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Biofortified nutri cereal pearl millet hybrid GHB 1225 (*Moti Shakti*)

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Abstract

The late maturing dual purpose biofortified pearl millet hybrid GHB 1225 (*Moti Shakti*) developed by Pearl Millet Research Station, Junagadh Agricultural University, Jamnagar (Gujarat) from the cross combination of ICMA₁ 98222 × J-2591 and released it at the state level for *kharif* season cultivation. This hybrid has been tested against national and state level recommended yield and biofortified checks from 2016 to 2018 during rainy season across the different testing location of Gujarat. It has given higher average grain yield over presently recommended relevant group check hybrid GHB-558 (22.98%), latest relevant group hybrid GHB-732 (10.74%) and private sector relevant group check hybrid Proagro 94444 (8.18%) during *kharif* season. It has also recorded 21.1% and 17.4% higher dry fodder yield over relevant checks GHB-558 and GHB-732, respectively and 12.1% higher dry fodder yield over private sector late type check Proagro 9444 during *kharif* season. Additionally, the grain of this hybrid contains average 76 ppm and 46 ppm essential micronutrients iron (Fe) and zinc (Zn) which is higher over all the public and private sector check and comparable with biofortified check variety *Dhanshakti*. In comparison to all the checks over the testing period, GHB 1225 has resistance capacity against downy mildew, blast and rust diseases.

Keywords: GHB 1225, *Moti Shakti*, Biofortified hybrid, Pearl Millet, Micro-nutrient Fe-Zn

Introduction

Pearl millet is the quick growing cereal, mainly cultivated in arid and semi arid regions and forms the stable food in Indian subcontinent and Africa (Srivastava *et al.*, 2020) [7]. It is the most suitable and efficient crop among cereals for arid and semi-arid conditions because of its efficient utilization of soil moisture and higher level of heat tolerance than sorghum and maize (Nambiar *et al.*, 2011) [4]. Pearl millet is a rich source of protein, calcium, phosphorus, iron and also has balanced profile of amino acids as compared to other cereals (Uppal *et al.*, 2015 and Weckwerth *et al.*, 2020) [8, 9]. It is often referred to as the “Camel”, because of its exceptional ability to tolerate drought.

More than two billion people globally are malnourished in terms of micronutrients (Mayer *et al.*, 2008) [2]. Micronutrient malnutrition because of iron and zinc deficiencies is a serious public health problem in low- and middle-economy countries worldwide including India, which primarily affects women and children. Crop biofortification, which refers to the breeding of cultivars with higher levels of micronutrients, is increasingly being recognized as a cost-effective and sustainable approach to overcome these deficiencies in the food chain. The wide range variations in Fe and Zn content, as well as their genetic inheritance, are well known (Pujar *et al.*, 2020) [6].

Looking to above facts, the work on development of high Fe and Zn content hybrids has been intensified at Pearl Millet Research Station, JAU, Jamnagar in collaboration with ICRISAT, Patancheru which resulted into developed GHB 1225 (*Moti Shakti*), a biofortified high Fe and Zn content dual purpose, late maturing hybrid which has been released at state level for *kharif* season cultivation

Materials and Methods

The pearl millet hybrid GHB 1225 is a biofortified hybrid developed under joint biofortification effort of Pearl Millet Research Station, JAU, Jamnagar and ICRISAT, Patancheru. It is a cross combination of ICMA₁ 98222 × J-2591 female line ICMA₁ 98222 is developed at ICRISAT and it is a identified high Fe and Zn content seed parent line.

The restorer line has been developed at Pearl Millet Research Station, JAU, Jamnagar by necessary bulking/selection, fertility restoration ability and screening against biotic stresses and designated as a J-2591 in the year 2016. This hybrid GHB 1225 has been tested against national and state level recommended yield and biofortified checks from 2016 to 2018 during rainy (*khariif*) season across the different testing location of Gujarat. This hybrid GHB 1225 has been tested as a testing code MH 2284 in AICRP on Pearl Millet national level special *khariif* Hybrid Trial (Fe and Zn) in the year 2016-17 across the 12 different locations of A₁, A and B zone of India. The recommended package of practices were followed to conduct the trial and to raise the good crop.

Results and Discussion

The pearl millet hybrid GHB 1225 (*Moti Shakti*) is a late maturing dual (grain and fodder) purpose biofortified hybrid which has given higher average grain yield over presently recommended relevant group check hybrid GHB-558 (22.98%), latest relevant group hybrid GHB-732 (10.74%) and private sector relevant group check hybrid Proagro 94444 (8.18%) during *khariif* season. It has also recorded 21.1% and 17.4% higher dry fodder yield over relevant checks GHB-558 and GHB-732, respectively and 12.1% higher dry fodder yield over private sector late type check Proagro 9444 during *khariif* season (Table 1). Furthermore, the grain of this hybrid contains average 76 ppm and 46 ppm essential micronutrients iron (Fe) and zinc (Zn) which is higher over all the public and private sector check and comparable with biofortified check variety *Dhanshakti* (Fe-91 ppm and Zn-41 ppm) (Table 2).

This hybrid also tested in AICRP on Pearl Millet at national level special *khariif* Hybrid Trial (Fe and Zn) during *khariif* 2016-17 as a testing code MH 2284 across the 12 different location of A₁, A and B zones of India. It has recorded 3159 kg ha⁻¹ average grain yield which was to the tune of 4.78%, 12.62%, 32.01%, and 8.74% higher over MPMH-17, ICMH 356, HHB-67 Improved and private sector check Pratap, respectively. It has also given comparable Fe (74 ppm) and Zn (45 ppm) content with that of high Fe and Zn content identified check variety *Dhanshakti* (Fe-90 ppm and Zn-47 ppm). It has also given 8200 kg ha⁻¹ dry fodder yield which was higher than all the checks against it was tested except 86M86 against which it has given at par dry fodder yield.

The biochemical / quality parameters test of grain (Table 2) and dry fodder (Table 3) indicated that, this hybrid possess good or comparable quality parameters when tested against checks. The organoleptic quality parameters evaluation of pearl millet chapatti of GHB 1225 was carried out against all its checks by taking the response from 22 respondents.

The result indicated that the overall 1st preference recorded by GHB 1225 against all check.

This hybrid found resistant against downy mildew when tested under sick plot condition at different locations during *khariif* and it was also found resistance against blast and rust (Table 4). The ergot and smut were not observed during its testing period. This hybrid also found moderately resistant against pearl millet major insect-pest *viz.*, shoot fly incidence at earhead stage (0.9%), stem borer at earhead stage (1.7%) and *heliathis* (2.7 larvae/5 earhead) as compared to checks under natural condition during both seasons (Table 5). Further, this hybrid also found resistance against lodging when tested against its checks during testing locations.

The mean ancillary traits of economic attribute of pearl millet hybrid GHB 1225 (Table 6) revealed that days to 50% flowering (52 days) so it's come under late group maturing hybrid, and days to maturity (81 days), plant height (211 cm), number of tillers panicle per plant (2.5), 1000 grain weight (9.0 g), earhead length (23.2 cm) and earhead diameter (3.2 cm). The above findings are in confirmation with similarly to those of Mungra *et al* (2019)^[3] and Parmar *et al* (2023)^[5] for pearl millet.



Fig 1: Pearl Millet Biofortified Hybrid GHB 1225 (*Moti Shakti*)

Table 1: Yield performance of pearl millet hybrid GHB 1225 in comparison with checks during *khariif* (2016-18) across different testing locations of Gujarat

Name of Entries	No. of trials/Locations	Average grain yield (kg ha ⁻¹)	% increase over	Average dry fodder yield (kg ha ⁻¹)	% increase over
GHB 1225	21	3023	-	7306	-
GHB 1225	16	3096	-	7482	-
GHB 1225	08	3043	-	7495	-
GHB 558 (C)	21	2458	22.98	6035	21.1
GHB 732 (C)	21	2730	10.74	6221	17.4
<i>Dhanshakti</i> (C)	16	1903	62.65	5472	36.7
Proagro 9444 (C)	08	2813	8.18	6688	12.1
Average yield under normal condition				Grain: 3023 kg ha ⁻¹ , Dry fodder: 7306 kg ha ⁻¹	

Table 2: Grain biochemical parameters of pearl millet hybrid GHB 1225 along with checks during *kharif* (2016-18) across different testing locations of Gujarat

Name of Entries	Fe Content (ppm)				Zn Content (ppm)				Protein (%)	Fat (%)	Carbohydrate (%)
	2018	2019	2020	Mean	2018	2019	2020	Mean			
GHB 1225	76.0	72.0	81.0	76.0	50.0	48.0	39.0	46.0	9.97	5.35	69.15
GHB 558 (C)	56.0	62.0	55.0	58.0	45.0	36.0	37.0	39.0	9.74	5.68	69.98
GHB 732 (C)	50.0	57.0	52.0	53.0	34.0	33.0	31.0	33.0	9.76	4.36	69.10
<i>Dhanshakti</i> (C)	90.0	88.0	96.0	91.0	47.0	32.0	43.0	41.0	9.17	5.88	68.64
Proagro 9444 (C)			56.0	56.0			33.0	33.0	8.76	5.15	70.12

Table 3: Dry fodder biochemical parameters of pearl millet hybrid GHB 1225 along with checks (On DM basis)

Name of Entries	Crude Protein (%)	Crude Fat (%)	Crude Fiber (%)	Total Ash (%)	NFE (%)	IVDMD (%)
GHB 1225	5.75	1.19	46.09	9.82	37.15	55.49
GHB 558 (C)	4.31	0.33	49.81	5.67	39.88	55.33
GHB 732 (C)	4.47	0.44	52.56	6.80	35.73	54.87
<i>Dhanshakti</i> (C)	4.53	1.17	43.43	7.77	43.10	55.60
Proagro 9444 (C)	5.98	0.67	52.97	6.01	34.37	52.11

Abbreviations: NFE = Nitrogen Free Extract; IVDMD = In Vitro Dry Matter Digestibility

Table 4: The reaction of disease incidence on pearl millet hybrid GHB 1225 under artificially epiphytotic condition

Name of Entries	Downy mildew (%) at 60 DAS	Blast (Score0-9)	Rust (%)
<i>Kharif</i> (2016-18) Location : 3 (Jamnagar, Anand and S. K. Nagar)			
GHB 1225	2.2 (0.0-7.8)	16.1 (8.9-37.8)	6.9 (0.0-27.8)
GHB 558 (C)	3.8 (0.0-14.0)	23.1 (0.0-45.6)	15.8 (0.0-63.3)
GHB 732 (C)	12.6 (0.0-45.3)	16.1 (7.9-24.4)	6.4 (0.0-25.6)
<i>Dhanshakti</i> (C)	4.2 (0.0-9.3)	43.7 (35.0-55.0)	0.0
Proagro 9444 (C)	7.7 (2.3-12.9)	16.7 (11.1-22.2)	0.0
7042 S (DM Susceptible)	88.1 (34.5-98.8)	45.9 (31.1-63.5)	21.7 (0.0-86.7)

Figure in parenthesis are range

DM: 0.1-5.0% highly resistant; 5.1-10.0% moderately resistant; 10.1-25.0% Susceptible; >25% highly susceptible;

Blast and Rust: 0.1-33.3% resistant; 33.3-55.5% moderately resistant, 55.5 to 77.7% susceptible

Table 5: The reaction of insect-pest incidence on pearl millet hybrid GHB 1225 comparison with checks

Name of Entries	Shoot fly at vegetative stage (%)	Shoot fly at earhead stage (%)	Stem borer incidence at vegetative stage (%)	Stem borer at earhead stage (%)	<i>Heliothis</i> larvae per 5 earheads
GHB 1225	3.0 (0-7.8)	0.9 (0-1.7)	3.7 (0-4.8)	1.7 (0-4.0)	2.7 (0-7.0)
GHB 558 (C)	5.4 (2.2-7.5)	4.8 (4.1-6.3)	14.1 (3.3-26.3)	9.1 (4.1-16.6)	4.2 (1.0-7.5)
GHB 732(C)	5.5 (3.8-7.5)	4.3 (1.7-6.7)	13.7 (1.5-20.9)	6.7 (3.7-10.5)	3.2 (0.5-5.5)
<i>Dhanshakti</i> (C)	4.8 (0-9.0)	7.3 (3.2-12.1)	17.6 (4.9-25.5)	11.0 (1.5-18.4)	2.5 (1.0-3.5)
Proagro 9444 (C)	1.3 (1.3-1.3)	0.6 (0.6-0.6)	20.0 (20.0-20.0)	0.6 (0.6-0.6)	5.5 (5.5-5.5)

Figures in parenthesis are range;

Shoot fly and Stem borer: 0% resistant; 0.1-5.0% moderate resistant; 5.1-10.0% tolerant; 10.1-20.0% susceptible; > 20.0% highly susceptible;

Heliothis larvaedamage limit: < 1 larva per 5 earheads: resistant; 1 to 5 larvae per 5 earheads: tolerant; 5.1 to 25 larvae per 5 ear heads: susceptible.

Table 6: Ancillary traits of economic attribute of pearl millet hybrid GHB 1225 along with checks during *kharif* (2016-18) across different testing locations of Gujarat

Name of Entries	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of tillers/plant	1000 grain weight (g)	Earhead length (cm)	Earhead diameter (cm)
GHB 1225	52 (45-57)	81 (74-94)	211 (141-257)	2.5 (1.0-4.7)	9.0 (5.8-12.7)	23.2 (17.3-30.2)	3.2 (2.7-4.3)
GHB 558 (C)	47 (40-55)	78 (68-86)	175 (144-210)	2.7 (1.2-3.8)	9.4 (7.1-12.5)	22.1 (17.0-28.7)	3.1 (2.6-3.7)
GHB 732 (C)	49 (42-55)	79 (73-89)	179 (153-200)	2.8 (1.2-4.6)	9.3 (7.1-13.0)	21.8 (20.0-24.5)	2.8 (2.3-3.4)
<i>Dhanshakti</i> (C)	46 (38-53)	77 (64-85)	175 (142-200)	2.3 (1.0-4.3)	10.5 (8.7-13.1)	21.4 (14.2-25.0)	2.9 (2.5-3.1)
Proagro 9444 (C)	49 (47-55)	78 (70-88)	193 (170-215)	2.6 (1.7-3.4)	9.6 (8.5-11.0)	22.0 (17.0-28.0)	2.8 (2.5-3.2)

Figures in parenthesis are range

Conclusion

GHB 1225 is has higher grain and dry fodder yield over latest relevant public and private sector checks. This hybrid has high Fe and Zn content for qualified as biofortified hybrid. The parental lines of this hybrid are well-synchronized, and hence hybrid seed production is not problematic. In comparison to all the checks over the testing period, GHB 1225 has a resistance to downy mildew.

Additionally, it is resistant to blast and rust. This hybrid possesses appealing panicle features, good quality stover, consumers preferred grain colour and lodging resistance trait. In comparison to controls, it also found increased resistance to stem borer, shoot fly and. Finally, the dual purpose, high yielding, late type, biofortified hybrid GHB 1225 (*Moti Shakti*) released and recommended for *kharif* season of pearl millet growing farmers of Gujarat State.

Finally, a word of caution: This biofortified pearl millet cultivar have been developed using natural genetic variability available in pearl millet and they are not GMO product.

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