameter (mm)	5.4 - 8.6	6.1	14.6
	Days to 80% maturity	98 - 152	120.3	11.2
Perilla	100 seed wt (g)	9.7 - 47.6	20.0	52.9
	Leaf length (cm)	10.7 - 16.8	12.6	14.0
	Leaf width (cm)	6.6 - 14.5	10.4	21.4
	Plant height (cm)	156.3 - 275	203.0	16.9
	Inflorescence length (cm)	5.6 - 10.9	7.5	19.3
	No. of inflorescences/ plant (cm)	89.0 - 161.5	132.2	20.3
	No. of branches/ plant (cm)	13.2 - 24.3	19.2	18.7
	1000-seed weight (g)	1.1 - 1.9	1.6	13.7
	Yield/plot (g)	150 - 410	209.00	36.42
	Rapeseed-Mustard	Plant height (cm)	72.00 - 144.00	112.99
No. of primary branches		3.40 - 7.0	4.89	19.6
Main shoot length (cm)		27.00 - 54.00	42.8	17.69
Siliqua on main shoot		16.40 - 34.40	26.99	18.41
Siliqua length (cm)		2.13 - 4.34	3.46	14.65
Seeds per siliqua		6.60 - 17.0	13.06	16.93
1000 seed weight (g)		1.10 - 4.75	2.73	30.54
Seed yield/plant (g)		1.21- 11.90	5.46	58.41
Harvest index		4.52 - 31.00	17.49	45.41
Oil content (%)		39.18 - 42.35	40.71	2.05
Protein content	19.15-21.76	20.29	2.9	

for IC540239 (4.5) and lowest for IC540275 (1.7). The CV of grain length width ratio was 17.5%. Maximum no. of panicle/plant (18.6) for IC540200 and minimum (2) for IC524507 with CV 22.7% was recorded. No. of seed/panicle showed wide variations. It was 321.8 for IC540185 and 43 for IC524507 observed. Maximum 5 panicle weight 35.5 g for IC540239 and minimum for 2.9 g for IC524567 with CV 39.9%. The maximum 100-

seed weight of 3.4 g was recorded for IC540225 and minimum of 1.2 g for IC540218. The CV for 100-seed weight 20.0% and mean 2.45 g was recorded. Amongst the collected rice accessions only nine were having an aroma. Wide variation was observed in husk colour; golden (33 accessions), brown furrows on straw (18 accessions), golden brown (12 accessions), brown (08 accessions) and straw colour (17 accessions).

Maize (*Zea mays* L.)

Maize is second important crop and grown on a large scale in the surveyed areas, and the tribal people consumed maize in various ways as food and poultry feed. A total of 50 accessions were collected in these exploration tours. The maximum cob length was 29.2 cm in the accession IC540180 IC540180, minimum length was 6.5 cm in IC524595 with CV 31.3%. The maximum observed cob diameter 6.1 cm was for IC540179 and the 2.3 cm. was for IC524592 IC540179, IC540179, 20.2% was recorded. The maximum number of kernel rows *i.e.* 20 was recorded for IC524474 and minimum 6 for IC524592. The CV was 30.8 % for number of kernel rows. The maximum number of kernel/ rows (58) was seen in IC540180 while minimum (15) in the accession IC524595 was recorded. The maximum 100-seed weight (51.2 g) was recorded for IC540180 and minimum (8.2) IC540241 with a CV of 42.4%. A wide range of variability was observed for qualitative characters. Kernel colours observed were; orange (06 accessions), yellow (06 accessions), mottled (05 accessions), white (10 accessions), cream (05 accessions), variegated (08 accessions), brown (04 accessions), purple (03 accessions), white cap (02 accessions) and red (01 accessions). Kernel row arrangement recorded were; regular (18 accessions), spiral (11 accessions), i (10 accessions) and straight (11 accessions). The grain texture was observed as round (30 accessions), flat (18 accessions) and beaked (02 accessions). The grain shape was recorded as rounded (10 accessions), shrunken (9 accessions), indented (30 accessions) and pointed (01 accessions). The grain size was recorded as bold (20 accessions), medium (13 accessions), and small (17 accessions). Each collected accession showed distinct variations among the collected genotypes based on the above morphological features.

Rice bean (*Vigna umbellata* L.)

Rice bean is very popular in Nagaland and is locally known as 'Naga Dal'. The rich diversity was observed in seed size, shape and colour. The earliest flowering accession based on days to 50% flowering was IC524464 (67 days) and the late flowering was IC524542 (80 days). The maximum plant height (99.3 cm) was recorded for IC524562 and minimum (58.5 cm) for IC524538 and the CV was 14.5%. Maximum number of branch per plant (4.7) was recorded for IC524537 and minimum

(2.7) for IC524561. The CV for branches per plant was 17.0%. Stem thickness was maximum (1.4 cm) for IC524534 and the minimum (0.7) cm for IC524538 the CV for this character was 15.7%. Seeds per pod were observed maximum (8.7) for IC524552 and minimum (3) for IC524538 and the CV was 21.3 %. The highest pod length of 13.3 cm was recorded for IC524512 and least of 5.9 cm recorded for IC524538 and the CV observed for 17.3 %. The maximum grain length and width (14.5 and 8.6 mm) were calculated for IC524464 and minimum (7.7 and 5.4 mm) for IC524522 was recorded, and the CV was calculated 22.3% and 14.6% respectively. The days to maturity ranged between 152 days (for IC524542) and 98 days (for IC524512). The maximum 100- seed weight (47.6 g) was recorded for IC524464 and minimum of 9.7 g for IC524561. The seed coat colour was observed as cream (04 accessions), green (03 accessions), black (01 accession), mottled black (03 accessions), mottled gray (01 accession) and maroon (02 accessions). The various seed shapes were kidney (02 accessions), cylindrical (04 accessions), flattened (06 accessions) and round (02 accessions).

***Perilla* (*Perilla frutescens* L.)**

Perilla is grown in Nagaland mainly in *jhum* fields and kitchen gardens only. A total of 12 accessions of *Perilla* were collected. Leaf length and width was the maximum in IC524455 (16.8 and 14.5) and the minimum in IC524600 (10.7 and 6.6). The maximum plant height (275.00 cm) was recorded for IC424622 and the minimum (156.3 cm) for IC524455. The CV was 16.9% for plant height. The maximum inflorescence length was 10.9 cm for IC524555 and the minimum was 5.7 cm for IC524546 (mean 7.8 cm and CV 19.3%). The maximum number of inflorescence was found 161.5 for IC52451 and minimum 89.0 for IC524622 (CV-20.3%). The number of branches/plant showed wide variation, the range was 13.2 (IC524600) to 24.3 (IC524551) and the CV was calculated 18.7%. 1000 seed weight was maximum (1.9 g) for IC524551 followed by 1.8 g for IC524554 and minimum (1.1g) for IC524504 and the CV 13.7%. Among the collected accessions the IC524551 was found promising accessions for the character inflorescence length, number of inflorescences per plant, number of branches per plant and 1000 seed weight.

Rapeseed-Mustard (*Brassica* spp.)

The collected germplasm belonged to three species viz. *Brassica juncea* (Indian mustard), *B. rapa* var. *toria* and *B. rapa* var. *yellow sarson*. These germplasm showed considerable variability for majority of the traits as indicated by CV (Table 1). The highest variability was observed for seed yield per plant (CV 58.4%) followed by harvest index (CV 45.4%) and 1000- seed weight (CV 30.5 %). The lowest variability was observed for oil content (CV 2.0%). Maximum plant height 144.00 cm was recorded for IC522378 and minimum 72.0 cm for IC522382 and CV was calculated 17.9%. The number of primary branches also showed wide variation with the range of 3.4 (IC522382) to 7.0 (IC522378) (CV 19.6%). The maximum main shoot length was recorded in IC522371 (54.00 cm) and minimum 27.00 for IC522366. The maximum siliqua on main shoot was found on IC522378 (34.40) and minimum on IC522366 (16.4) accession. The siliqua length was maximum for IC522354 (4.34 cm) and minimum for IC522355 (2.13 cm). The seeds/siliqua also showed wide variation, the maximum (17.0) was seen in IC 522378 and the minimum (6.60) in IC522357 and CV was 16.9%. Maximum oil content was recorded in IC522379 (42.35%) followed by IC522381 (41.79%). The highest protein content was 21.76% in IC522378. Similar observation was also reported by Ghosh et al. (2001), Singh et al. (2003) and Misra et al. (2004, 2007).

CONCLUSION

The traditional crop cultivation seen in the surveyed areas of Nagaland were rich in variability in rice and maize landraces. Along with rice and maize, it was observed that tribal people are growing rapeseed – mustard. *Perilla* and other vegetables are growing mainly in kitchen garden area. The farmers go for planting of multiple crop varieties, which are suitable to local environment. This allows developing both intraspecific and

interspecific diversity in nature. The wide variability of primitive crop cultivars corresponds well with the heterogeneity of the social and ecological environment (Brush 1982). The statement is very much true and applicable to this area. The cultivation methodology, post harvest technique and food habit of the local tribes and overall inaccessibility lead to less exploitation and possibly due to this the availability of diversity was more. Local tribal people kept their seed over the chimney to keep free from insect and pest. They preferably dry vegetable and maize seeds in fruit form.

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