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Multi-Environment Screening of Nepalese Finger Millet Landraces against Blast Disease [*Pyricularia grisea* (Cooke) Sacc.)]

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ABSTRACT

Three hundred finger millet genotypes (295 landraces from 54 districts and five released varieties) were evaluated for leaf, finger, and neck blast resistance under natural epiphytotic conditions across three hill locations in Nepal, namely Kabre, Dolakha (1740m); Vijaynagar, Jumla (2350 m); and Khumaltar, Lalitpur (1360 m) during the summer seasons of 2017 and 2018. The highest incidence of leaf, neck, and finger blast was observed at Lalitpur, followed by Dolakha and Jumla, whereas the overall disease incidence was higher in 2018 compared to 2017. Combined analysis over environments revealed non-significant differences among accessions for leaf blast, but the difference was highly significant for neck and finger blast. Correlation analysis suggested that there was a strong positive correlation between neck blast and finger blast (r = 0.71), leaf blast (seedling stage) and neck blast (r = 0.68), and leaf blast (seedling stage) and finger blast (r = 0.58) diseases. Among 300 accessions, 95 had lower scores for finger blast, 30 for neck blast, and 74 for leaf blast than the score of Kabre Kodo-2, the latest released variety in Nepal. Genotypes NGRC04798, NGRC03478, NGRC05765, NGRC03539, NGRC06484, NGRC01458, NGRC01495 and NGRC01597 were found the resistant genotypes for finger blast (2.1-2.3) and neck blast (1.5-2.3) based on pooled mean scores. This study shows the variable reactions of finger millet genotypes against blast disease in various environments and reports the promising landraces having field resistance to leaf, finger, and neck blast, which ultimately serve as important donors for blast resistance in finger millet breeding.

Keywords: *Eleusine coracana*, finger blast, landraces, leaf blast, neck blast, *Pyricularia grisea*

सारांश

नेपालका ५४ जिल्लाबाट संकलन गरिएका २९५ वटा स्थानीय र ५ वटा सिफारिस गरिएका गरी जम्मा ३०० वटा जातहरुलाई काब्रे, दोलखा (१७४० मि.); विजयनगर, जुम्ला (२३५० मि.) र खुमलटार, ललितपुर (१३६० मि.) को प्राकृतिक वातावरणमा सन् २०१७ र २०१८ को बर्षा याममा फिल्ड परीक्षण गरेका थियौं । कोदोको पात, घाँटी र औंलामा लाग्ने तीनै किसिमको मरुवा रोगको प्रकोप सबैभन्दा धेरै ललितपुरमा, त्यसपछि दोलखा र जुम्लामा पाइयो भने पहिलो वर्ष (सन् २०१७) मा भन्दा दोस्रो वर्ष (सन् २०१८) मा समग्रमा मरुवा रोग धेरै लागेको पाइयो । तीनवटै परीक्षण स्थलहरुको औसत आंकडा विश्लेषण गर्दा पातको मरुवाको आधारमा जातहरुमा तात्विक भिन्नता पाइएन भने घाँटी र औंलाको मरुवा रोगको आधारमा जातहरुको बीचमा अत्यन्तै ठुलो भिन्नता भेटियो । सह-सम्बन्ध विश्लेषणको आधारमा घाँटीको मरुवा र औंलाको मरुवा (०.७१), वेर्ना अवस्थाको पातको मरुवा र घाँटीको मरुवा (०.६८) तथा वेर्ना अवस्थाको पातको मरुवा र औंलाको मरुवा (०.५८) को बीचमा बलियो सकारात्मक सह-सम्बन्ध रहेको पाइयो । सबैभन्दा पछि सिफारिस गरिएको कोदोको जात 'काब्रे कोदो-२' सँग तुलना गर्दा औंलाको मरुवा रोग कम लाग्ने ९५ वटा जातहरु, घाँटीको मरुवा रोग कम लाग्ने ३० वटा जातहरु एवं पातको मरुवा रोग कम लाग्ने ७४ वटा जातहरु देखियो । समग्रमा एन.जी.आर.सी.०४७९८, एन.जी.आर.सी.०३४७८, एन.जी.आर.सी.०५७६५, एन.जी.आर.सी.०३५३९, एन.जी.आर.सी.०६४८४,

एन.जी.आर.सी.०१४५८, एन.जी.आर.सी.०१४९५ र एन.जी.आर.सी.०१५९७ आदि जातहरुमा औंलाको मरुवा रोग (२.१-२.३) तथा घाँटीको मरुवा रोग (१.५-२.३) कम देखियो । यस लेखमा फरक फरक वातावरणमा विविधतायुक्त कोदोका जातहरुले विभिन्न मरुवा रोगहरुसँग के-कस्तो प्रतिक्रिया देखाए भन्ने कुरा प्रस्तुत गर्नुका साथै कोदो प्रजनन् कार्यमा प्रयोग गर्न सकिने मरुवा रोग अवरोधी केही उत्कृष्ट दाता जातहरुको पहिचान गरिएको छ ।

INTRODUCTION

Finger millet [*Eleusine coracana* (L.) Gaertn.] is a small seeded crop of grass family grown mainly in the semi-arid areas of Eastern and Southern Africa and South Asia. Globally, it ranked fourth among millet crops after sorghum, pearl millet and foxtail millet (Upadhyaya et al 2007). It is cultivated in 3.8 million ha (12% of the total millet area) in the world with major coverage in the countries of Africa and Asia (Bora 2013, Hittalmani et al 2017, Kumar et al 2016, Upadhyaya et al 2010, Vetriventhan et al 2020). It is grown in a wide range of environments from the tropical coastal regions of India (Upadhyaya et al 2006) to high mountains (3130 masl) of Nepal (Bastola et al 2015, Gaihre et al 2021). It is a hardy crop grown in marginal land and stress environments with very low or minimum input (Goron et al 2015, Parvathi et al 2019). Finger millet is nutritionally superior to major staples such as rice, maize and wheat (Mirza et al 2015). It is transitioning from a neglected and underutilized crop to a high-potential crop for healthy and functional foods with high nutritive value (Kandel and Shrestha 2019, Kandel et al 2020). It is rich in calcium content (0.34%), dietary fiber (18%), protein (6-13%), minerals (2.5-3.5%), phytates (0.48%) and phenolic compounds (0.3-3%) (Chandra et al 2016, O'Kennedy et al 2006, Upadhyaya et al 2011). This crop is also valued for its health beneficial effects like anti-diabetic, anti-tumorigenic, antioxidant and antimicrobial properties (Devi et al 2011, Kumar et al 2016, Nakarani et al 2020). Finger millet is the fourth most important crop of Nepal after rice, maize and wheat in terms of area and production (MoALD 2021). Nepal produces 326,442 tons of finger millet grains (2.9% of total cereal production) from 265,401 ha (7.7% of total cereal area) with a yield of 1.23 t/ha (MoALD 2022). The major finger millet producing districts in the country are Khotang, Baglung, Sindhupalchok, Kaski, Syangja and Gorkha (MoALD 2021). It has multiple benefits as a healthy and nourishing diet as well as palatable animal feed. Besides food and nutrition, it has been an integral component of agro-tourism in Nepal due to its *dhindo* (thick porridge) and high quality *raksi* (home-made whisky) (Gaihre et al 2021, Ghimire et al 2017).

Blast is an economically important and widespread fungal disease of finger millet caused by *Pyricularia grisea* (Cooke) Sacc. [teleomorph: *Magnaporthe grisea* (Hebert.) Barr.]. This is the most important biotic factor limiting the finger millet productivity worldwide (Babu et al 2014, Das et al 2021, Dida et al 2020). It is seed borne disease, hibernates in infected crop debris and occurs during rainy season damaging the foliage, neck and finger at different stages of crop growth (Manandhar et al 2016). The extent of damage depends on the severity of the disease and the stage of plant it attacks. The pathogen attacks from seedling to maturity stages showing mainly three symptoms i.e leaf blast, neck blast and finger blast. Leaf blast is the initial one and most damaging if the crop is severely affected at early seedling stage since many agronomic traits such as number of productive tillers, length of fingers, number of fingers and yield are severely affected (Kiran Babu et al 2013). Leaf blast appears on leaves as small elliptical or diamond shaped brown spots with grey centers. Neck blast appears in the neck region as brown lesions and girdling the neck causing sterility. Finger blast is characterized by the discoloration followed by either partial or complete drying of the fingers leading to spikelet sterility (Manandhar et al 2016). Neck blast and finger blast before milking stage lead to great reduction in grain yield which is estimated around 28–36% each year in Asia (Nagaraja et al 2007) but the yield loss can go as high as 80–100% (Prajapati et al 2013). The crop is more vulnerable to leaf, neck and finger blast disease when conducive environments with lower temperature and higher humidity (>70%) exists during growing season.

After the establishment of National Genebank of Nepal in 2010, collection and conservation of finger millet germplasm got high priority, holding more than 950 finger millet genetic resources in medium and long-term conservation (Ghimire et al 2017). Resistance breeding for a crop like finger millet against diseases like blast is always in low priority in global as well as national research systems. Management of blast disease in finger millet using fungicides is not economical in Nepal because this crop is grown by low-income farming communities. Evaluation of a large number of germplasm over multiple environments helps to identify stable sources of blast resistance (Das et al 2021). The high yielding finger millet varieties with durable blast resistance could be developed through the introgression of resistant genes from these potential sources, which is the only efficient, economic, effective and environment friendly approach to manage this problematic disease. The objective of this study was to screen finger millet accessions of diverse origins under various hill environments and to identify potential accessions for blast disease resistance which could be utilized for finger millet improvement programme.

MATERIALS AND METHODS

Plant materials

A total of 300 finger millet genotypes, including 295 landraces collected from 54 districts of six provinces and five released varieties of Nepal were received from National Agriculture Genetic Resources Centre (Genebank), Khumaltar, Lalitpur, Nepal (**Annex table** 1). Each accession is prefixed with NGRC (Nepal Genetic Resource Collection). Five released varieties include Okhle-1 (NGRC07044), Dalle-1 (NGRC07021), Kabre-1 (NGRC07039), Shailung-1 (NGRC05049) and Kabre Kodo-2 (NGRC05050). The collection altitude and coordinates of the accessions were ranged from 78–2850 masl, 26.55–30.00°N and 80.38–88.01°E, respectively.

Experimental sites

Experiments were conducted under natural epiphytotic conditions at three mountain locations of Nepal, namely Hill Crops Research Programme, Dolakha (1740 m asl, 27.64°N, 86.14°E); National Agriculture Genetic Resources Centre, Lalitpur (1360 masl, 27.65°N, 85.32°E) and Agriculture Research Station, Jumla (2350 masl, 29.27°N, 82.18°E) representing eastern high hills, central mid hills and western mountains, respectively, during summer seasons of two consecutive years 2017 and 2018 giving six screening environments: Dolakha-2017 (D17), Jumla-2017 (J17), Lalitpur-2017 (L17), Dolakha-2018 (D18), Jumla-2018 (J18) and Lalitpur-2018 (L18). All the three sites were having coarse textured sandy loam soil (Ghimire et al 2020). Rainfall, relative humidity and temperature of the three sites during finger millet growing season (May to November) of both years have been presented in Table 1.

Table 1. Rainfall, relative humidity and temperature of the experiment locations during 2017 and 2018 cropping seasons

Location	Year	May	June	July	August	September	October	November
Total rainfall (mm) during the month								
Dolakha	2017	209	402	801	497	415	45	0
	2018	189	106	554	614	493	22	3
Jumla	2017	61	180	280	124	75	2	2
	2018	62	65	180	253	103	24	0
Lalitpur	2017	150	200	216	266	103	1	0
	2018	60	128	387	322	53	0	0
Monthly mean of relative humidity (%)								
Dolakha	2017	79.3	85.5	89.3	90.4	87.1	89.3	86.2
	2018	78.2	83.4	89.0	91.0	89.2	89.6	91.6
Jumla	2017	54.5	57.7	78.5	77.1	64.5	51.4	42.9
	2018	45.2	56.1	73.1	80.7	67.2	42.6	34.9
Lalitpur	2017	75.5	80.5	81.5	81.3	78.5	79.2	75.1
	2018	73.2	81.4	84.0	81.5	80.2	69.4	72.3
Monthly mean of minimum temperature (°C)								
Dolakha	2017	17.1	18.9	23.4	20.1	18.2	12.3	10.7
	2018	18.6	22.9	19.1	19.0	18.1	13.8	9.9
Jumla	2017	10.9	15.5	16.4	16.2	13.9	7.2	0.0

	2018	8.6	14.4	15.5	16.2	14.7	11.7	0.7
Lalitpur	2017	16.3	20.1	20.6	20.5	19.6	15.6	8.0
	2018	16.5	19.7	20.8	20.5	19.2	11.8	6.9
Monthly mean of maximum temperature (°C)								
Dolakha	2017	25.1	28.6	29.7	26.3	24.9	22.1	20.8
	2018	26.0	27.7	26.3	27.1	25.4	19.3	21.5
Jumla	2017	25.4	25.7	24.1	24.6	25.4	23.7	19.1
	2018	25.2	27.3	25.7	23.9	25.1	25.1	21.4
Lalitpur	2017	27.6	29.3	28.1	28.2	28.7	27.6	23.5
	2018	26.9	29.1	28.1	27.7	28.4	25.9	22.8

Source: Department of Hydrology and Meteorology, Nepal

Layout and management

Each experiment was laid out in alpha lattice design with 300 entries and two replications. Each replication had 15 blocks with 20 plots in each block. Each plot was of 0.1 m^2 size (single row of 1 m length with the row to row and plant to plant spacing of 10 cm × 5 cm, respectively). Seeding was done on 24th and 14th June, respectively for D17 and D18, 8th and 5th May, respectively for J17 and J18, 21st July for L17 and 21st June for L18. Chemical fertilizers at the rate of 60:10:10 kg/ha (20:10:10 kg/ha $N:P_2O_5:K_2O$ as basal doses, followed by 40 kg/ha N was top dressed in two split doses at 30 and 50 days after seeding) were applied. Three rows of maize were planted a month earlier than the test entries around the experimental plots as wind breaks followed by four spreader rows of finger millet susceptible mixture at one week interval to create a conducive environment for the blast disease (Thapa and Manandhar 1985). Direct sowing method was followed by thinning within 25-30 days after seeding to maintain a plant-to-plant spacing of 5 cm within rows. Manual weeding was done as per requirement, but no irrigation and pesticides were applied.

Data recording

Four blast traits namely leaf blast at seedling stage (LBS), leaf blast at flowering stage (LBF), neck blast at maturity stage (NB) and finger blast at maturity stage (FB) were recorded. LBS and LBF were scored from 10 random plants of each plot in 0-9 scale (Kiran Babu et al 2013, Manandhar et al 2016) where 1 = <1% leaf area covered, 2 = 1-5%, 3 = 6-10%, 4 = 11-20%, 5 = 21-30%, 6 = 31-40%, 7 = 41-50%, 8 = 51-75% and 9 = >75% leaf area covered, or all leaves dead. These scores were simplified as five levels of reactions: resistant (0-1), moderately resistant (2-3), moderately susceptible (4-5), susceptible (6-7) and highly susceptible (8-9). NB and FB were scored simultaneously at physiological maturity stage from 10 random plants of each plot based on 1-5 scale (Kiran Babu et al 2013, Manandhar et al 2016). NB scales were based on lesion size on the neck with 1 = no lesions to pin head size of lesions, 2 = 0.1-2.0 cm, 3 = 2.1-4.0 cm, 4 = 4.1-6.0 cm and 5 = >6.0 cm size of typical blast lesions on the neck region. In contrast, FB scales were based on the percent infected finger over total fingers in 10 plants, where 1 = <2%, 2 = 2.1-10%, 3 = 10.1-25%, 4 = 25.1-50% and 5 = >50% fingers were affected (Kiran Babu et al 2013).

Data analysis

Reaction frequencies of each trait for each environment were tabulated. Analysis of variance (ANOVA) for each environment as well as combined over environments was done for LBS, LBF, NB and FB by using Genstat-18 (VSN International 2015). Mean blast scores were plotted in the graphs using Excel worksheet (V15). Descriptive statistics such as range, mean and standard error of the mean as well as Karl Pearson's correlation coefficient (r) between LBS, LBF, NB and FB were calculated based on mean score data of all six environments using statistical software Minitab (Minitab 2020).

RESULTS

Frequency and descriptive statistics of disease reactions

Frequency distribution of five reaction levels for LBS, LBF, NB and FB among the 300 accessions are presented in **Table** 2. The level of incidence of all blast diseases was higher during the first year as compared to the second year. Most of the accessions showed resistant (R) to moderately resistant (MR) reactions for LBS and LBF at all six environments. For NB, majority of the accessions showed R to MR reactions at D17, J17 and J18 but majority of the accessions showed MS to S at D18, L17 and L18. Similarly for FB, majority of the accessions showed R to MR reactions at J17, MS to S reactions at J18, D17, D18 and L17. All accessions showed S to HS reactions for FB at L18. None of the accessions were free from FB at L17, L18 and D18. In J17, 81% of the accessions showed R and rest of the accessions showed MR reactions for LBS and LBF whereas in J18, 54.5% accessions showed R reaction for LBS and LBF, and 85.7% accessions showed R reaction for NB but 51.3% accessions showed MS reaction for FB. Susceptibility level for all three blast diseases was the highest at Lalitpur in both years followed by Dolakha and Jumla (Table 2).

Table 2. Reactions of 300 finger millet accessions to blast diseases at Jumla, Lalitpur and Dolakha in 2017 and 2018

Location	Disease	2017						2018					
		R	MR	MS	S	HS	NA	R	MR	MS	S	HS	NA
Dolakha	LBS	119	181	0	0	0	-	7	263	30	0	0	-
	LBF	17	250	33	1	0	-	1	261	38	0	0	-
	NB	170	94	25	10	1	-	2	19	105	124	50	-
	FB	27	78	165	27	3	-	0	0	18	210	72	-
Jumla	LBS	268	32	0	0	0	-	266	34	0	0	0	-
	LBF	220	80	0	0	0	-	61	146	86	7	0	-
	NB	217	68	0	0	0	15	257	40	3	0	0	-
	FB	107	59	10	0	0	124	2	68	154	55	2	19
Lalitpur	LBS	7	278	15	0	0	-	3	214	83	0	0	-
	LBF	9	195	93	3	0	-	30	220	45	5	0	-
	NB	2	93	191	53	0	-	0	7	50	178	63	2
	FB	0	21	113	171	6	-	0	0	0	88	210	2

Note: R = resistant, MR = moderately resistant, MS = moderately susceptible, S = susceptible, HS = highly susceptible, NA = not observed due to late flowering, LBS = leaf blast at seedling stage, LBF = leaf blast at flowering stage, NB = neck blast and FB = finger blast

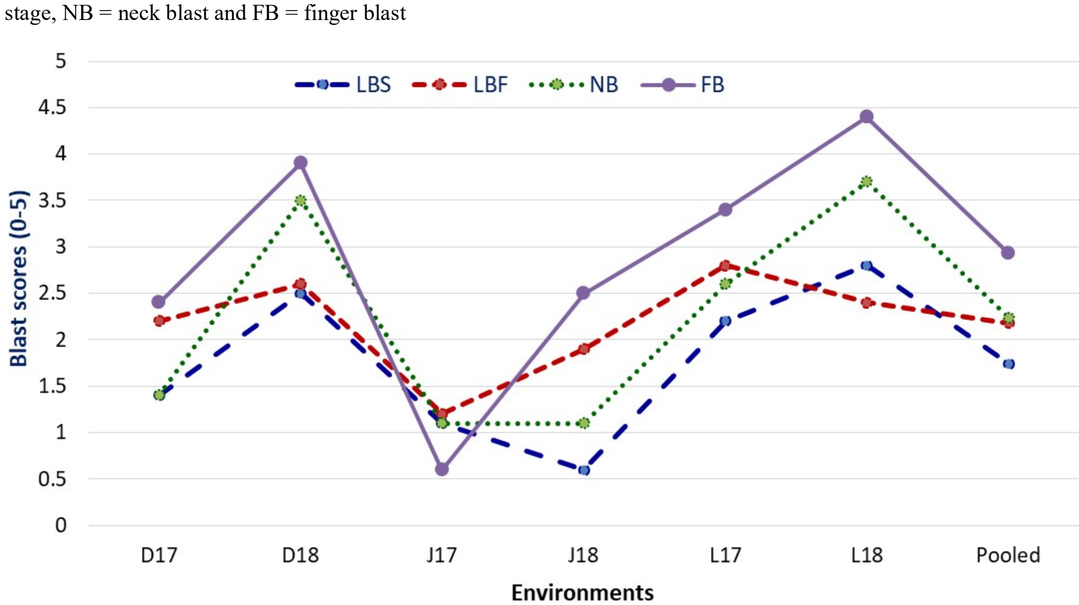

Figure 1. Population mean of blast scores of finger millet accessions across environments (D17=Dolakha-2017, D18=Dolakha-2018, J17=Jumla-2017, J18=Jumla-2018, L17=Lalitpur-2017, L18=Lalitpur-2018, and pooled (combined over environments)

There was variation in LBS, LBF, NB and FB scores over six environments (Figure 1, Table 3). Population mean of LBS score was the highest in L18 (2.8) but the lowest in J18 (0.6) while mean LBF score was the highest in L17 (2.8) but the lowest in J17 (1.2). Similarly, the population mean of NB and FB scores were found the highest in L18 (3.7 and 4.4) but the lowest in J17 (1.1 and 0.6). Overall behaviour of the population was R to MR for leaf blast, MR to S for NB and MS to HS for FB.

Table 3. Means and ranges of leaf, neck and finger blast scores at Dolakha, Jumla and Lalitpur during 2017 and 2018

Environment	LBS (0-9)		LBF (0-9)		NB (1-5)		FB (1-5)	
	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range	Mean ± SE	Range
D17	1.4 ± 0.60	0 – 3	2.2 ± 0.79	0 – 7	1.4 ± 0.49	1 – 5	2.4 ± 0.81	1 – 5
J17	1.1 ± 0.29	1 – 3	1.2 ± 0.43	1 – 4	1.1 ± 0.33	1 – 3	0.6 ± 0.51	1 – 3
L17	2.2 ± 0.85	1 – 6	2.8 ± 1.41	1 – 7	2.6 ± 0.39	1 – 5	3.4 ± 0.48	2 – 5
D18	2.5 ± 0.74	1 – 5	2.5 ± 0.74	1 – 5	3.5 ± 0.98	1 – 5	3.9 ± 0.69	2 – 5
J18	0.6 ± 0.61	0 – 3	1.9 ± 0.88	0 – 5	1.1 ± 0.43	1 – 4	2.7 ± 0.63	1 – 5
L18	2.8 ± 1.05	1 – 6	2.4 ± 1.03	0 – 8	3.7 ± 0.65	1 – 5	4.4 ± 0.53	2 – 5

Correlation analysis

The Karl Pearson's coefficient of correlation (*r*) of each trait association based on pooled mean data over six environments has been presented in Table 4. There was highly significant ($p < 0.001$) positive correlation between each of the six trait pairs. The strongest correlation ($r = 0.709$) was observed between NB and FB followed by between LBS and NB ($r = 0.681$), however, the variation in strength ranged from 0.385 to 0.709.

Table 4. Pearson's correlation coefficient (*r*) between leaf, neck and finger blast diseases based on mean scores data of all six environments

Sample 2	Sample 1	Correlation (*r*)	P-Value
Leaf blast at seedling stage	Leaf blast at flowering stage	0.447	0.000
Leaf blast at seedling stage	Neck blast at maturity stage	0.681	0.000
Leaf blast at seedling stage	Finger blast at maturity stage	0.575	0.000
Leaf blast at flowering stage	Neck blast at maturity stage	0.385	0.000
Leaf blast at flowering stage	Finger blast at maturity stage	0.435	0.000
Neck blast at maturity stage	Finger blast at maturity stage	0.709	0.000

Analysis of variance

The evaluated finger millet genotypes showed variable response to different blast diseases at different environments. Analysis of variance (ANOVA) for each trait was performed and mean sum of squares due to genotypes are presented in Table 5. Genotypes did not differ significantly for LBS at all six environments and for LBF at five environments except at L18 (significant at 1% level). In contrast, the genotypic difference was highly significant (at 5% level) for NB at D17 and L17 as well as for FB at all three locations during the first year (D17, J17 and L17). Pooled ANOVA revealed that the difference among genotypes was highly significant (at 5% level) for NB and FB but not significant for leaf blast at both seedling and flowering stage.

Table 5. Analysis of variance (ANOVA) of leaf, neck and finger blast scores of finger millet accessions in different environments

Disease	Dolakha, 2017	Jumla, 2017	Lalitpur, 2017	Dolakha, 2018	Jumla, 2018	Lalitpur, 2018	Pooled
LBS	0.392	0.074	0.760	0.625	0.438	1.089	0.316
LBF	0.579	0.211	1.912	0.493	0.777	1.641*	0.493
NB	0.859**	0.121	0.367**	1.277*	0.197	0.502	0.483**
FB	1.332**	1.197**	0.404**	0.438	0.733*	0.281	0.840**

Note: Values are mean sum of squares due to genotypes, ** and * are significant at 1% and 5% level, respectively. LBS, LBF, NB and FB denote for leaf blast at seedling stage, leaf blast at flowering stage, neck blast and finger blast, respectively.

Genotypic performance

Although the genotypes reacted differently for different blast diseases at different environments, FB was found to be the most important trait to differentiate the genotypes. Figure 2 showed the best eight (resistant) and worst eight (susceptible) finger millet accessions based on the mean FB score. NGRC05050, the latest released variety (Kabre Kodo-2) showed the mean FB score of 2.8, NB score of 1.9, LBS score of 0.6 and LBF score of 1.1. The overall FB score of resistant genotypes ranged from 2.1 to 2.3 while that of susceptible genotypes ranged from 3.7 to 4.2, whereas the mean NB score ranged between 1.5 and 2.3 for resistant genotypes while between 1.6 and 3.0 for susceptible genotypes. Accessions resistant for NB were found resistant for FB, LBS and LBF too but susceptible accessions for FB showed susceptibility for NB but not for LBS and LBF.

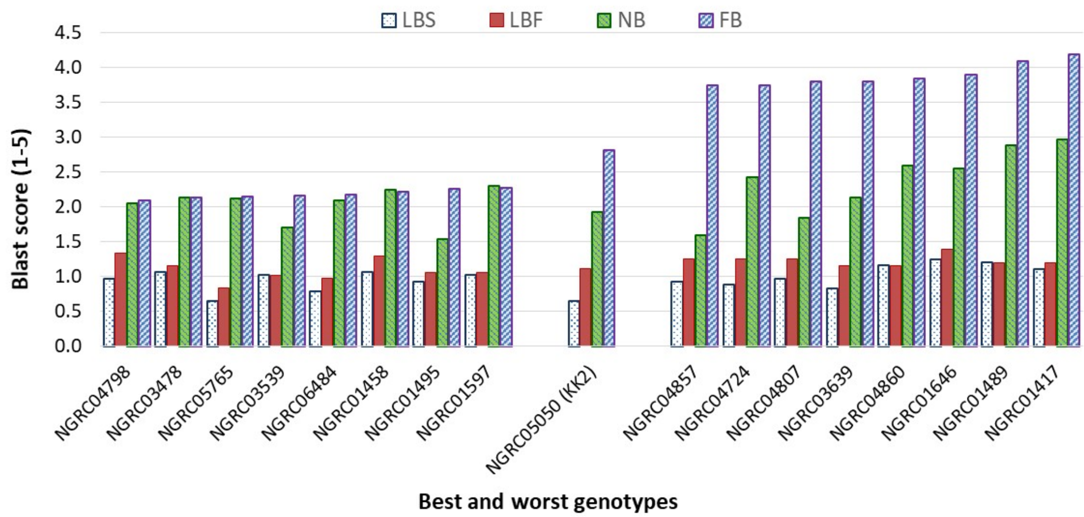

Figure 2. Top eight (resistant) and bottom eight (susceptible) finger millet accessions selected based on mean finger blast score. Accession in the middle is the latest released variety Kabre kodo-2 (NGRC05050). Data are mean of 12 sets of observations (2 replications × 3 locations × 2 years).

DISCUSSION

We observed strong positive correlation between finger blast and neck blast (r=0.71), finger and leaf blast (r=0.58) and neck and leaf blast (r=0.68) which is commonly reported in finger millet germplasm screening by many authors (Kiran Babu et al 2013, Das et al 2021, Nagaraja et al 2010) because leaf, neck and finger blasts are caused by the same pathogen i.e., *Pyricularia grisea* (Cooke) Sacc. This fungus also causes leaf, neck and panicle blast in many other economically important crop species of grass family (Das et al 2021, Gupta et al 2017, Khadka et al 2012, Mbinda and Masaki 2021, Sharma et al 2014). This fungus spreads mainly by air borne conidia (Das et al 2021). It has been reported that a day temperature of 25–30°C with cooler night (15–20°C) and the relative humidity of more than 80% favours the rapid development of blast diseases (Kiran Babu et al 2013, Das et al 2021, Manandhar et al 2016, Mbinda and Masaki 2021). The humidity and temperature were favourable for blast disease development in four out of six environments throughout the crop growing period (June–September) in the experiment (**Table** 1). The relative humidity during disease development period is quite low in Jumla during both the years, which is the reason for low incidence of blast diseases at that particular location. Relatively more disease severity in Lalitpur and Dolakha was because of more favourable weather conditions than in Jumla. Dolakha received more rainfall with high humidity during the blast development period (June–September) followed by Lalitpur. A study on the reaction variability of finger millet blast isolates from different places of Nepal reported that Dolakha (Kabre) is one of the best sites for finger millet blast screening (Khadka et al 2013). However, we observed Lalitpur (Khumaltar) as another hotspot for blast screening in finger millet. Relatively less disease severity of the population as indicated by population means over locations as well as at individual location was mostly attributed by the disease escape due to unfavourable environment, less pathogen pressure and might be the presence of blast resistant accessions in the diverse Genebank collection.

Neck and finger blast reactions are more destructive than leaf blast and can be considered as important parameters for blast resistance (Nagaraja et al 2010, Takan et al 2004). Thus, the finger and neck blast in finger millet may be jointly called head blast, like panicle blast in rice to make scoring easy and to avoid complications arisen by two different names. Highly significant ($P< 0.001$) variation among the accessions for neck and finger blast reactions in most of the environments separately as well as in the pooled data indicated high variation among the genotypes for blast resistance. The pooled population mean suggested that almost one-third entries were showing better resistance for finger blast, one-tenth entries showing better resistance to neck blast and around one-fourth accessions are showing better resistance to leaf blast compared to the best released variety Kabre Kodo-2. Since there was no standard resistant or susceptible variety to include as checks, we compared test accessions with NGRC05050 (Kabre Kodo-2) which is a newest released variety for mid hills and possesses field resistance to finger and neck blast (Joshi et al 2017). The large proportion of resistant genotypes was observed because of the genetic diversity present in the test entries which were the landraces collected from 54 districts of six provinces. Kiran Babu et al (2013) has reported 66 of the 80 accessions from ICRISAT mini-core collections showed combined resistance to leaf, neck and finger blast in two seasons of field screening. Similarly, Das et al (2021) has also reported that 29 out of 115 genotypes showed resistance either for finger blast or for neck blast. Present study identified eight germplasm accessions, namely NGRC04798, NGRC03478, NGRC05765, NGRC03539, NGRC06484, NGRC01458 and NGRC01597, which were the resistant genotypes for both finger and neck blast based on pooled data. The phenotypic observations on these genotypes suggested that they have better grain yield, compact fingers, optimum plant height and medium maturity period.

The monthly minimum temperature at Jumla during October 2017 dropped below 8°C which hindered flowering and grain filling of the accessions with late maturity period. This caused missing data (NA) of 15 accessions for neck blast and 124 accessions for finger blast (**Table** 2). During 2018, all the accessions were headed but only 19 accessions had missing information for finger blast. The major limitation of the present study was screening only under natural epiphytotic conditions. However, it is recommended for screening under disease inoculated conditions with conducive environment to achieve more precise screening results by avoiding unfavourable natural environments for disease development.

CONCLUSION

There were variable reactions observed in the finger millet germplasm panel for blast diseases at different growth stages of the crop. The genotype × environment interaction was also evident for different stages of blast disease. Leaf blast was not so severe in all environments, but neck and finger blasts were more severe. Finger blast is strongly associated with neck blast and leaf blast. Out of the 300 finger millet accessions evaluated, 95 accessions were having less score of finger blast compared to the best released variety Kabre Kodo-2. Among them, accessions viz. NGRC04798, NGRC03478, NGRC05765, NGRC03539, NGRC06484, NGRC01458 and NGRC01597 are found the resistant genotypes for finger as well as neck blast. Utilization of these genotypes could be the best approach to develop blast resistant varieties of finger millet for hill agro-ecosystem of Nepal.

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Annex Table 1. Detail of genotypes used in the experiment with their mean disease scores

SN	Accession	Local name	District	LBS	LBF	NB	FB
1	NGRC01400	Thangre	Ilam	1.2	1.9	1.9	3.1
2	NGRC01401	Nangkatuwa	Ilam	1.8	2.0	2.0	3.4
3	NGRC01406	Kodo	Ilam	1.8	2.3	2.0	3.3
4	NGRC01414	Dalle	Doti	1.6	2.2	2.2	3.1
5	NGRC01417	Dalle	Bhojpur	2.0	2.2	3.0	4.2
6	NGRC01418	Seto	Bhojpur	1.7	1.7	2.2	3.2
7	NGRC01419	Pahenle	Bhojpur	1.8	1.8	2.1	2.5
8	NGRC01420	Mudke	Bhojpur	1.6	2.4	2.3	3.3
9	NGRC01421	Seto dhan	Bhojpur	1.8	2.3	2.2	3.0
10	NGRC01422	Nangre	Bhojpur	1.3	2.5	2.3	3.2
11	NGRC01423	Pangdure	Bhojpur	1.4	2.2	2.0	3.3
12	NGRC01424	Nangkatuwa	Dhankuta	1.8	2.2	2.0	3.5
13	NGRC01425	Dude mudke	Sankhuwasabha	1.8	1.9	1.9	2.6
14	NGRC01426	Thulo mudke	Sankhuwasabha	1.6	1.9	2.0	3.0
15	NGRC01427	Kattike	Sankhuwasabha	1.4	1.8	2.4	3.2
16	NGRC01428	Seto	Sankhuwasabha	1.8	2.1	2.4	3.6
17	NGRC01429	Nangkatuwa	Sankhuwasabha	1.5	2.3	2.0	3.0
18	NGRC01430	Kalo mudke	Tehrathum	1.7	2.8	1.9	2.6
19	NGRC01431	Chhatre	Tehrathum	1.8	2.6	2.4	3.3
20	NGRC01432	Makwanpur	Gorkha	1.6	1.9	2.2	3.0
21	NGRC01433	Seto	Gorkha	1.5	1.8	2.6	2.9
22	NGRC01435	Jhamke	Gorkha	1.5	1.9	2.6	3.1
23	NGRC01436	Thulo	Gorkha	1.7	2.2	2.4	3.0
24	NGRC01438	Kalo dalle	Gorkha	1.4	2.0	2.3	3.2
25	NGRC01441	Andhikhole	Lamjung	1.7	2.2	1.8	3.1
26	NGRC01443	Chamre	Lamjung	1.3	2.0	2.1	2.9
27	NGRC01444	Kattike	Lamjung	1.8	2.5	2.4	2.6
28	NGRC01446	Kodo	Lamjung	1.8	2.6	2.0	3.3
29	NGRC01447	Mudke	Tanahun	1.7	2.2	2.5	2.9
30	NGRC01449	Baidy	Tanahun	1.4	2.3	2.3	3.6
31	NGRC01451	Jhyaure	Tanahun	1.6	2.3	1.7	2.7
32	NGRC01452	Mangsire	Tanahun	1.8	2.5	2.5	3.1
33	NGRC01455	Dalle	Kaski	1.8	1.9	2.5	3.1
34	NGRC01456	Dudhe	Tanahun	2.3	2.1	2.1	2.5
35	NGRC01458	Kalo bhuni	Kaski	1.9	2.3	2.3	2.2
36	NGRC01459	Kalo maurelo	Kaski	1.5	1.7	2.0	3.1
37	NGRC01462	Urchho	Kaski	2.2	2.5	2.7	3.0
38	NGRC01476	Laibare	Solukhumbu	1.3	1.7	2.1	3.0
39	NGRC01477	Pangdure	Solukhumbu	1.9	1.9	2.0	2.9
40	NGRC01478	Pangdure	Solukhumbu	2.0	2.2	2.2	3.5
41	NGRC01479	Lekali	Solukhumbu	1.8	2.2	2.0	3.6
42	NGRC01481	Kalo chyathe	Okhaldhunga	1.8	2.0	3.0	2.7
43	NGRC01482	Matyangre	Okhaldhunga	2.0	2.3	2.8	3.2
44	NGRC01483	Asoje	Okhaldhunga	1.8	1.8	2.0	3.3
45	NGRC01484	Latte	Okhaldhunga	1.8	1.9	2.1	3.2
46	NGRC01485	Dudhe pangdure	Okhaldhunga	2.0	1.8	2.5	3.0

SN	Accession	Local name	District	LBS	LBF	NB	FB
47	NGRC01487	Achhame	Khotang	1.7	2.1	2.6	2.7
48	NGRC01488	Latre	Khotang	1.8	2.1	1.6	2.4
49	NGRC01489	Maduwa	Udayapur	2.2	2.2	2.9	4.1
50	NGRC01490	Kali	Khotang	2.0	1.8	2.2	2.4
51	NGRC01491	Seto	Khotang	1.7	2.4	2.0	3.1
52	NGRC01492	Dalle	Khotang	2.3	2.3	2.4	3.2
53	NGRC01494	Pangdure	Khotang	1.8	1.9	2.3	3.0
54	NGRC01495	Thulo chuchhe	Khotang	1.7	1.9	1.5	2.3
55	NGRC01497	Asoje	Jajarkot	1.9	2.3	2.5	2.9
56	NGRC01498	Sano	Rukum	1.5	1.8	2.4	2.3
57	NGRC01512	Kodo	Rukum	1.5	2.7	2.1	2.6
58	NGRC01516	Seto	Jajarkot	2.0	2.3	1.7	2.7
59	NGRC01517	Seto	Sallyan	1.9	2.3	2.8	3.2
60	NGRC01521	Tauke	Sallyan	1.6	2.3	2.1	2.5
61	NGRC01524	Sano	Baglung	1.6	2.2	2.3	3.3
62	NGRC01525	Urchho	Baglung	1.8	1.9	2.1	3.1
63	NGRC01526	Seto	Baglung	2.2	2.7	2.3	2.9
64	NGRC01527	Dalle	Myagdi	1.8	1.9	2.3	3.1
65	NGRC01539	Jhopae	Myagdi	1.8	1.7	2.3	3.4
66	NGRC01546	Dalle jhope	Baglung	1.9	2.5	2.4	2.4
67	NGRC01559	Thulo jhape	Baglung	1.8	2.5	2.0	2.6
68	NGRC01563	Thulo jhape	Myagdi	1.6	3.1	2.3	2.8
69	NGRC01578	Seto jhope	Parbat	2.0	2.3	2.1	2.9
70	NGRC01586	Dalle	Parbat	2.0	2.2	2.3	2.6
71	NGRC01590	Jhopae dalle	Parbat	1.8	2.3	2.1	2.7
72	NGRC01591	Dalle jhope	Parbat	2.0	2.6	2.3	2.6
73	NGRC01592	Vachuwa	Parbat	2.3	2.3	2.3	2.8
74	NGRC01594	Jhopae	Parbat	1.8	2.7	2.3	2.9
75	NGRC01597	Seto	Kaski	1.8	1.9	2.3	2.3
76	NGRC01599	Asare	Kaski	1.7	2.0	2.0	2.5
77	NGRC01600	Jhopae	Kaski	1.9	2.5	2.3	2.9
78	NGRC01603	Kodo	Kaski	1.8	2.5	2.2	3.0
79	NGRC01608	Kalo	Parbat	1.8	2.0	2.3	2.7
80	NGRC01609	Kukurkane	Parbat	1.7	2.2	2.4	2.4
81	NGRC01610	Bhochuwa	Parbat	1.9	2.3	2.5	2.8
82	NGRC01622	Lurkae	Parbat	1.9	2.2	2.4	3.0
83	NGRC01623	Bhochuwa	Baglung	1.6	2.6	2.2	2.6
84	NGRC01627	Jhopae	Kaski	1.7	1.9	1.8	2.8
85	NGRC01634	Juntali	Syangja	1.8	2.1	2.3	3.2
86	NGRC01636	Katike	Syangja	1.7	1.8	2.1	2.9
87	NGRC01639	Danja	Syangja	1.5	2.3	2.5	2.5
88	NGRC01644	Kalo	Jumla	1.5	1.8	2.4	2.8
89	NGRC01645	Rato	Jumla	1.8	1.9	2.2	2.8
90	NGRC01646	Rato	Jumla	2.3	2.5	2.6	3.9
91	NGRC01649	Kalo	Jumla	1.9	2.0	2.3	3.1
92	NGRC01652	Kalo	Kalikot	2.1	2.3	2.9	3.2
93	NGRC01653	Dalle	Dolpa	2.2	2.6	2.2	2.9

SN	Accession	Local name	District	LBS	LBF	NB	FB
94	NGRC01654	Gamki rato	Mugu	1.9	2.2	2.1	3.5
95	NGRC01655	Barakoti	Mugu	2.1	2.0	2.2	3.6
96	NGRC01656	Jaad	Mugu	1.6	2.0	2.7	3.4
97	NGRC03441	Saraya	Kapilbastu	1.7	2.4	2.4	3.0
98	NGRC03442	Fulbiranj	Kapilbastu	1.8	2.3	2.3	3.6
99	NGRC03443	Jhapre	Palpa	1.8	1.8	2.4	2.8
100	NGRC03445	Dalle	Palpa	1.6	2.1	2.6	3.4
101	NGRC03447	Dalle	Arghakhanchi	1.8	2.3	2.3	2.8
102	NGRC03458	Kodo	Ramechhap	1.5	1.7	1.9	3.4
103	NGRC03459	Nuwakote	Solukhumbu	1.5	1.8	2.0	3.0
104	NGRC03460	Dalle	Solukhumbu	2.0	2.3	2.4	3.0
105	NGRC03463	Mansele	Solukhumbu	1.9	2.7	2.5	2.5
106	NGRC03466	Nangre	Gorkha	1.8	1.9	1.8	3.5
107	NGRC03467	Local	Gorkha	2.2	2.4	2.3	3.1
108	NGRC03478	Dalle	Dhading	1.9	2.1	2.1	2.1
109	NGRC03482	Dunkote	Dhading	1.5	2.3	2.3	2.6
110	NGRC03483	Paundar	Dhading	1.8	1.9	1.8	2.6
111	NGRC03484	Tauke	Dhading	1.6	2.2	2.1	2.7
112	NGRC03485	Kalo dhuskote	Dhading	1.8	2.1	2.3	3.1
113	NGRC03486	Chaure dalle	Dhading	1.8	2.1	2.4	2.6
114	NGRC03488	Palise	Solukhumbu	1.8	2.0	2.3	3.3
115	NGRC03491	Pandharu	Dolakha	1.6	1.7	1.8	3.5
116	NGRC03493	Sunkosi	Dolakha	2.3	2.2	2.1	3.3
117	NGRC03498	Charsa	Dolakha	1.8	2.3	2.3	2.7
118	NGRC03500	Jarpire	Ramechhap	1.8	2.2	2.3	3.0
119	NGRC03501	Soutare	Ramechhap	1.6	2.3	2.3	2.7
120	NGRC03502	Mulura	Ramechhap	1.3	2.3	2.3	2.9
121	NGRC03503	Nagare	Sindhuli	1.5	2.3	2.3	3.2
122	NGRC03505	Bharuke	Dolakha	1.7	1.8	1.9	2.8
123	NGRC03507	Maruke	Ilam	1.6	1.9	2.7	2.6
124	NGRC03508	Dalle	Panchthar	1.8	2.4	1.9	3.1
125	NGRC03509	Muluke	Panchthar	1.7	2.0	2.0	3.2
126	NGRC03510	Kodo	Panchthar	1.5	1.9	2.4	2.5
127	NGRC03511	Chhyangre	Taplejung	1.8	2.3	2.2	2.9
128	NGRC03512	Kodo	Taplejung	2.0	2.8	2.3	3.2
129	NGRC03513	Muluke	Taplejung	2.3	2.6	1.9	2.8
130	NGRC03521	Kalo	Darchula	1.8	2.0	2.3	3.2
131	NGRC03523	Kodo	Bajhang	1.7	2.3	1.9	3.4
132	NGRC03526	Kodo	Darchula	2.0	2.1	2.3	3.1
133	NGRC03528	Pangli	Dandeldhura	2.0	2.4	3.1	2.6
134	NGRC03539	Jhapre	Jhapa	1.8	1.8	1.7	2.2
135	NGRC03540	Muruwa	Sunsari	1.7	2.4	1.4	2.6
136	NGRC03544	Kodo	Mustang	1.8	2.2	2.2	3.0
137	NGRC03551	Kodo	Myagdi	1.4	2.3	2.4	3.2
138	NGRC03554	Archaure	Kaski	1.5	2.6	2.5	2.3
139	NGRC03559	Kodo	Nuwakot	1.7	2.0	2.1	3.2
140	NGRC03563	Rato kodya	Humla	1.7	2.3	2.5	2.9

SN	Accession	Local name	District	LBS	LBF	NB	FB
141	NGRC03564	Temasya kodya	Humla	2.3	2.3	1.9	2.8
142	NGRC03565	Dalle kodya	Humla	1.8	1.9	2.4	3.1
143	NGRC03566	Mudke	Humla	1.6	1.9	2.4	3.2
144	NGRC03568	Rato	Mugu	1.8	2.3	2.9	3.5
145	NGRC03570	Jhaure	Bajura	1.6	2.2	2.1	2.7
146	NGRC03573	Rato	Mugu	1.4	2.8	2.5	3.1
147	NGRC03575	Bablale	Bajura	1.3	2.1	2.2	2.8
148	NGRC03577	Lapre	Bajura	1.8	2.0	1.8	2.9
149	NGRC03579	Kalo	Bajura	1.8	2.1	2.8	3.5
150	NGRC03580	Kalo	Achham	1.8	2.1	2.2	3.5
151	NGRC03581	Lwakhde	Achham	1.8	2.3	2.9	3.5
152	NGRC03583	Nanu	Doti	1.6	2.3	2.4	2.8
153	NGRC03586	Thulo	Doti	1.7	1.8	2.2	2.9
154	NGRC03589	Local	Humla	1.8	1.7	2.4	3.7
155	NGRC03603	Suki	Syangja	1.8	2.1	2.1	2.9
156	NGRC03604	Jhapre	Syangja	1.8	2.2	2.2	2.7
157	NGRC03605	Seto	Syangja	1.8	2.2	2.1	2.9
158	NGRC03607	Juneli kodo	Gorkha	1.6	2.5	2.0	3.0
159	NGRC03612	American	Myagdi	1.6	2.2	2.1	2.7
160	NGRC03615	Jhope	Myagdi	1.6	1.9	2.2	3.1
161	NGRC03620	Sirubare	Sindhupalchok	1.7	1.8	2.2	3.4
162	NGRC03623	Lurke	Sindhupalchok	2.2	1.8	2.3	2.9
163	NGRC03624	Boulaha	Baglung	1.4	2.1	2.3	3.2
164	NGRC03626	Kirne	Sindhupalchok	1.8	1.9	2.2	2.6
165	NGRC03627	Chulthe	Sindhupalchok	2.0	2.2	2.0	2.6
166	NGRC03629	Sangle	Sindhupalchok	1.6	2.5	2.6	3.5
167	NGRC03630	Mudke	Baglung	1.6	2.3	2.1	2.9
168	NGRC03631	Jhapre	Baglung	2.2	2.0	1.8	2.9
169	NGRC03632	Khairo	Doti	1.6	1.9	2.7	3.2
170	NGRC03635	Kali kode	Doti	1.5	2.0	2.2	3.5
171	NGRC03636	Gam kode	Doti	1.6	2.2	2.4	3.3
172	NGRC03639	Jhakere	Baitadi	1.5	2.1	2.1	3.8
173	NGRC03644	Thulo kodo	Dandeldhura	1.9	1.9	2.1	3.3
174	NGRC03650	Temase	Darchula	1.6	2.3	2.8	3.7
175	NGRC03653	Jhapre	Darchula	2.1	2.7	2.1	3.1
176	NGRC03654	Mudke	Darchula	2.1	2.2	3.0	3.0
177	NGRC03656	Mudke	Dolakha	1.8	2.2	2.2	3.1
178	NGRC03657	Pahelo	Dolakha	1.9	2.2	2.0	3.2
179	NGRC03662	Khershe	Dolakha	1.8	2.4	2.4	3.4
180	NGRC03668	Pahelo	Dolakha	1.5	1.9	2.1	3.3
181	NGRC03674	Seto kodo	Dolakha	2.1	2.5	2.3	2.8
182	NGRC03677	Nesanga	Rasuwa	1.8	2.5	2.4	3.5
183	NGRC03678	Seto	Rasuwa	2.0	2.8	2.1	2.8
184	NGRC03680	Local nesanga	Rasuwa	1.7	2.4	2.3	3.1
185	NGRC03683	Local chyalda	Rasuwa	1.8	2.8	2.3	2.6
186	NGRC03685	Jhyatle	Rasuwa	1.8	2.9	2.1	2.6
187	NGRC03690	Kartike	Nuwakot	1.7	2.3	2.2	3.0

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188	NGRC03691	Chainpure	Nuwakot	1.7	2.3	1.9	2.4
189	NGRC03693	Dalle	Nuwakot	2.3	2.3	2.1	3.3
190	NGRC03694	Local	Nuwakot	1.8	2.1	2.4	3.4
191	NGRC04724	Maile	Doti	1.6	2.3	2.4	3.8
192	NGRC04727	Local	Dandeldhura	1.7	2.7	1.9	2.9
193	NGRC04729	Kalo kodo	Baitadi	1.7	2.3	2.3	2.9
194	NGRC04730	Mudke kodo	Baitadi	1.5	1.7	2.3	3.3
195	NGRC04732	Gaun kode	Baitadi	1.8	2.2	2.6	3.4
196	NGRC04733	Kodo	Mustang	1.8	2.3	2.4	3.1
197	NGRC04734	Kodo	Baitadi	1.8	2.3	2.5	2.8
198	NGRC04737	Bikase	Bhojpur	1.4	2.3	2.0	3.3
199	NGRC04738	Mudke	Gorkha	1.7	2.1	2.5	2.9
200	NGRC04740	Jhupara	Darchula	1.6	2.5	2.5	3.6
201	NGRC04746	Kartike	Rasuwa	1.5	2.1	2.1	3.1
202	NGRC04747	Barlabote	Rasuwa	1.8	2.6	2.0	2.6
203	NGRC04751	Nanglibang	Myagdi	1.6	1.9	1.8	2.9
204	NGRC04766	Rutle kodya	Humla	1.8	2.1	2.1	2.6
205	NGRC04769	Mansile	Ilam	1.5	2.3	2.1	2.5
206	NGRC04773	Mansire	Kavre	1.8	3.1	2.5	2.8
207	NGRC04775	Bhadaure	Kavre	1.8	2.5	2.2	3.0
208	NGRC04777	Chalthya	Kavre	1.8	2.4	2.0	2.9
209	NGRC04778	Dalle	Kavre	2.3	2.2	1.9	2.5
210	NGRC04779	Chyalthe	Kavre	1.7	2.2	2.4	3.1
211	NGRC04781	Kalo	Dolakha	1.9	2.6	2.6	3.2
212	NGRC04786	Chyalthe	Dolakha	1.7	2.7	2.2	2.9
213	NGRC04788	Dolkhe	Dolakha	1.4	2.1	2.4	2.9
214	NGRC04789	Kodo	Kavre	1.8	2.2	2.6	2.6
215	NGRC04790	Nangkatuwa	Ramechhap	1.4	2.3	2.4	2.9
216	NGRC04792	Seto	Ramechhap	1.5	2.4	2.3	2.5
217	NGRC04794	Kalo	Ramechhap	1.7	1.9	2.2	2.6
218	NGRC04795	Charikote	Ramechhap	1.6	2.2	2.2	2.5
219	NGRC04798	Okhaldhunge	Ramechhap	1.8	2.4	2.0	2.1
220	NGRC04803	Chayalse	Dolakha	2.1	2.5	2.1	3.2
221	NGRC04804	Jhuppe	Dolakha	1.5	1.9	2.2	2.4
222	NGRC04806	Dalle	Ramechhap	1.5	2.1	1.8	2.5
223	NGRC04807	Thulo	Pyuthan	1.8	2.3	1.8	3.8
224	NGRC04808	Thulo	Pyuthan	1.5	2.8	2.3	3.2
225	NGRC04809	Kodo seto	Surkhet	1.7	2.1	2.2	2.7
226	NGRC04812	Aghaute	Dailekh	1.9	1.7	2.2	3.6
227	NGRC04814	Gaun	Dailekh	1.4	2.0	2.6	3.0
228	NGRC04816	Mangsire	Dailekh	1.8	2.2	2.0	2.8
229	NGRC04817	Lamre	Dailekh	1.9	2.4	2.3	3.3
230	NGRC04818	Jhamre	Dailekh	2.1	2.0	3.1	2.9
231	NGRC04820	Tiyase	Dailekh	1.7	2.0	2.3	3.5
232	NGRC04821	Kalo	Dailekh	1.8	1.9	2.1	3.5
233	NGRC04824	Sano kalo	Dailekh	2.1	2.2	2.0	3.1
234	NGRC04828	Thulo	Sindhupalchok	1.5	1.8	2.9	2.9

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235	NGRC04830	Mudke	Sindhupalchok	1.9	2.2	2.5	3.5
236	NGRC04832	Dhaule	Bajhang	1.8	2.8	2.1	2.9
237	NGRC04833	Kalo	Bajhang	1.8	2.8	2.4	2.8
238	NGRC04836	Chaumase	Bajhang	1.8	2.3	2.3	2.7
239	NGRC04837	Dalle	Bajhang	2.1	2.7	2.2	3.0
240	NGRC04846	Tauke	Rukum	2.0	2.6	2.2	3.4
241	NGRC04847	Rato	Rukum	1.8	2.4	2.4	3.1
242	NGRC04848	Kuture	Rukum	1.9	2.4	1.8	3.2
243	NGRC04849	Thulo	Rukum	1.8	2.3	3.4	3.0
244	NGRC04850	Jhamre dolo	Jajarkot	2.0	2.3	2.0	3.1
245	NGRC04852	Arun	Sindhupalchok	1.6	2.0	2.3	3.0
246	NGRC04857	Rato	Jumla	1.7	2.3	1.6	3.7
247	NGRC04860	Rato	Kalikot	2.1	2.1	2.6	3.8
248	NGRC04863	Kalo	Jumla	1.7	1.8	2.2	3.4
249	NGRC04871	Kodo	Udayapur	1.8	2.3	2.7	3.5
250	NGRC04873	Dude	Lalitpur	1.7	2.3	2.2	2.6
251	NGRC04876	Chyalthe	Sindhupalchok	1.6	1.9	2.5	2.4
252	NGRC04877	Pahelo	Dhading	1.4	2.0	2.3	3.0
253	NGRC04878	Dalle	Dailekh	1.7	1.7	2.3	3.5
254	NGRC04880	Sailung-1	HCRP	1.9	2.2	2.2	2.5
255	NGRC05049	Kabre kodo-2	HCRP	1.7	2.5	2.2	2.6
256	NGRC05050	Kalo dalle	Arghakhanchi	1.2	2.0	1.9	2.8
257	NGRC05109	Ashoje	Baglung	1.7	2.4	2.2	3.3
258	NGRC05125	Dalle	Baglung	2.2	2.3	2.3	3.0
259	NGRC05126	Jhape	Baglung	1.6	2.1	2.3	3.2
260	NGRC05129	Seto	Palpa	1.8	2.1	2.0	2.5
261	NGRC05738	Kalo jhuse	Palpa	1.8	2.2	2.3	2.9
262	NGRC05739	Kaise	Palpa	1.9	2.2	1.9	3.1
263	NGRC05744	Khairo local	Palpa	1.5	2.3	2.4	2.8
264	NGRC05748	Buche jhabari	Palpa	1.4	1.8	2.3	2.7
265	NGRC05751	Murke	Palpa	1.4	2.0	2.6	2.4
266	NGRC05752	Thulle jhabre	Palpa	1.6	1.8	2.5	2.8
267	NGRC05754	Kukur kane	Palpa	1.4	1.8	2.1	2.6
268	NGRC05755	Lan jhabre	Palpa	1.7	2.3	1.8	2.9
269	NGRC05757	Kalo dalle	Palpa	1.6	2.4	2.7	2.4
270	NGRC05758	Kalo jhabari	Palpa	1.9	2.2	1.9	3.1
271	NGRC05760	Seto jhabari	Palpa	2.3	2.2	2.4	3.3
272	NGRC05763	Maikuti	Palpa	1.3	1.9	2.9	3.0
273	NGRC05764	Dade	Kaski	1.6	1.8	1.8	2.4
274	NGRC05765	Kalo sthaniya	Jumla	1.2	1.5	2.1	2.2
275	NGRC06476	Dudhe	Tanahun	1.9	2.0	2.2	3.0
276	NGRC06478	Kattike	Tanahun	1.6	1.9	2.0	2.6
277	NGRC06479	Tanunge	Tanahun	2.3	2.6	2.7	2.7
278	NGRC06480	Laafre	Tanahun	1.7	1.7	2.4	2.5
279	NGRC06481	Mudke sano	Tanahun	1.8	2.3	1.6	3.0
280	NGRC06483	Jwain seto	Tanahun	1.5	2.1	2.3	2.5
281	NGRC06484	Paundure	Tanahun	1.4	1.8	2.1	2.2

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282	NGRC06485	Chamre	Tanahun	1.5	1.6	2.3	3.2
283	NGRC06486	Kali	Sindhuli	1.7	1.9	2.3	2.7
284	NGRC06487	Lwang fuli	Sindhuli	1.8	2.3	2.0	2.5
285	NGRC06489	Hasure	Sindhuli	2.1	2.4	2.3	3.1
286	NGRC06490	Seto	Sindhuli	1.8	2.1	2.1	2.8
287	NGRC06492	Sipali	Sindhuli	1.3	1.8	2.4	3.3
288	NGRC06493	Kalo	Kailali	1.8	2.0	2.0	3.5
289	NGRC06494	Rato	Kailali	1.8	2.0	1.8	3.6
290	NGRC06495	Kodo	Sankhuwasabha	1.6	2.6	2.2	3.2
291	NGRC06496	Mudke	Doti	1.7	2.3	1.8	3.6
292	NGRC06498	Kalo dalle	Doti	2.1	1.7	2.3	3.2
293	NGRC06499	Seto jhyape	Dhading	1.7	1.7	2.1	3.1
294	NGRC06500	Seto	Dhading	1.9	2.5	2.3	2.9
295	NGRC06501	Mudke	Dhading	1.7	2.3	2.3	3.2
296	NGRC06503	Sthaniya	Kanchanpur	1.9	1.8	2.5	3.5
297	NGRC06504	Dalle	Kailali	1.4	2.2	2.3	2.4
298	NGRC07021	Dalle-1	HCRP	1.9	2.3	2.4	3.4
299	NGRC07039	Kabre kodo-1	HCRP	1.3	2.0	1.9	3.3
300	NGRC07044	Okhle-1	HCRP	1.8	2.9	2.7	3.0