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Effect of wheat residue management and fertilizer levels on growth, yield attributes and yield of summer pearl millet [*Pennisetum glaucum* (L.) R. Br.] under north Gujarat condition

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Abstract
A field experiment was conducted during the summer seasons of 2017 and 2018 on loamy sand soils of Agronomy Instructional Farm, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat to assess the effect of wheat residue management and fertilizer levels on Growth, yield attributes and yield of summer pearl millet [*Pennisetum glaucum* (L.) R. Br.] Under North Gujarat conditions. The results indicated that among the wheat residue management treatments, harvesting through combine harvester and straw incorporate in soil + decomposer fungal consortia (1 lit/t) + 25 kg N/ha enhanced the growth parameters *viz.*, plant height, number of tillers and likewise yield attributes *viz.*, number of earhead, length of earhead, grains weight/earhead, test weight, grain yield and straw yield of pearl millet. Application of 120:60:00 kg N:P_2O_5:K_2O/ha (100 per cent RDF) to pearl millet significantly improved growth parameters, yield attributes, seed and straw yield.

Keywords: Residue management, Fertilizer levels, *T. viride*, madhyam,

Introduction
Pearl millet commonly known as [*Pennisetum glaucum* (L.) R. Br.] *Bajra* or *Bajri* is the staple food for millions of people in the arid and semi-arid tropics of the world. The nutritive value of pearl millet grain is fairly higher with 69.4 per cent carbohydrate, 5 per cent fat, 9-11 per cent marginal protein and 2.7 per cent minerals. It is also rich in vitamins 'A' and 'B.' In addition to grains, it also supplies larger amount of good quality green and dry fodder for animals. Pearl millet is one of the major millet crops and is considered as a poor man's food. It is well adapted to production systems characterized by drought, low soil fertility and high temperature. Because of its tolerance to adverse growing conditions, it can be grown in areas where other cereal crops, such as maize would not survive.

Sustainable food and nutritional security involves meeting current need of agriculture production without endangering the natural resources to meet the need of future generation. We are facing many challenges in our quest to achieve sustainable food security. Farmers of Saurashtra region of the Gujarat, usually practice the burning of crop residues such as wheat residues for fast land preparation for the next crop. This burning of crop residues leads to emission of greenhouse gases *viz.,* carbon dioxide, methane, nitrous oxide *etc.* causing global warming apart from causing numerous human and animal health related problems due to release of soot particles and smoke. It also causes considerable nutrient losses, about 25 per cent of N and P, 50 per cent of S and 75 per cent of K which otherwise are valuable nutrient sources. The burning of crop residues is wastage of valuable resources which could be a source of carbon, bio-active compounds, feed and energy for rural households and small industries. Heat generated from the burning of crop residues elevates soil temperature causing death of active beneficial microbial population. The burning of agricultural residues leads to significant emissions of chemically and radioactively important trace gases such as methane (CH_4), carbon monoxide (CO), nitrous oxide (N_2O), oxides of nitrogen (NO_X), sulphur (SO_X) and other hydrocarbons into the atmosphere. One tons of rice straw on burning will release about 3 kg particulate matter, 60 kg CO, 1460 kg CO_2, 199 kg ash and 2 kg SO_2 (Gadi *et al*., 2003) [8]. These gases are major concern for their global impact and may lead to increase in the levels of aerosols, acid deposition, increase in tropospheric ozone and depletion of the stratospheric ozone layer.

Material and Methods

A field experiment was carried out during summer seasons of the year 2017 and 2018 at Agronomy Instructional Farm, Department of Agronomy, Chimanbhai Patel College of Agriculture, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, to study the effect of wheat residue management and fertilizer levels on Growth, yield attributes and yield of summer pearl millet [*Pennisetum glaucum* (L.) R. Br.] under North Gujarat conditions. The soil of the experimental plot was loamy sand in texture having pH (7.43 and 7.38 during 2017 and 2018 respectively) and EC (0.14 and 0.12 dS/m during 2017 and 2018 respectively). Analysis showed that the experimental soil was low in organic carbon (0.176 and 0.191 per cent during 2017 and 2018 respectively) and available nitrogen (155.20 and 156.11 kg/ha during 2017 and 2018 respectively) and medium in phosphorus (37.76 and 38.43 during 2017 and 2018 respectively) and potassium status (255.19 and 253.23 kg/ha during 2017 and 2018). There were twenty-one treatment combinations comprising of seven residue management practices no residue incorporation (manual harvesting) (R_1), Wheat harvesting through combine harvester and burning the straw (R_2), Wheat harvesting through combine harvester and straw incorporation in soil (R_3), Wheat harvesting through combine harvester and straw incorporation in soil + 5 kg *T. viride* + 25 kg N/ha (R_4), Wheat harvesting through combine harvester and straw incorporation in soil + 5 kg madhyam + 25 kg N/ha (R_5), Wheat harvesting through combine harvester and straw incorporate in soil + decomposer fungal consortia (1 lit/t) + 25 kg N/ha (R_6) and Wheat harvesting through combine harvester and straw incorporate in soil + decomposer bacterial consortia (1 lit/t) + 25 kg N/ha (R_7) as a main plot treatment along with three fertilizer levels as a sub-plot treatment *viz*., 50 per cent RDF (F_1), 75 per cent RDF (F_2) and 100 per cent RDF (F_3). The experiment was laid out in split plot design with three replications. The required quantity of nitrogen and phosphorus were calculated as per the treatments (F_1, F_2 and F_3) in form of urea and DAP, respectively. The entire quantity of phosphorus (RDF) in the form of DAP and half quantity of nitrogen in the form of urea were applied prior to sowing in the opened furrows and furrows were lightly covered with soil after fertilizer application in all plots. The remaining dose of nitrogen was applied as top dressing in two equal splits at 30 and 45 DAS. All other cultural practices were performed uniformly for all treatments. Pearl millet hybrid "GHB 732" was sown on 21st March and 13th March during 2017 and 2018, respectively using recommended seed rate of 3.75 kg/ha keeping 45 cm distance between two rows. The intra row spacing of 15 cm approximately was maintained by thinning. Weeding and plant protection measures were undertaken as per the need and the required plant population was maintained.

The observations were recorded during course of study including plant height, number of tillers and likewise yield attributes *viz.,* number of earhead, length of earhead, grains weight/earhead, test weight, grain yield and straw yield of pearl millet. The collected data for various parameters were statistically analyzed using Fishers' analysis of variance (ANOVA) technique and the treatments were compared at 5% level of significance.

Results and Discussion

Effect of residue management

Growth and yield attributes (Table 1) of pearl millet were significantly influenced due to different residue management practices. Wheat harvesting through combine harvester and straw incorporation in soil + decomposer fungal consortia (1 lit/t) + 25 kg N/ha (R_6) recorded significantly higher plant height of pearl millet at harvest (184.26, 188.16 and 186.21 cm), number of tillers (31.49, 33.40 and 32.45), higher number of earheads (27.91, 28.37and 28.14), earhead length (25.52, 26.69 and 26.10 cm), grain weight per earhead of pearl millet (13.16, 13.37 and 13.26 g per earhead), test weight (12.13, 12.23 and 12.18 g), grain yield (4242, 4321 and 4281 kg/ha) and straw yield (7999, 8128 and 8064 kg/ha) during 2017, 2018 and in pooled results, respectively (Table 4). Enhanced nutrient supply through residue decomposition coupled with starter nitrogen application created conducive environment for plant growth and development in terms of higher yield attributes and yield. Similar findings were reported by Rajkhowa and Borah (2008) [12], Ali *et al.* (2012) [1], Arshadullah *et al*. (2012) [3], Shah *et al.* (2015) [14], Choudhary *et al*. (2016) [6] and Soleymani *et al*. (2016) [16].

Effect of fertilizer levels

Application of 100 per cent RDF (F_3 - 120:60:00 kg NPK/ha) recorded significantly higher plant height at harvest (176.48, 181.24 and 178.86 cm), number of tillers (27.49, 29.03 and 28.26), number of earheads (27.32, 27.41 and 27.36/meter row length), earhead length (23.36, 24.43 and 23.89 cm), grain weight (12.13, 12.61and 12.37 g/earhead), test weight (11.98, 12.06 and 12.02 g), grain yield (3851 kg/ha, 3992 kg/ha and 3921 kg/ha) and straw yield (7283, 7694 and 7489 kg/ha) during 2017, 2018 and in pooled results, respectively. Higher fertilizer level enhanced the grain yield of pearl millet to the tune of 18.41, 19.96 and 19.17 per cent in 2017, 2018 and on pooled basis, respectively (Table 4). Hence, higher doses of fertilizers (100% RDF) might have stimulated increased activity of meristematic cells and cell elongation of internodes resulting in higher growth rate of stem in turn promoting the growth and yield attributes of pearl millet. These results are in the conformity with those of Chaudhary *et al.* (2002) [5], Tetarwal and Rana (2006) [17], Ansari *et al.* (2011) [2], Sakarvadia *et al.* (2012) [13], Singh *et al.* (2013) [15], Prasad *et al.* (2014) [11], Chouhan *et al*. (2015) [10] and Owla *et al*. (2015) [10], Balwan *et al.* (2017) [4], and Meena *et al.* (2017) [9].

Interaction effect

The interactions effect between residue management and fertilizer levels were found significant with respect to number of earheads in pooled results.

Data presented in Table 2 revealed that treatment combination R_6F_3 (wheat harvesting through combine harvester and straw incorporation in soil + decomposer fungal consortia (1 lit/t) + 25 kg N/ha+ 100% RDF) recorded significantly higher number of earheads (30.53/meter row length) which was on par with R_5F_3 and R_6F_2. Whereas, treatment combination R_2F_1 (wheat harvesting through combine harvester and burning the straw + 50% RDF) was produced the lowest number of earheads (18.42/meter row length).

Table 1: Effect of wheat residue management and fertilizer levels on growth and yield attributes of summer pearl millet

Treatments	Plant height (cm)			Number of tillers/ meter row length			Number of earhead per meter row length			Length of earhead (cm)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
Wheat residue management (R):												
R_1	161.53	165.00	163.26	23.92	24.40	24.16	22.22	22.56	22.39	20.20	20.90	20.55
R_2	156.40	161.97	158.69	22.47	23.73	23.10	21.84	22.37	22.10	18.87	19.90	19.38
R_3	165.15	171.12	168.13	25.46	26.85	26.15	24.21	25.06	24.63	21.46	22.50	21.98
R_4	169.80	173.74	171.77	26.53	27.62	27.08	24.91	25.56	25.24	21.62	23.72	22.67
R_5	175.53	181.50	178.52	29.31	31.96	30.64	27.57	27.53	27.55	24.56	26.11	25.34
R_6	184.26	188.16	186.21	31.49	33.40	32.45	27.91	28.37	28.14	25.52	26.69	26.10
R_7	170.00	175.17	172.59	26.65	29.18	27.92	25.74	25.62	25.68	22.78	24.22	23.50
S.Em.±	4.43	4.10	3.02	0.91	1.00	0.68	0.68	0.85	0.55	0.65	0.78	0.51
C.D. at 5%	13.67	12.64	8.82	2.81	3.08	1.98	2.10	2.64	1.60	2.01	2.43	1.49
C.V.%	7.87	7.09	7.48	10.32	10.64	10.50	8.21	10.18	9.26	8.82	10.10	9.52
Fertilizer levels (F):												
F_1	162.02	166.68	164.35	5.94	27.39	26.66	22.49	22.92	22.70	20.78	22.56	21.67
F_2	168.36	173.09	170.72	26.22	28.07	27.14	24.94	25.56	25.25	22.29	23.31	22.80
F_3	176.48	181.24	178.86	27.49	29.03	28.26	27.32	27.41	27.36	23.36	24.43	23.89
S.Em.±	2.42	2.32	1.67	0.34	0.31	0.23	0.35	0.31	0.24	0.26	0.38	0.23
C.D. at 5%	7.00	6.72	4.74	0.98	0.90	0.65	1.01	0.91	0.67	0.76	1.10	0.65
Interaction (R × F):												
S.Em.±	6.39	6.14	4.43	0.89	0.82	0.61	0.92	0.83	0.62	0.69	1.00	0.61
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	1.76	2.00	NS	1.72
C.V.%	6.55	6.12	6.33	5.82	5.06	5.43	6.43	5.69	6.07	5.40	7.40	6.54

Table 2: Interaction effect of wheat residue management and fertilizer levels on number of earheads of summer pearl millet (Pooled)

Fertilizer levels	Wheat residue management						
	R_1	R_2	R_3	R_4	R_5	R_6	R_7
F_1	21.00	18.42	23.02	22.26	25.55	24.91	23.75
F_2	21.94	23.36	24.52	25.92	26.98	29.00	25.04
F_3	24.23	24.52	26.35	27.53	30.11	30.53	28.26
S.Em.±	0.62						
C.D. at 5%	1.76						

The interaction effect between residue management and fertilizer levels (R × F) was found significant with respect to earhead length during the year 2017 and in pooled analysis. Data presented in Table 3 revealed that treatment combination R_6F_3 (wheat harvesting through combine harvester and straw incorporation in soil + decomposer fungal consortia (1 lit/t) + 25 kg N/ha+ 100% RDF) recorded significantly higher length of earhead (28.17 and 28.10 cm 2017 and in pooled results, respectively) which was at par with R_6F_2 in pooled analysis. Whereas, treatment combination R_2F_1 (wheat harvesting through combine harvester and burning the straw + 50% RDF) was recorded lower length of earhead (18.31 and 19.12 cm 2017 and in pooled results, respectively).

The interaction effects between residue management and fertilizer levels (R × F) with respect to grain yield were found to be significant during 2017, 2018 and in pooled results as presented in Table 5 revealed that treatment combination R_6F_3 (wheat harvesting through combine harvester and straw incorporation in soil + decomposer fungal consortia (1 lit/t) + 25 kg N/ha + 100% RDF)

Table 3: Interaction effect of wheat residue management and fertilizer levels on length of earhead (cm) of summer pearl millet (2017 and Pooled)

Fertilizer levels	Wheat residue management						
	R_1	R_2	R_3	R_4	R_5	R_6	R_7
2017							
F_1	19.56	18.31	20.64	20.80	23.71	22.27	20.18
F_2	19.99	18.76	21.84	21.42	24.76	26.11	23.15
F_3	21.06	19.55	21.91	22.62	25.21	28.17	25.02
S.Em.±	0.69						
C.D. at 5%	2.00						
Pooled							
F_1	19.75	19.12	21.33	21.91	24.87	23.69	21.03
F_2	20.41	19.28	22.10	22.40	25.12	26.52	23.79
F_3	21.50	19.76	22.52	23.68	26.03	28.10	25.69
S.Em.±	0.61						
C.D. at 5%	1.72						

Table 4: Effect of wheat residue management and fertilizer levels on yield attributes and yield of summer pearl millet

Treatments	Grain weight/ earhead (g)			Test weight (g)			Grain yield (kg/ha)			Straw yield (kg/ha)		
	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled	2017	2018	Pooled
Wheat residue management (R):												
R_1	11.14	11.67	11.41	11.23	11.31	11.27	3127	3164	3145	5829	6226	6027
R_2	11.05	11.26	11.16	11.01	11.12	11.07	2813	2847	2830	5419	5750	5584
R_3	11.28	11.78	11.53	11.50	11.62	11.56	3141	3267	3204	6253	6909	6581
R_4	11.82	12.15	11.99	11.70	11.78	11.74	3434	3597	3516	6569	6982	6776
R_5	12.47	12.82	12.65	11.98	12.10	12.04	4051	4218	4134	7439	7892	7665
R_6	13.16	13.37	13.26	12.13	12.23	12.18	4242	4321	4281	7999	8128	8064
R_7	12.01	12.31	12.16	11.82	11.86	11.84	3743	3832	3788	7259	7373	7316
S.Em.±	0.31	0.30	0.22	0.08	0.09	0.06	88	92	63	200	223	150
C.D. at 5%	0.98	0.93	0.64	0.26	0.30	0.19	271	284	186	617	689	438
C.V.%	8.08	7.46	7.77	2.16	2.50	2.33	7.54	7.67	7.61	9.0	9.54	9.29
Fertilizer levels (F):												
F_1	11.70	11.88	11.79	11.29	11.38	11.33	3142	3195	3169	6059	6331	6195

F_2	11.71	12.10	11.90	11.60	11.71	11.66	3528	3633	3580	6700	7086	6893
F_3	12.13	12.61	12.37	11.98	12.06	12.02	3851	3992	3921	7283	7694	7489
S.Em.±	0.13	0.16	0.10	0.05	0.06	0.04	48	50	34	100	106	73
C.D. at 5%	0.39	0.46	0.29	0.15	0.17	0.11	141	145	99	290	308	206
Interaction (R × F:												
S.Em.±	0.35	0.42	0.27	0.14	0.15	0.10	128	132	92	265	281	193
C.D. at 5%	NS	NS	NS	NS	NS	NS	373	384	261	NS	NS	NS
C.V.%	5.16	5.94	5.57	2.06	2.26	2.16	6.36	6.37	6.37	6.87	6.92	6.90

Table 5: Interaction effect of wheat residue management and fertilizer levels on grain yield of summer pearl millet (2017, 2018 and Pooled)

Fertilizer levels	**Wheat residue management**						
	R_1	**R_2**	**R_3**	**R_4**	**R_5**	**R_6**	**R_7**
2017							
F_1	2760	2294	2900	2840	3745	3827	3631
F_2	3214	3051	3144	3564	3674	4275	3673
F_3	3406	3094	3378	3899	4623	4633	3927
S.Em.±	128						
C.D. at 5%	373						
2018							
F_1	2767	2337	2931	3077	3939	3948	3368
F_2	3299	3056	3389	3593	3951	4097	4046
F_3	3427	3150	3480	4120	4764	4918	4082
S.Em.±	132						
C.D. at 5%	384						
Pooled							
F_1	2764	2315	2915	2959	3842	3888	3500
F_2	3257	3053	3266	3579	3862	4186	3859
F_3	3416	3122	3429	4009	4698	4771	4004
S.Em.±	92						
C.D. at 5%	261						

recorded significantly higher grain yield (4633, 4918 and 4771 kg/ha during 2017, 2018 and in pooled results, respectively), which was at par with treatment combinations R_5F_3 and R_6F_2 during the year of 2017. In the case of 2018 and pooled result, it was at par with treatment combination R_5F_3 only. Whereas, treatment combination R_2F_1 (wheat harvesting through combine harvester and burning the straw + 50% RDF) recorded lower grain yield of 2294, 2337 and 2315 kg/ha during 2017, 2018 and in pooled results, respectively.

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