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

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Abstract
A field study 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 residual effect of wheat residue and fertilizer levels on growth, yield attributes, yield and economics of summer pearl millet [*Pennisetum glaucum* (L.) R. Br.] Under north Gujarat condition. The pooled results indicated that among the wheat residue management treatments, wheat harvesting through combine harvester and straw incorporate in soil + decomposer fungal consortia (1 lit/t) + 25 kg N/ha enhanced the plant height, number of tillers, number of earhead, length of earhead, test weight, grain yield, straw yield, gross return, net returns and benefit : cost ratio. In the case of fertilizer levels, 100 percent RDF (F_3 - 120: 60 : 00 kg N : P_2O_5 : K_2O/ha) to pearl millet significantly improved growth, yield attributes, yield, gross return, net returns and benefit : cost ratio.

Keywords: Residue management, fertilizer levels, *T. viride*, madhyam, decomposer fungal consortia and decomposer bacterial consortia

Introduction
Crop residue incorporation is an environmental friendly strategy which is becoming a common soil management practice for sustainability of soil health. This would necessitate optimization of our efforts in land utilization, soil and moisture conservation with greater emphasis on residue management with adequate nutrition through different sources. Crop residues are certainly an asset in these countries and seldom left in the field. In India, 516 million tonnes (mt) crop residues were produced, among that 122 and 110 mt dry rice and wheat straw were generated (MOSPI, 2013-14). Total crop residue burned 129.07 mt, out of that 30.65 rice straw and 27.58 mt wheat straws may end up in field burning. In Gujarat, total crop residue production was about 22.9 mt, among that 5.73 mt was burned out in the field (Devi *et al.*, 2017) [5]. 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 percent of N and P, 50 percent of S and 75 percent 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. 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) [6]. 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.

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. Pearl millet is one of the major millet crops and is considered as a poor man's food. 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 extensively grown in the dry areas of western and southern India, Asia and Africa. 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. Summer cultivation of pearl millet, particularly in the irrigated areas of North Gujarat has attracted the farmers because of the assurance of targeted crop yield. During summer season, water is the limiting factor and costly inputs for crop production for arid and semi-arid tropics. In recent years summer area under pearl millet in Gujarat has increased substantially. In Gujarat, between 2004-05 and 2008-09 the share of summer pearl millet area in total pearl millet area has increased from 16 percent to 25 percent while share of *kharif* pearl millet has declined. However, the production share of summer pearl millet is 44 percent in total pearl millet production since the productivity of summer pearl millet is more than twice of *kharif* pearl millet. For summer pearl millet, Banaskantha is the leading district with more than 40 percent of the area and production followed by Anand and Kheda. Pearl millet is an exhaustive crop which needs to be supplied with high doses of inorganic fertilizers to meet the nutritional requirements of the crop. Among three major plant nutrients, nitrogen is one of the most important nutrients, which plays a vital role in all living plant tissues and constitutes about 1-4 percent of the dry weight. It imparts green colour to leaves and stem and enable them for efficient photosynthesis. It is an integral part of chlorophyll and enzymes essential for plant growth. Phosphorus plays a key role in various physiological processes like root growth and dry matter production.

Materials 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 percent 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 percent RDF (F_1), 75 percent RDF (F_2) and 100 percent 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, 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 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 (186.21 cm), number of tillers (32.45), number of earheads (28.14), earhead length (26.10 cm), test weight (12.18 g), grain yield (4281 kg/ha) and straw yield (8064 kg/ha). Higher gross return (`75564/ha), net return (`43926/ha) and benefit: cost ratio (BCR) (1.39) was secured under the treatment R_6 (wheat harvesting through combine harvester and straw incorporation in soil + decomposer fungal consortia (1 lit/t) + 25 kg N/ha). The next best treatment in view of gross return, net return and BCR was R_5 (wheat harvesting through combine harvester and straw incorporation in soil + 5 kg madhyam + 25 kg N/ha) which recorded the gross return and net return of ` 72603/ha, 41315/ha, respectively, with the BCR value of 1.32. A significant increase in grain yield observed under these treatments because, straw incorporation with microbial inoculants leads to faster decomposition of straw, improved the status of soil organic matter, leading to higher uptake of available nutrients from soil and ultimately increased the growth and yield components. This might be attributed due to higher grain and straw yield of pearl millet under this treatment. The findings are in conformity with those of Amgain *et al.* (2013) [1], Singh and Meena (2013) [14], Kumari *et al.* (2014) [7] and Choudhary *et al.* (2016) [3].

Effect of fertilizer levels

Application of 100 percent RDF (F_3 - 120:60:00 kg NPK/ha) recorded significantly higher plant height at harvest (178.86 cm), number of tillers (28.26), number of earheads (27.36/meter row length), earhead length (23.89 cm), test

weight (12.02 g), grain yield (3921 kg/ha) and straw yield (7489 kg/ha). The highest gross return (₹69519/ha), net return (₹ 37616/ha) and BCR (1.18) was incurred under the treatment F_3 (100% RDF). Highest grain yield of pearl millet under higher NPK levels (100% RDF) could be traced to adequate nutrient availability as was observed from significant and positive association between grain yield and N uptake. Favourable conditions experienced by the crop under 100 percent RDF in turn aided the plants to put forth improved performance over lower levels of fertilizer 50 percent RDF. These results are in conformity with the results obtained by Patel *et al.* (2004) [9], Tetarwal and Rana (2006) [15], Ansari *et al.* (2011) [2], Sakarvadia *et al.* (2012) [12], Prasad *et al.* (2014) [10], Chouhan *et al*. (2015) [4], Reddy *et al.* (2016) [11] and Sharma *et al.* (2017) [13].

Interaction effect

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 grain yield (4771 kg/ha), which was at par with treatment combination R_5F_3 only (Table 3). Whereas, treatment combination R_2F_1 (wheat harvesting through combine harvester and burning the straw + 50% RDF) recorded lower grain yield of 2315 kg/ha.

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

Treatments	Plant height (cm)	Number of tillers/ meter row length	Number of earhead per meter row length	Length of earhead (cm)	Test weight (g)
Wheat residue management (R) :					
R_1	163.26	24.16	22.39	20.55	11.27
R_2	158.69	23.10	22.10	19.38	11.07
R_3	168.13	26.15	24.63	21.98	11.56
R_4	171.77	27.08	25.24	22.67	11.74
R_5	178.52	30.64	27.55	25.34	12.04
R_6	186.21	32.45	28.14	26.10	12.18
R_7	172.59	27.92	25.68	23.50	11.84
S.Em.±	3.02	0.68	0.55	0.51	0.06
C.D. at 5%	8.82	1.98	1.60	1.49	0.19
C.V. %	7.48	10.50	9.26	9.52	2.33
Fertilizer levels (F) :					
F_1	164.35	26.66	22.70	21.67	11.33
F_2	170.72	27.14	25.25	22.80	11.66
F_3	178.86	28.26	27.36	23.89	12.02
S.Em.±	1.67	0.23	0.24	0.23	0.04
C.D. at 5%	4.74	0.65	0.67	0.65	0.11
Interaction (R × F) :					
S.Em.±	4.43	0.61	0.62	0.61	0.10
C.D. at 5%	NS	NS	1.76	1.72	NS
C.V. %	6.33	5.43	6.07	6.54	2.16

Table 2: Effect of wheat residue management and fertilizer levels on yield and economics of summer pearl millet (pooled data)

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Gross return (/ha)	Net return (/ha)	BCR
Wheat residue management (R):					
R_1	3145	6027	55821	26297	0.89
R_2	2830	5584	50712	20928	0.70
R_3	3204	6581	58191	28167	0.94
R_4	3516	6776	62520	31032	0.99
R_5	4134	7665	72603	41315	1.32
R_6	4281	8064	75564	43926	1.39
R_7	3788	7316	67404	35766	1.13
S.Em.±	63	150	-	-	-
C.D. at 5%	186	438	-	-	-
C.V. %	7.61	9.29	-	-	-
Fertilizer levels (F) :					
F_1	3169	6195	56613	26986	0.91
F_2	3580	6893	63639	32862	1.07
F_3	3921	7489	69519	37616	1.18
S.Em.±	34	73	-	-	-
C.D. at 5%	99	206	-	-	-
Interaction (R × F) :					
S.Em.±	92	193	-	-	-
C.D. at 5%	261	NS	-	-	-
C.V. %	6.37	6.90	-	-	-

Table 3: Interaction effect of wheat residue management and fertilizer levels on grain yield of summer pearl millet (pooled data)

Fertilizer levels	Wheat residue management						
	R_1	**R_2**	**R_3**	**R_4**	**R_5**	**R_6**	**R_7**
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						

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