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Effect of wheat residue management and fertilizer levels on yield, content, uptake and nutrient status in soil 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 yield, content, uptake and nutrient status in soil of summer pearl millet [*Pennisetum glaucum* (L.) R. Br.] under North Gujarat Condition. The pooled 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 grain yield and straw yield of pearl millet highest content and uptake of NPK, soil chemical and biological properties over burning of crop residues. Application of 100 per cent RDF (F_3 - 120 : 60 : 00 kg N : P_2O_5 : K_2O/ha) to pearl millet significantly improved seed yield, straw yield, highest content and uptake of NPK, soil chemical and biological properties than 50 per cent RDF (F_1 - 60 : 30 : 00 kg N : P_2O_5 : K_2O/ha).

Keywords: residue management, fertilizer levels, *T. viride*, madhyam, decomposer fungal consortia

Introduction
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. First land is a shrinking resource for agricultural and we have to produce more and more food from less and less land. 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 residue incorporation is an environmental friendly strategy which is becoming a common soil management practice for sustainability of soil health.

In less affluent countries such as South and South East Asia, grains are directly used for human consumption and crop residues are the main source of cattle feed apart from their usage as thatching of dwelling huts and cattle shed. 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) [2].

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. In India, it ranks fourth in acreage after rice, wheat and sorghum. Pearl millet is extensively grown in the dry areas of western and southern India, Asia and Africa. It is well adapted to production systems characterised 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 semiarid 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 per cent to 25 per cent while share of *kharif* pearl millet has declined. However, the production share of summer pearl millet is 44 per cent 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 per cent 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 per cent of the dry weight.

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 yield, content, uptake and nutrient status in soil of summer pearl millet [*Pennisetum glaucum* (L.) R. Br.] under North Gujarat Condition. 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.

Results and Discussion

Effect of residue management

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 grain yield (4281 kg/ha), straw yield (8064 kg/ha), higher percentage of organic carbon (0.307%), available nitrogen (184.52 kg/ha), available phosphorus (50.26 kg/ha), which was at par with wheat harvesting through combine harvester and straw incorporation in soil + 5 kg madhyam + 25 kg N/ha (R_5). Different residue management treatments exhibited their non-significant influence on harvest index during course of investigation. Wheat harvesting through combine harvester and burning the straw (R_2) recorded significantly higher available potassium (272.55 kg/ha). NPK content and uptake by grain and straw was significantly affected due to residue management treatments. Wheat harvesting through combine harvester and straw incorporation in soil + decomposer fungal consortia (1 lit/t) + 25 kg N/ha (R_6) estimated significantly the highest N content (1.79% in grain and 0.73% in straw), P content (0.517% in grain and 0.344% in straw), K content (0.72% in grain and 1.74% in straw), N uptake (76.88 kg/ha by grain and 59.13 kg/ha by straw), P uptake (22.23 kg/ha by grain and 27.97 kg/ha by straw), K uptake (30.81 kg/ha by grain and 140.76 kg/ha by straw). Increased soil incorporation of residues improves soil water relation for plant and microbial activity, thus enhancing nutrient cycling. The findings are in conformity with those of Yadav *et al*. (2009) [12], Mbah and Nneji (2011) [5] and Wang *et al.* (2012) [11].

Effect of fertilizer levels

Application of 100 per cent RDF (F_3 - 120:60:00 kg NPK/ha) recorded significantly higher grain yield (3921 kg/ha), straw yield (7489 kg/ha), highest organic carbon (0.277%), available nitrogen (179.54 kg/ha), available phosphorus (46.93 kg/ha), available potassium (267.79 kg/ha). Increased levels of fertilizer also failed to exert significant influence on harvest index of pearl millet. NPK content and uptake by grain and straw was significantly affected due to fertilizer levels. Treatment F_3 (100% RDF) recorded significantly highest N content (1.79% in grain and 0.68% in straw), P content (0.474% in grain and 0.280% in straw), K content (0.65% in grain and 1.73% in straw), N uptake of pearl millet crop (70.48 kg/ha by grain and 51.09 kg/ha by straw), P uptake (18.82 kg/ha by grain and 21.51 kg/ha by straw) and K uptake (25.86 kg/ha by grain and 130.60 kg/ha by straw). The vigor of aerial organ occurred due to its high rate of synthesis of protoplasmic protein and in turn protein synthesis, increase in cell size which was mainly responsible for vertical development of plant (Lopez *et al*., 1988) [4]. So growth and development of plant depends on proper availability of nutrients. These results are in tune with the findings of Jakhar *et al*. (2003), Singh and Agarwal (2004) [8], Tetarwal and Rana (2006) [3], Yadav *et al*. (2009) [12], Choudhary and

Prabhu (2014) [9] and Meena *et al.* (2017) [6]. who opined that increased in N content in both grain and straw with increased in total dry matter production and nitrogen application induced a positive influence on the development of vegetative cells thereby increasing total N uptake (Vora *et al.*, 2010) [10].

Table 1: Effect of wheat residue management and fertilizer levels on yield and nutrient content and uptake by summer pearl millet (pooled data)

Treatments	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)	N content (%)		P content (%)		K content (%)		N uptake (%)	
				Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw
Wheat residue management (R) :											
R_1	3145	6027	34.29	1.71	0.59	0.420	0.200	1.71	0.59	0.420	0.200
R_2	2830	5584	33.59	1.69	0.58	0.395	0.184	1.69	0.58	0.395	0.184
R_3	3204	6581	32.76	1.71	0.61	0.435	0.218	1.71	0.61	0.435	0.218
R_4	3516	6776	34.14	1.72	0.65	0.455	0.244	1.72	0.65	0.455	0.244
R_5	4134	7665	34.99	1.77	0.72	0.500	0.335	1.77	0.72	0.500	0.335
R_6	4281	8064	34.72	1.79	0.73	0.517	0.344	1.79	0.73	0.517	0.344
R_7	3788	7316	34.13	1.73	0.67	0.467	0.300	1.73	0.67	0.467	0.300
S.Em.±	63	150	0.48	0.01	0.01	0.06	0.003	0.01	0.01	0.06	0.003
C.D. at 5%	186	438	NS	0.04	0.03	0.019	0.009	0.04	0.03	0.019	0.009
C.V.%	7.61	9.29	5.92	3.20	6.01	6.00	4.97	3.20	6.01	6.00	4.97
Fertilizer levels (F) :											
F_1	3169	6195	33.77	1.68	0.63	0.437	0.243	1.68	0.63	0.437	0.243
F_2	3580	6893	34.20	1.72	0.65	0.457	0.259	1.72	0.65	0.457	0.259
F_3	3921	7489	34.29	1.79	0.68	0.474	0.280	1.79	0.68	0.474	0.280
S.Em.±	34	73	0.27	0.01	0.01	0.000	0.002	0.01	0.01	0.000	0.002
C.D. at 5%	99	206	NS	0.02	0.01	0.009	0.005	0.02	0.01	0.009	0.005
Interaction (R × F) :											
S.Em.±	92	193	0.71	0.02	0.01	0.008	0.005	0.02	0.01	0.008	0.005
C.D. at 5%	261	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
C.V.%	6.37	6.90	5.13	2.13	5.07	4.27	4.46	2.13	5.07	4.27	4.46

Table 2: Effect of wheat residue management and fertilizer levels on nutrient uptake and status of soil after harvest of summer pearl millet (pooled data)

Treatments	P uptake (kg/ha)		K uptake (%)		Organic carbon (%)	Available N (kg/ha)	Available P_2O_5 (kg/ha)	Available K_2O (kg/ha)
	Grain	Straw	Grain	Straw				
Wheat residue management (R) :								
R_1	13.25	12.12	16.93	96.37	0.205	163.69	41.51	254.72
R_2	11.21	10.38	14.68	84.83	0.167	159.21	38.77	272.55
R_3	13.96	14.41	18.66	107.87	0.235	168.30	43.05	257.18
R_4	16.12	16.58	21.89	112.50	0.279	172.58	46.33	258.98
R_5	20.71	25.81	29.13	132.67	0.302	180.05	48.94	266.73
R_6	22.23	27.97	30.81	140.76	0.307	184.52	50.26	267.56
R_7	17.75	21.99	24.50	123.64	0.291	174.18	46.82	260.29
S.Em.±	0.40	0.53	0.40	0.53	0.003	1.63	0.50	2.41
C.D. at 5%	1.17	1.53	1.17	1.53	0.005	4.76	1.46	7.04
C.V.%	10.36	12.07	10.36	12.07	4.96	4.03	4.72	3.90
Fertilizer levels (F) :								
F_1	14.05	15.58	18.99	97.47	0.236	164.60	43.10	258.12
F_2	16.52	18.30	22.26	114.21	0.253	171.23	45.26	261.81
F_3	18.82	21.51	25.86	130.60	0.277	179.54	46.93	267.79
S.Em.±	0.19	0.27	0.24	1.32	0.001	0.82	0.21	1.10
C.D. at 5%	0.55	0.76	0.69	3.74	0.003	2.33	0.60	3.11
Interaction (R × F) :								
S.Em.±	0.51	0.71	0.65	3.49	0.003	2.18	0.56	2.90
C.D. at 5%	1.46	2.02	1.83	NS	NS	NS	NS	NS
C.V.%	7.65	9.48	7.07	7.50	3.13	3.10	3.02	2.71

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