Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [3] 2017: 607-611

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD
Global Impact Factor 0.533
Universal Impact Factor 0.9804
NAAS Rating 4.95

FULL LENGTH ARTICLE **OPEN ACCESS**

Agro-morphological characters of little millet (*Panicum sumatrense*) associated with grain smut incidence

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ABSTRACT
Relationship of grain smut incidence with agro-morphological characters was studied in twenty little millet cultivars and significant variations recorded in agro-morphological characters showed the existence of genetic variability in the studied material. Significant positive association of grain smut incidence with grain smut severity (0.771) and grain smut susceptibility index (0.926*) was recorded. Negative association of grain smut parameters namely grain smut incidence, smut severity and susceptibility index with days to 50% flowering and days to maturity were recorded , which indicates that early maturing cultivars are more susceptible to grain smut. Retarding effect of grain smut incidence on morphological characters of little millet plant was observed. Average reduction in plant height varied 9.3 to 12.5% with a mean of 11.2% , number of tillers plant^{-1} 5.3 to 7.1% with a mean of 6.0%, ear head length 6.6 to 14.7% with a mean of 10.2% and average loss in grain yield plant^{-1} was 16.5 to 35.8% with a mean of 26.9% was recorded in little millet cultivars.*
Key Words: *Agro-morphological characters, little millet, grain smut, association*

Received 29.07.2017 Revised 12.08.2017 Accepted 28.08. 2017

INTRODUCTION

Little millet (*Panicum sumatrense* Roth ex Roemer and Schultes), locally known as kutki, menjhari, medo is one of the hardiest minor cereal crop belonging to the family Poaceae (Gramineae) and is indigenous to Indian sub continent [de Wet et al, 1983]. In India, the crop is cultivated in an area of 291 thousand hectares with annual production of 102 thousand tones and productivity of 349 kg per hectare which is very less as compared to other cereal crops. Andhra Pradesh, Chhattisgarh, Madhya Pradesh, Odisha, Tamil Nadu, Karnataka, Jharkhand and Gujarat are major little millet growing states in the country [Anon., 2011]. In Madhya Pradesh, the crop is cultivated in 51.54 thousand hectare with productivity of 525.5 kg per hectare. Dindori, Mandla, Chhindwara, Balaghat, Seoni, Anuppur, Betal, Singrauli, Umaria, Sidhi, Shahdol, Jabalpur, Narsinghpur, Raisen and Khandwa are major little millet growing districts of Madhya Pradesh [www.landrecords.mp.gov.in]. The crop is highly drought tolerant and nutritionally as well as medicinally superior or at par with other cultivated cereals. Grains of little millet are recommended for diabetic and patients of cardio – vascular diseases. Grain smut caused by *Macalpinomyces sharmae* is an important fungal disease of early maturing cultivars of little millet and reported to cause economic yield losses (Jain and Tripathi, 2007 and Jain and Joshi, 2015). In India, grain smut was first reported by Sharma and Khare (1987) from Dindori district of Madhya Pradesh and causal organism was identified as *Tolyposporium species.* Later, it was described as *Macalpinomyces sharmae* K. Vanky (Vanky, 1995). The disease is also reported from Jharkhand, Chhattisgarh and Tamil Nadu states of the country (Anon., 2012, Haider, 1997). The disease is ovaricolous and symptoms appear at grain formation stage. The affected ovary is converted into smut sorus, but does not increase in size than the normal grain. Some of the late developing grains remain greenish and increase in size slightly over the normal grains (Sharma and Khare, 1987). In the present investigation, association of agro – morphological characters of little millet cultivars with grain smut and effect of smut on morphological characters was studied.

MATERIALS AND METHODS

Twenty pre-released and released cultivars of little millet (Table-1) were sown in two rows of 3.0 m length in three replications in randomized block design at experimental area of College of Agriculture,

Rewa (M.P.) during 2014-15. The spacing between rows and plant was maintained 22.5 cm and 7.5 cm, respectively. Recommended doses of fertilizers i.e. 40 : 20 : 0 kg NPK ha^{-1} was applied ad recommended package of practices were followed for optimum plant growth. The agro-morphological characters namely days to 50% flowering, days to maturity, plant height (cm), number of tillers per plant and grain yield per plant (g) were recorded at appropriate time. Grain smut incidence (%) and severity (%) were recorded at dough stage by counting smutted plants per row and smutted grains per panicle. Susceptibility index (SI) was calculated using the following formula.

$$\text{Grain smut incidence}(\%) = \frac{\text{Total smutted plants in one row}}{\text{Total plants in one row}} \times 100$$

$$\text{Grain smut Severity}(\%) = \frac{\text{Total smutted grains per panicle}}{\text{Total grains per panicle}} \times 100$$

Susceptibility index (SI) = Susceptibility index= $\sqrt{\text{incidence} \times \text{severity}}$

Correlation coefficient among the agro-morphological characters of 20 little millet cultivars and grain smut parameters in all possible combinations at phenotypic levels were estimated using WASP 2.0 software. Retarding effect of grain smut incidence on morphological characters was studied in three cultivars namely JK 8, JK 36 and DLM 89 of little millet. Plant height (cm), number of tillers per plant, ear head length (cm) and grain yield per plant (g) were recorded from five healthy and five smut infected plants from each replication and mean data were used for computation of reduction in yield and yield parameters.

Table 1. Pedigree of pre-released & released cultivars of little millet

S.No.	Cultivar	Pedigree
1.	DhLtMV 36-3	CO 4 × PY2
2.	TNPSU 174	CO 4 × IPM 113
3.	BL 8	CO 2 × OLM 56
4.	Kadiri 1	Selection from Kadiri local
5.	DLM 89	Pure line Selection from local germplasm of Dindori district
6.	TNPSU 167	CO 2 × TNAU 26
7.	BL 150	Paiyur × DLM 369
8.	OLM 203*	Pure line Selection from Lakshmipur local
9.	DLM 103	Pure line Selection from local germplasm of Dindori district
10.	TNPSU 171	CO 2 × TNAU 28
11.	JK 8*	Selection from local germplasm of MP.
12.	TNPSU 170	CO 4 × IPM 113
13.	BL 6	Paiyur 1 × OLM 29
14.	DhLtMV 10-2	CO 4 X PY2
15.	TNAU 160	TNAU 91 × MS 4729
16.	BL 41-3	Paiyur 2 × TNAU 97
17.	KOPLM 53	IPS from local germplasm of district Shahdol, MP.
18.	GPUL 1	Pure line Selection from Paddasame
19.	GPUL 2	Pure line Selection from Paddasame
20.	JK 36	Selection from local germplasm

RESULTS AND DISCUSSION

Grain smut parameters and agro-morphological characters

Grain smut incidence, severity and susceptibility index in 20 cultivars of little millet were presented in table-2. Grain smut incidence ranged 0.0 to 56.8% with a mean of 21.7%, severity 0.0 to 6.7% with a mean of 1.3% and susceptibility index 0.0 to 17.2 with a mean of 5.1 in the evaluated cultivars. Six cultivars namely DhLtMV 36-3, Kadiri-1, OLM 203, KOPLM 53, GPUL 1 and GUPL 2 were completely free from grain smut. Two cultivars namely JK 36 and DLM 89 were highly susceptible to grain smut. Earlier, OLM 203 was also reported free from grain smut by Jain (2002). Mean performance of agro-morphological characters and grain yield $plant^{-1}$ are presented in Table 2 and data revealed that cultivars differed significantly for studied characters indicating that considerable genetic variability exists in the present material. Days to 50% flowering and days to maturity ranged 45 to 75 days and 76 to 109 days,

respectively. Variation in plant height was 63.9 to 92.7 cm, number of basal tillers per plant was 3 to 4 and grain yield per plant was 1.39 to 2.74 g. Wide range of variation in morphological characters including grain yield per plant was reported in 109 little millet germplasm by Nirmalakumari et al (2010).

Table 2. Agro-morphological characters and grain smut parameters in pre-release and released little millet cultivars

S. No.	Entry	Grain smut			Days to 50% flowering	Days to Maturity	Plant height (cm)	No. of tillers plant^{-1}	Grain yield plant^{-1} (g)
		Incidence (%)	Severity (%)	Susceptibility index (SI)					
1.	DhLtMV 36-3	0.0	0.0	0.0	73	105	80.5	3.0	1.48
2.	TNPSU 174	55.7	2.2	11.1	53	84	76.9	4.0	1.59
3.	BL 8	30.4	0.7	4.6	59	90	78.5	3.0	2.45
4.	Kadiri 1	0.0	0.0	0.0	70	102	65.3	3.0	1.39
5.	DLM 89	56.8	4.3	15.6	45	76	68.0	4.0	2.19
6.	TNPSU 167	34.5	1.4	6.9	53	82	74.3	4.0	2.16
7.	BL 150	27.1	1.2	5.7	58	89	71.4	4.0	2.74
8.	OLM 203*	0.0	0.0	0.0	75	106	77.0	4.0	1.74
9.	DLM 103	35.7	2.1	8.7	53	85	70.2	3.0	2.03
10.	TNPSU 171	19.5	0.8	3.9	60	90	66.4	3.0	1.93
11.	JK 8*	42.6	4.9	14.4	48	79	77.0	4.0	1.67
12.	TNPSU 170	24.1	0.7	4.1	57	88	75.4	4.0	2.5
13.	BL 6	22.1	0.4	3.0	71	101	92.7	3.0	2.71
14.	DhLtMV 10-2	21.1	0.6	3.6	63	94	74.9	4.0	1.5
15.	TNAU 160	10.1	0.6	2.5	59	91	83.7	4.0	1.56
16.	BL 41-3	13.7	0.5	2.6	64	93	80.7	3.0	2.55
17.	KOPLM 53	0.0	0.0	0.0	71	103	73.8	3.0	1.73
18.	GPUL 1	0.0	0.0	0.0	72	105	83.7	3.0	1.87
19.	GPUL 2	0.0	0.0	0.0	72	109	74.4	4.0	1.67
20.	JK 36	44.4	6.7	17.2	48	79	63.9	3.0	2.66
	Mean CD(P=0.05)	21.7 7.603	1.3 0.248	5.1 -	61 1.335	92 1.935	75.4 9.333	3.5 0.986	2.0 0.836

Association of agro-morphological characters of host plant with grain smut

The correlation coefficients among the agro- morphological characters and grain smut parameters in all possible combinations are presented in Table 3. Significant positive correlation of grain smut incidence was found with grain smut severity (0.771*) and grain smut susceptibility index (0.926*). Grain smut severity was also found positively correlated with grain smut susceptibility index (0.955*). Grain smut incidence showed significant negative association with days to 50% flowering (-0.919*) and maturity period (-0.919*). Similarly, grain smut severity was found negatively correlated with days to 50% flowering (-0.818*) and maturity period (-0.793*). Significant negative correlation of grain smut susceptibility index with days to 50% flowering (-0.918*) and maturity period (-0.898*) was observed. Days to 50% flowering exhibited significant positive association with days to maturity (0.983*). Early maturing cultivars of little millet were reported susceptible to grain smut rather late maturing cultivars (Jain and Tripathi, 2007). Probably weather conditions during flowering period and floral characteristics of little millet genotypes may influence the grain smut incidence.

Rests of the correlations were non-significant with either positive or negative sign.

Table 3. Correlation coefficients among agro-morphological characters of host plant with grain smut parameters in little millet.

-	Grain smut Incidence (%)	Grain smut Severity (%)	Susceptibility index (SI)	Days to 50% flowering	Days to Maturity	Plant height (cm)	No. of tillers/ plant	Grain yield/ plant
Grain smut Incidence (%)	1.000	0.771*	0.926*	-0.919*	-0.919*	-0.270	0.281	0.364
Grain smut Severity(%)		1.000	0.955*	-0.818*	-0.793*	-0.434	0.122	0.268
Susceptibility index (SI)			1.000	-0.918*	-0.898*	-0.394	0.220	0.305
Days 50% flowering				1.000	0.983*	0.427	-0.319	-0.307
Days to Maturity					1.000	0.384	-0.274	-0.357
Plant height (cm)						1.000	-0.018	0.053
No. of tillers/plant							1.000	-0.167
Grain yield/plant								1.000

* Significant at 5% level

Reduction in yield and yield traits of little millet due to incidence of grain smut

Adverse effect of *Macalpinomyces sharmae* on grain yield and yield attributing traits in three cultivars of little millet are presented in Table 4.

Table 4. Reduction in Yield and yield traits of little millet due to grain smut incidence

Cultivars/ traits		**JK 8**	**% reduction**	**JK 36**	**% reduction**	**DLM 89**	**% reduction**	**Mean reduction (%)**
Plant height (cm)	H	76.5	9.3	63.9	12.5	68.0	11.8	11.2
	S	70.0		56.8		60.8		
No. of tillers plant^{-1}	H	4.0	5.3	3.0	7.1	3.8	5.6	6.0
	S	3.6		2.8		3.6		
Earhead length (cm)	H	24.3	6.6	27.0	9.3	25.8	14.7	10.2
	S	22.8		24.7		22.5		
Grain yield plant^{-1} (g)	H	1.67	35.8	2.66	28.5	2.19	16.5	26.9
	S	1.23		2.07		1.88		

H = Healthy, S = smut infected

Data on adverse effect of grain smut on grain yield and yield attributing traits of little millet cultivars are presented in table 4. Reduction in plant height and number of tillers plant^{-1} varied 9.3 to 12.5% with a mean of 11.2% and 5.3 to 7.1% with a mean of 6.0% in little millet cultivars. Ear head length was reduced 6.6 to 14.7% with a mean of 10.2% and loss in grain yield plant^{-1} was recorded 16.5 to 35.8% with a mean of 26.9% in three cultivars of little millet. Percent reduction in yield and yield attributing traits varied from cultivar to cultivar depending upon the interaction between the host and the pathogen. Induced imbalance in the physiology of host tissues during infection and successive growth may be one of the reasons for retarding effect on host plant. Jain and Tripathi (2007) also reported loss in grain yield and its traits due to grain smut in six cultivars of little millet. Phenotypic variations in host plant due to smut incidence were reported in kodo millet (Nemade, 2012), wheat and triticale (Chatrath *et al.* ,1976 , Beniwal *et al.*,1990, Ahmad *et al.*,1994) ,barnyard millet (Jain et al, 1997a) and barley (Jain *et al.*1997b). These observations are in agreement with the present findings.

CONCLUSION

Six cultivars namely DhLtMV 36-3, Kadiri-1, OLM 203, KOPLM 53, GPUL 1 and GUPL 2 were completely free from grain smut. Whereas two cultivars namely JK 36 and DLM 89 were highly susceptible to grain

smut. Significant positive correlation was observed within grain smut parameters. Grain smut severity exhibited significant positive correlation with grain smut severity (r= 0.771*) and susceptibility index (r= 0.926*). Significant negative association of grain smut parameters with days to 50% flowering and days to maturity was found. Average reduction in plant height, number of tillers/plant, ear head length and grain yield per plant was 11.2, 6.0, 10.2 and 26.9%, respectively.

ACKNOWLEDGEMENT

Authors are thankful to AICRP on small millets and Vishwa Vidyalaya authorities for financial support and encouragement during the present investigation.

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CITATION OF THIS ARTICLE

Ashwini Kumar, A.K. Jain, , Ashish Kumar Ratan Lal Sharma. Agro-morphological characters of little millet (*Panicum sumatrense*) associated with grain smut incidence. Bull. Env. Pharmacol. Life Sci., Vol 6 Special issue [3] 2017: 607-611