Mysore J. Agric. Sci., 56 (3) : 185-195 (2022)

GPUP 28 : A New High Yielding Proso Millet Variety (*Panicum miliaceum* L.) for Southern and Eastern Dry Zones of Karnataka

T. E. Nagaraja, C. Nandini, Sujata Bhat, T. S. Sukanya, K. B. Palanna, Prabhu C. Gangier, H. S. Saritha, Gazal S. Praveen and D. N. Vinutha

Project Co-ordinating Unit, ICAR-AICRP on Small Millets, ZARS, UAS, GKVK, Bengaluru - 560 065

e-Mail : nandini.vinutha@gmail.com

Authors Contribution

T. E. Nagaraja : Monitoring of farm trials
C. Nandini & Sujata Bhat : Conducting trials
T. S. Sukanya : Agronomic evaluation
K. B. Palanna : Disease screening of the variety
Prabhu C. Gangier : Pest screening
H. S. Saritham : DUS characterization and molecular finger printing
Gazal S. Praveen & D. N. Vinutha : Conducting farm trials and manuscript preparation

Corresponding Author:

C. Nandini
Project Co-Ordinating Unit, ICAR-AICRP on Small Millets, ZARS, UAS, GKVK, Bengaluru

Received : January 2022

Accepted : June 2022

Abstract

New Proso millet variety GPUP 28 was developed at Project Coordinating unit, ICAR-AICRP on Small Millets, University of Agricultural Sciences, GKVK, Bengaluru for cultivation in Zone 5 and 6 of Karnataka. It has been evolved through hybridization between two released varieties GPUP 8 and K1. This variety has desirable characteristics of both the parents. This new variety matures in 80-85 days. It has intermediate compact with globose-elliptic shaped inflorescence. Grain is oval shaped with golden yellow colour possesses higher test weight. This variety is moderately resistant to leaf blight and resistant to brown spot diseases. GPUP 28 contains more grain calcium (127.7 ppm) content compared to the check GPUP 21. This variety has iron content of 28.8 ppm, 11.6 per cent protein, and 24.2 ppm of Zinc. Fodder contains high crude fiber (39.91 %) and crude fat (0.62 %) content. New variety GPUP 28 recorded an average grain yield of 29.43 q/ha in station trials, 27.8 q/ha in multilocation trials and 12.76 q/ha in farm trials with mean grain yield of 23.33 q/ha. Across all the trials GPUP 28 registered an average yield of 23.33 q/ha with 20.84 per cent increased yield over check variety GPUP 21. In All India Co-ordinated trials, GPUP 28 yielded 1643 kg/ha across the locations. GPUP 28 ranked 2nd and recorded 13.38 per cent increased seed yield over the check GPUP 21 in AICRP trials. This new variety is recommended for release in annual plant scientists group meeting held at UAS, GKVK, Bengaluru on 1-3rd March 2021, Annual ZREP workshop of Zone-6 held on 5th April 2021, Annual ZREP workshop of Zone-5 held on 8th April 2021 and State varietal evaluation committee (SVEC) meeting held on 13th to 16th December 2021. NBPGR, New Delhi has issued national identity number IC 635735 for this variety. Because of its superior performance in Zone 5 and 6 of Karnataka this variety has been recommended for cultivation in Southern (Zone 6) and Eastern (Zone 5) Dry Zones of Karnataka state.

Keywords: Coordinated trials, Grain yield, Inflorescence, Proso millet, Variety

Proso millet (*Panicum miliaceum* L.) is one of the important small millet crops, commonly known as broomcorn millet, hog millet, Russian millet, common millet and by other names in different regions. It is a warm-season annual grass, grows at a wide range of altitudes, with a short growth cycle and can complete its life cycle within 60-100 days (Rao, 1989 and Baltensperger, 2002). It is highly adapted to different soil and climatic conditions. It also has the capacity to efficiently convert water to dry matter and grain yield (Theisen *et al*., 1978 and Hulse *et al*., 1980). The high-water use efficiency of the crop is attributed to the short growth period rather than its drought tolerance capacity (Arnon, 1972 and Baltensperger, 2002) and is admired for growing as an emergency crop in late seasons (Yegna Narayan Aiyer, 1958). They are less prone to pests and diseases. Unlike the major crops *viz*., rice, wheat and maize, the resilience exhibited by

The Mysore Journal of Agricultural Sciences

proso millet is helpful in their adjustment to different ecological situations and make ideal crop for climate change and contingency plantings.

Proso millet is grown in India, China, Republic of Korea, South Eastern Russia, Pakistan, Afghanistan, Southern Europe and Mongolia. Among the millet species produced worldwide, proso millet is the most important species traded in the world market. Proso millet is used for feeding birds and as livestock feed in developed countries and for food in some parts of Asia (Rajput *et al*., 2014). In India proso millet is largely grown in Madhya Pradesh, Eastern Uttar Pradesh, Bihar, Tamil Nadu, Maharashtra, Andhra Pradesh and Karnataka.

Nutritionally, proso millet grains are rich in protein which ranges from 11.3 to 17 per cent of grain dry matter and its grains are richer in essential amino acids (leucine, isoleucine and methionine) than those of wheat (Saleh *et al.*, 2013). It is also rich in dietary fiber (14.2g / 100g seed) and micro nutrients *viz*., iron, zinc and potassium (Demirbas, 2005 and Gomeshe, 2017). Green plants are excellent fodder for cattle and horses and are also used as hay. Proso millet has been receiving growing interest from food industries in Europe and North America because of its mild flavor, light colour, gluten-free quality and potential health benefits (Wang *et al*., 2016).

Genetic improvement and cultivar development of proso millet has been achieved largely through direct selection of promising germplasm. In India, 17 cultivars have been released, of which nine were developed by hybridization followed by selection and the remaining by selection from landraces.

Generally lower yields in prosomillet are due to lack of high yielding varieties and non-adoption of improved cultural practices by the dry land farmers. There is a need to improve the genetic yield potentiality and evolve new high yielding varieties with shoot fly resistance, suitable for proso millet growing areas. Keeping this objective in view, breeding work was initiated to evolve new high yielding proso millet varieties to promote cultivation of this crop in different agro climatic conditions. The new cultivar GPUP 28, derivative of a cross GPUP 8 and K1 developed by recombining the desirable characteristics of both the parents.

Material and Methods

The Proso millet variety GPUP 28 was developed at Project Coordinating unit, ICAR-AICRP on Small Millets, University of Agricultural Sciences, GKVK, Bengaluru for cultivation in Zone 5 and 6 of Karnataka state. It has been evolved through hybridization between two released varieties GPUP 8 (It's a variety developed from UAS, Bengaluru during 2001. This variety has characters like tall plants, large compact panicles with ovoid shaped bold grains) and K1 (It's a variety developed from Tamil Nadu Agricultural University during 1982. This variety has characters like semi dwarf plants, open and loose panicles with large branches with smoky white colored grains) followed by pedigree method of selection.

The elite plants were selected from F_2 onwards and they were evaluated for their sustained yield ability and homozygosity and the GPUP 28 was found the best one among the selected lines. This variety was evaluated with local and national checks in station trials at Project Coordinating unit, ICAR-AICRP on Small Millets, University of Agricultural Sciences, GKVK, Bengaluru starting from 2017-2020 and All India Co-ordinated trials during 2018-2020. Besides this, this variety was also screened for brown spot, leaf blight diseases and shoot fly incidence as per the standard scale. This entry was tested in different locations of Zone 5 (Eastern dry zone) and Zone 6 (Southern dry zone) of Karnataka state. In Zone 5 this entry evaluated in Krishi Vigyan Kendra, Tiptur, Agriculture Research Station, Balajigapade and Agriculture Research Station, Kunigal. Similary, In Zone 6 it was evaluated in Agriculture Research Station, Mandya, Krishi Vigyan Kendra, Chamarajanagara and Agriculture Research Station, Madenur. Farm trials are conducted in 50 farmer's field of Zone 5 and 6 in Karnataka. In each farmer's field test entry and check variety are evaluated in 0.125 acres each. Details of the farm trial conducted in different districts are mentioned in Table 1.

Development of Proso millet variety GPUP 28

GPUP 8 X K1
↓
F1 (summer 2014)
↓
F2 (kharif 2014)
↓
F3 (summer 2015)
↓
F4 (kharif 2015)
↓
F5 (summer 2016)
↓
Preliminary yield Trial (2016)
↓
Station Trial (2017-2020)
↓
AICRP on Small Millets (2018-2020)
↓
Multilocation trials (2019)
↓
Agronomy Trial (2020)
↓
Farm trial (2020)
↓
Proposed for variety release (2020)

TABLE 1

Details of Farm trials conducted at different locations of Zone 5 and Zone 6 of Karnataka

District/ Organization	Trials conducted	District/ Organization	Trials conducted
KSDA, Kolar	2	KSDA, Mysuru	4
KSDA, Chikkaballapur	3	KSDA, Mandya	5
EEU, Bengaluru	5	KSDA, Chamarajanagara	2
KVK, Hadonalli	5	EEU, Nagenahalli	4
KVK, Chintamani	5	KVK, Mandya	5
KVK, Ramanagara	5	KVK, Chamarajanagara	5
Total	25	Total	25

RESULTS AND DISCUSSION

Yield Performance of Variety GPUP 28 in Station Trials

GPUP 28 was evaluated for yield and other ancillary characters in station trials from 2017 to 2020 along with check variety GPUP 21. GPUP 28 recorded mean seed yield of 29.43 q/ha. While, check GPUP 21 recorded mean seed yield of 23.47 q/ha. The new variety GPUP 28 recorded 25.39 per cent increased seed yield over the check GPUP 21. Other ancillary characters, Days to maturity over years ranged from 79 to 81 days. Similarly, Number of productive tillers ranged from 4.2 to 4.6, Plant height from 94 to 104 cm and Straw yield ranged from 2.5 to 3.9 t/ha. Mean seed yield and other ancillary characters of GPUP 28 over years in station trial is presented in Table 2.

Yield Performance of GPUP 28 in All India Coordinated Trials

In All India Co-ordinated trials, new variety GPUP 28 was tested in Initial Varietal Trial (IVT) during *kharif* 2018 and Advanced Varietal Trials (AVT) during 2018-19 and 2019-20. Summary grain yield data of Coordinated Varietal Trials were presented in Table 3. New variety GPUP 28 yielded 1643 kg/ha across the locations. While, check variety GPUP 21 yielded 1449 kg/ha. Likewise, GPUP 28 ranked 2nd and check GPUP 21 ranked 9th across the locations. The new variety GPUP 28 recorded 13.38 per cent increased seed yield over the check GPUP 21 in AICRP trials. In Advanced Varietal Trial during 2019 and 2020, new variety recorded 2001 kg/ha and 1967 kg/ha, respectively.

Yield Performance of GPUP 28 for Grain Yield in Multilocations of Zone 5 (Eastern dry zone) and Zone 6 (Southern Dry Zone) of Karnataka

In Zone 5, new variety GPUP 28 was evaluated in Bengaluru, Tiptur, Balajigapade and Kunigal along with check variety GPUP 21. Centre-wise grain yield data of GPUP 28 and check GPUP 21 is presented in Table 4. GPUP 28 registered a grain yield of 41.30 q/ha in Bengaluru, 12.37 q/ha in Tiptur, 26.67 q/ha in Balajigapadae and 24. 22 q/ha in Kunigal with mean

The Mysore Journal of Agricultural Sciences

TABLE 2

Mean seed yield and ancillary characters of new variety GPUP28 over years in station trial

Varieties	*kharif* 2017					*kharif* 2018				
	Grain yield (Q/ha)	Straw yield (t/ha)	No. of tillers	Days to maturity	Plant height (cm)	Grain yield (Q/ha)	Straw yield (t/ha)	No. of tillers	Days to maturity	Plant height (cm)
GPUP28	27.56 *	2.5	4.3	81	94.5	25.92 *	2.9	4.2	79	97.3
GPUP 21*	18.02	2.65	4.1	82	86.3	20.49	2.4	5	80	89.4
Mean	22.77	2.32	3.8	78	88.4	20.16	2.6	4.5	78	81.3
CD at 5%	3.3	0.61	0.71	2.43	6.5	2.7	0.81	0.68	2.1	6.21
CV (%)	8.13	6.33	5.82	1.56	6.23	7.96	5.92	6.1	1.48	6.0

Varieties	*kharif* 2019					*kharif* 2020					Mean grain yield (Q/ha) over years	% increase over check
	Grain yield (Q/ha)	Straw yield (t/ha)	No. of tillers	Days to maturity	Plant height (cm)	Grain yield (Q/ha)	Straw yield (t/ha)	No. of tillers	Days to maturity	Plant height (cm)		
GPUP 28	41.3 *	2.59	4.62	79	97.30	22.96	3.2	4.20	79	104.1	29.43	25.39
GPUP 21*	34.96	3.52	4.6	78	94.60	20.44	3.0	4.60	80	102.3	23.47	
Mean	35.02	2.95	4.83	79.85	111.7	20.83	2.63	4.76	79	114.2		
CD at 5%	4.8	0.94	0.69	1.42	4.03	6.9	0.84	0.51	1.65	4.28		
CV (%)	8.91	9.5	93	2.6	8.12	19.12	8.36	6.2	3.1	2.17		

*Check

TABLE 3

Performance of GPUP 28 in All India Coordinated Advanced varietal trial during *kharif* 2018

Entries	Days to 50 % Flowering	Grain yield (kg/ha)	Increase over check	Rank
GPUP 28	42	1643	13.38	2
GPUP 21 *	40	1449		9
C.D. (5%)		408		
C.V. (%)		20.12		

*Check

grain yield of 26.14 q/ha.While, GPUP 21 registered 34.96 q/ha, 8.42 q/ha, 21.52 q/ha and 23.04 q/ha in Bengaluru, Tiptur, Balajigapade and Kunigal respectively. Mean grain yield of GPUP 21 was 21.98 q/ha. New variety GPUP 28 recorded 18.90 per cent increased yield over check GPUP 21 in Zone 5 of Karnataka.

In Zone 6, GPUP 28 was evaluated in Mandya, Chamarajanagara and Madenur along with check variety GPUP 21. GPUP 28 registered a grain yield of 33.19 q/ha, 36.07 q/ha and 19.11 q/ha in Mandya, Chamarajanagara and Madenur, respectively. Mean grain yield of GPUP 28 was 29.46 q/ha. While, GPUP 21 registered 26.81 q/ha, 29.44 q/ha and 18.33 q/ha in Mandya, Chamarajanagara and Madenur, respectively. Mean grain yield of GPUP 21 was 24.86 q/ha. GPUP 28 recorded 18.47 per cent increased yield over check GPUP 21 in Zone 6 of Karnataka. Centre-wise grain yield data of GPUP 28 and check GPUP 21 is presented in Table 5.

TABLE 5

Results of Multi Location trials conducted on GPUP 28 in Zone 6 (grain yield, q/ha) during *kharif* 2019

Entries	Mandya	Chamaraja-nagara	Madenur	Mean	% increase over check GPUP 21
GPUP 28	33.19	36.07	19.11	29.46	18.47
GPUP 21 *	26.81	29.44	18.33	24.86	
C.D. (5%)	5.33	3.79	4.53		
C.V. (%)	12.89	7.93	16.40		

*Check

Across the locations Zone 5 and Zone 6 GPUP 28 recorded the mean grain yield of 27.80 q/ha and GPUP 21 recorded 23.42 q/ha. Across the locations GPUP 28 recoded 18.67 per cent increased grain yield over check GPUP 21. Mean performance of GPUP 28 and check GPUP 21 across zones is presented in Table 6.

TABLE 6

Mean performance of proposed variety GPUP 28 across zones (grain yield, q/ha)

Entries	Zone 5	Zone 6	Mean	% increase over check GPUP 21
GPUP 28	26.14	29.46	27.80	18.67
GPUP 21 *	21.98	24.86	23.42	

*Check

Performance of GPUP 28 in Farm Trials

Farm trials are used to validate small plot research with larger field scale evaluations. Farm trials are

TABLE 4

Results of Multi Location trials conducted on GPUP 28 in Zone 5 (grain yield, q/ha) during *kharif* 2019

Entries	Bengaluru	Tiptur	Balajigapade	Kunigal	Average	% increase over GPUP 21(check)
GPUP 28	41.30	12.37	26.67	24.22	26.14	18.90
GPUP 21*	34.96	8.42	21.52	23.04	21.98	
C.D. (5%)	4.81	1.63	4.8	3.58		
C.V. (%)	8.90	9.82	15.43	10.87		

*Check

TABLE 7

Performance of GPUP 28 in Farm Trials conducted in Zone 5 (Mean grain yield, q/ha) during *kharif* 2020

District/Organization	Trials allotted	Trials conducted	GPUP 28	GPUP 21*	% increase over check
KSDA, Kolar	5	3	11.93	10.83	10.15
KSDA, Chikkaballapur	5	3	Conducted 3 trials but vitiated due to high rain fall		
EEU, Bengaluru	5	5	17.00	13.92	22.13
KVK, Hadonalli	5	5	17.84	15.03	18.70
KVK, Chintamani	5	5	15.83	13.64	16.10
KVK, Ramanagara	5	5	13.20	11.96	10.37
Total	30	26	15.16	13.07	15.95

Overall, per cent increase over check 15.95

*Check

conducted in farmer's field in collaboration with Krishi Vigyan Kendra and Karnataka state department of agriculture. New variety and check variety were evaluated in farmer's field of different villages and taluk of each district.

In Zone 5, farm trials are conducted at KSDA Kolar, KSDA, Chikkaballapur, EEU, Bengaluru, KVK, Hadonalli, KVK, Chintamani and KVK, Ramanagara. GPUP 28 registered 10.15 per cent increased grain yield over GPUP 21 in KSDA Kolar. Similarly, 22.13 per cent in EEU, Bengaluru, 18.70 per cent in KVK, Hadonalli, 16.10 per cent in KVK, Chintamani and 10.37 per cent in KVK, Ramanagara. Overall new variety GPUP 28 showed 15.95 per cent increased yield over check GPUP 21 in Zone 5. Centre-wise grain yield data of GPUP 28 and check GPUP 21 in farm trials is presented in Table 7.

In Zone 6, farm trials are conducted at KSDA, Mysuru; KSDA, Mandya; KSDA, Chamarajanagara; EEU, Nagenahalli; KVK, Mandya and KVK, Chamarajanagara. Centre-wise grain yield data of GPUP 28 and check GPUP 21 in farm trials is presented in Table 8. GPUP 28 registered 11.84 per cent, 13.62 per cent, 31.71 per cent, 13.52 per cent, 12.96 *per cent* and 5.99 per cent increased grain yield over GPUP 21 at KSDA Mysuru, KSDA Mandya, KSDA Chamarajanagara, EEU Nagenahalli, KVK Mandya and KVK, Chamarajanagara, respectively. Overall new variety GPUP 28 recorded 14.20 per cent increased yield over check variety GPUP 21 in zone 6.Across the zones GPUP 28 recorded 15.26 per cent increased yields over check. Overall mean grain yield of Farm Trials Results of GPUP 28 in Zone 5 and Zone 6 is presented in Table 9.

TABLE 8

Performance of GPUP 28 in Farm Trials conducted in Zone 6 (Mean grain yield, q/ha) during *kharif* 2020

District/ Organization	Trials allotted	Trials conducted	GPUP 28	GPUP 21*	% increase over check
KSDA, Mysuru	5	4	8.43	7.53	11.84
KSDA Mandya	5	5	4.84	4.26	13.62
KSDA Chamarajanagara	5	2	10.80	8.20	31.71
EEU Nagenahalli	5	4	13.85	12.20	13.52
KVK, Mandya	5	5	20.47	18.12	12.96
KVK Chamarajanagara	5	5	11.96	11.28	5.99
Total	30	25	11.72	10.26	14.20

Overall, per cent increase over check: 14.20

*Check

TABLE 9

Overall mean (grain yield, q/ha) of Farm Trials Results of GPUP 28 in Zone-V and Zone-VI

Varieties	Zone-V		Zone-VI	
	Mean yield	% yield increase	Mean yield	% yield increase
GPUP 28	15.16	15.95	11.72	14.20
GPUP 21*	13.07		10.26	

*Check

Overall Performance of GPUP 28 in Station Trials, Multilocation Trials and Farm Trials

New variety GPUP 28 recorded an average grain yield of 29.43 q/ha in station trials, 27.8 q/ha in Multilocation trials and 13.44 q/ha in farm trials with mean grain yield of 23.55 q/ha. The check variety GPUP 21 recorded 23.47 q/ha, 23.42 q/ha and 11.66 q/ha in station trials, multilocation trials and farm trials, respectively with mean grain yield of 19.51 q/ha. Across all the trials GPUP 28 registered an average yield of 23.55 q/ha with 20.70 per cent increased yield over check variety GPUP 21. Over all mean grain yield of Station trials, Multilocation trials and Farm trials are presented in Table 10.

TABLE 10

Over all Mean grain yield (q/ha) of Station trials, Multilocation trials and Farm trials

Entries	Station trial	MLT s	Farm Trial	Mean	% increase over check
GPUP 28	29.43	27.8	13.44	23.55	20.70
GPUP 21*	23.47	23.42	11.66	19.51	

*Check

GPUP 28 has performed superior in all trials and given increased yield over check. Hence, this new variety is recommended for release in Annual Plant Scientists Group meeting held at UAS, GKVK, Bengaluru on 1-3rd March, 2021, Annual ZREP workshop of Zone-6

TABLE 11

Agronomic evaluation of proposed variety GPUP 28 and check variety GPUP 21 during *kharif* 2020 at Project Coordinating Unit, Small millets, UAS, GKVK, Bengaluru

Name of Experiment	Treatments	Grain yield (Kg/ha)		Straw yield (Kg/ha)	
		Proposed variety GPUP 28	GPUP 21 *	Proposed variety GPUP 28	GPUP 21 *
Fertilizer levels	F1(75% RDF)	1049.29	857.37	2047.81	2456.25
	F2(100% RDF)	1320.56	1105.33	2776.78	2084.14
	F3(125% RDF)	1231.58	679.87	2560.62	2561.75
	Mean	1200.47	880.86	2461.74	2367.38
	% increase over check in F2(100% RDF)= 19.47				
	SEm±	173.70	280.55		
	CD @ 5%	509.45	822.85		
Spacing (cm)	S1 (22.5 x 10)	1262.40	1000.91	2614.97	2350.07
	S2 (30 x 10)	1138.55	760.80	2308.51	2384.7
	Mean	1200.47	880.86	2461.74	2367.38
	% increase over check in S1 (22.5 x 10)= 26.12				
	SEm±	141.82	229.07		
	CD @ 5%	415.97	671.85		

*Check

TABLE 12

Screening of Leaf blight and Brown spot disease at Project Coordinating Unit, Small millets, UAS, GKVK, Bengaluru

Entries	2018		2019		Mean	
	Leaf blight	Brown spot	Leaf blight	Brown spot	Leaf blight	Brown spot
GPUP 28	5.33 (MR)	1.00 (R)	4.10 (MR)	1.00 (R)	4.71 (MR)	1.00 (R)
GPUP 21*	6.10 (S)	1.00 (R)	6.50 (S)	1.00 (R)	6.3 (S)	1.00 (R)

*Disease rating scale for brown spot/ leaf blight (1-9 scale)

Description	Disease Reaction
<1% leaf area affected	Highly Resistant (HR)
1-5% leaf area affected	Resistant (R)
6-10 % leaf area affected	Resistant (R)
11-20% leaf area affected	Moderately Resistant (MR)
21-30% leaf area affected	Moderately Resistant (MR)
31-40% leaf area affected	Susceptible (S)
41-50% leaf area affected	Susceptible (S)
51-75% leaf area affected	Highly Susceptible (HS)
>75% leaf area affected	Highly Susceptible (HS)

TABLE 13

Reaction against insect pest infestation at Project Coordinating Unit, Small millets, UAS, GKVK, Bengaluru

Entries	2018	2019	Mean
	Shoot fly	Shoot fly	
GPUP 28	14.44 (T)	12.41 (T)	13.42 (T)
GPUP 21*	18.89 (T)	17.45 (T)	18.17 (T)

*Check

Rating scale for shoot fly infestation

Level of tolerance	Per cent dead-heart
Highly Tolerant	≤ 10
Tolerant	10-20
Moderately Tolerant	20-35
Moderately Susceptible	35-50
Susceptible	≥ 50

(Southern dry zone) held on 5th April 2021, Annual ZREP workshop of Zone-5 (Eastern dry zone) held on 8th April 2021 and State varietal evaluation committee (SVEC) meeting held on 13th to 16 th December 2021.

Because of superior performance of this variety in Zone 5 (Eastern dry zone) and Zone 6 (Southern dry zone) of Karnataka, this variety has been recommended for cultivation in Zone 5 and Zone 6 of Karnataka state. Eastern dry zone includes districts *viz*., Bengaluru urban, Bengaluru rural, Chikkaballapur, Kolar, Ramanagara and some taluk of Tumkur districts. Similarly, Southern dry zone includes districts *viz*., Mandya, Mysuru and Chamrajanagara.

Agronomic Superiority

Grain yield: GPUP 28 exhibited grain yield of 1200.47 kg/ha and 19.47 per cent increased grain yield than check GPUP 21 under 100 per cent recommended dose of fertilizers. Summary of grain and straw yield data of Agronomic Trial (2020) is presented in Table 11.

Straw yield: Under agronomic trial new variety GPUP 28 recorded increased straw yield of 2461.74 kg/ha. While, check GPUP 21 recorded 2367.38 kg/ha, under 100 per cent recommended dose of fertilizers.

Reaction to Disease and Insect Pests

Proso millet crop is generally affected by shootfly incidence and with respect to diseases it is affected


Fig. 1 : Field view of new variety GPUP 28

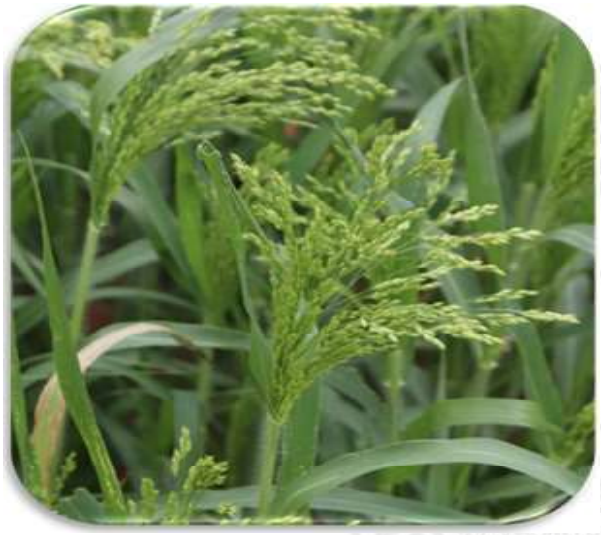

Fig. 1a : Panicle of new variety GPUP 28

Fig 2: Seed of new variety GPUP 28

by leaf blight and brown spot. Hence variety GPUP 28 is screened for insect shootfly and diseases like leaf blight and brown spot during *kharif* 2018 and 2019.

Variety GPUP 28 showed fewer incidences than check GPUP 21 for disease reaction to leaf blight (4.71) and it showed resistance reaction to brown spot disease (1.0). The new variety GPUP 28 exhibited less infestation of shoot fly and showed tolerant reaction. Reaction to diseases and insect pests were represented in Table 12 and 13, respectively.

TABLE 14

characteristics of proposed variety GPUP 28 and Check variety, GPUP 21

Characters		GPUP 28	GPUP 21*
Growth habit	:	Decumbent	Decumbent
Pigmentation	:	Absent	Absent
Days to flowering	:	39-42 days	38-41 days
		Medium duration	
Plant height (cm)	:	118 cm	129cm
Leaf sheath pubescence	:	Sparse	Sparse
Inflorescence shape	:	Globose-elliptic	Diffused
Culm branching	:	Absent	Absent
Panicle compactness	:	Intermediate	Intermediate
Grain colour	:	Golden yellow	Black
Grain shape	:	Oval	Oval
Test weight (g)	:	6.00	5.90

*Check

Distinguishing Traits of GPUP 28

This new variety matures in 80-85 days and has decumbent plant type with medium height (110-120 cm). This variety has intermediate compact with globose-elliptic shaped inflorescence. The grains are oval shape and golden yellow in colour with test weight of 6.0 g. The variety is suitable for sowing in both *kharif* (June-July) and summer (January). Descriptors of the new variety GPUP 28 is presented in Table 14. Field view of new variety GPUP 28 andits panicle and seed is depicted in Fig. 1, Fig. 2 and Fig. 3, respectively.

Grain and Fodder Quality Parameters of GPUP 28

Proso millet is one of the important small millet crops which contain high calcium, iron, and zinc. Because of its high nutritional quality, it is considered as one of the important nutri-cereal. Consumption of this millet has lot of health benefits like preventing cardio vascular diseases, diabetes, cancer and managing liver diseases.

The new variety GPUP 28 contains more grain calcium (127.7 ppm) content compared to the check GPUP 21. This variety has iron content of 28.8 ppm, 11.6 per cent protein, and 24.2 ppm of Zinc. Grain quality characteristics of variety GPUP 28 and check GPUP 21is presented in Table 15.

TABLE 15

Grain quality parameters of new variety GPUP 28 and check variety GPUP 21

Variety	Iron (ppm)	Zinc (ppm)	Calcium (ppm)	Protein %
GPUP 28	28.8	24.2	127.7	11.6
GPUP 21	35.9	29.9	96.9	12.2

Fodder contains high crude fiber (39.91 %) and crude fat (0.62 %) content than check variety GPUP 21. Fodder quality characteristics of variety GPUP 28 and check GPUP 21 is presented in Table 16.

DNA Finger Printing of New Variety GPUP 28

New variety GPUP 28 along with check variety GPUP 21 were used for DNA finger printing using SSR markers. Two SSR markers *viz*., GB-PMM-013 and GBPMM-098, were differentiated between variety GPUP 28 and check variety GPUP 21. Gel picture depicting polymorphism between new variety and check variety were depicted in Fig 3.

The DNA finger print of Proso millet variety GPUP 28 and GPUP 21 using SSR markers. P = GPUP 28, C= GPUP 21 and L = 100bp DNA ladder.

The new variety GPUP 28 produced significant increased yield over check in three years of station trail, multilocation trials and farm trials. This new variety is medium height and short duration. It has intermediate compact with globose-elliptic shaped inflorescence. Grain is oval shaped with golden yellow colour possesses higher test weight. This variety is moderately resistant to leaf blight and resistant to brown spot diseases. The variety is medium duration and matures in 80-85 days. The variety is suitable for sowing in both *kharif* (June-July) and summer (January). It yields 17-20 q/ha under protective irrigation. GPUP 28 Grain contains high calcium than check GPUP 21. Fodder contains good quality crude fat and crude fiber. Hence, this new variety is recommended for release in Annual Plant Scientists Group meeting held at UAS, GKVK, Bengaluru on 1-3rd March 2021, Annual ZREP Workshop of Zone-6 held on 5th April 2021, Annual ZREP workshop of Zone-5 held on 8th April 2021. NBPGR, New Delhi has issued IC 635735 for this variety. Because of superior performance of this variety

TABLE 16

Fodder quality parameters of Proposed variety GPUP 28 and check variety GPUP 21

Parameters	GPUP 28	GPUP 21*
Moisture (%)	6.78	6.58
Crude Protein (%)	4.37	6.21
Crude Fat (%)	0.62	0.46
Crude Fibre (%)	39.91	37.87
Total Ash (%)	6.58	6.98
Acid Insoluble Ash (%)	3.39	3.67

*Check

(ICAR-National Institute of Animal Nutrition and Physiology, Adugodi, Bengaluru)

in Zone 5 (Eastern dry zone) and Zone 6 (Southern dry zone) of Karnataka this variety has been recommended for cultivation in Zone 5 and Zone 6 of Karnataka state

Acknowledgements : We would also like to show our gratitude to the Tamil Nadu Agricultural University (TNAU) for sharing their parent material K1, which was included as one of parent in crossing programme to develop this variety. We thank Dr. A. Seetharam, Ex-Project co-ordinator, Small millets, for guiding in crossing and selection of this newly developed Proso millet variety GPUP 28 and we also thank all the scientists and Agricultural officers who are involved in conducting the multilocation trial farm trial for this variety.

REFERENCES

ARNON, I., 1972, Crop production in dry regions. Vol. 11. London, UK: Leonard Hill, pp. : 136 - 138.

BALTENSPERGER, D. D., 2002, Progress with proso, pearl and other millets, *Trends in New Crops and New Uses*, eds J. Janick and A. Whipkey (Alexandria: ASHS Press), pp. : 100 - 103.

DEMIRBAS, A., 2005, Glucanand mineral nutrient contents of cereals grown in Turkey. *Food Chemistry,* **90** : 773 - 777.

GOMESHE, S. S., 2017, Proso millet, (*Panicum miliaceum* (L.) : Geneticimprovement and research needs, In: J.V. Patil (Ed.), Milletsand Sorghum. *Biology and Genetic Improvement*, John Wiley & Sons, Ltd. 2017, pp. : 150 - 179.

HULSE, J. H., LAING, E. M. AND PEARSON, O. E., 1980, Sorghum and the millets : Their composition and nutritional value. New York, USA: Academic Press, pp. : 89.

RAJPUT, S. G., PLYLER-HARVESONT SANTRA, D. K., 2014, Development and characterization of SSR markers in proso millet based on switch grass genomics. *American Journal of Plant Science,* **5** : 175 - 186.

RAO, M. V., 1989, Small millets in global agriculture. The small millets : Their importance, present status and outlook. Delhi. Oxford and IBH Publishing Co. Pvt. Ltd., pp. : 9 - 12.

SALEH, A. S., ZHANG Q., CHEN J. AND SHEN, Q., 2013, Millet grains : Nutritional quality, processing and potential health beneûts. *Comprehensive Review of Food Science and Food Safety,* **12** : 281 - 295.

THEISEN, A.A., KNOX, E.G. AND MANN, F. L., 1978, Feasibility of introducing food crops better adapted to environmental stress in Individual crop reports. Vol. II. Arlington, Virginia, USA: National Science Foundation. pp : 168 - 172.

WANG, R., HUNT, H. V., QIAO, Z., WANG, L. AND HAN, Y., 2016, Diversity andcultivation of broomcorn millet (*Panicum miliaceum* L.) in China: a review, *Economic Botony,* **70** : 332 - 342.

YEGNA NARAYAN AIYER, 1958, Baragu. (*Panicum miliaceum*). In: Field crops of India. The Bangalore Printing and Publishing Co. Ltd., Bangalore, pp. : 102 - 104.