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Yield and soil fertility influence by soybean residue management in soybean based cropping system

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Abstract
A long term (10 years) field experiment was conducted at Agriculture Research Station, Buldana, Dr. Panjabrao Deshmukh Krishi Vidyapeeth, Akola, Maharashtra during Kharif and Rabi season of 2003-04 to 2013-14 in split plot design with three replication and twelve treatment combination of crop residue management and fertilizer to find out the effect of soybean crop residual on the yield of succeeding rabi crops and soil health. Result indicated that soybean crop residue incorporation treatment significantly higher than non crop residue incorporation treatment in both rabi crops. In fertilizer treatment 100 percent RDF to wheat and chickpea recorded significantly highest grain yield. While interaction effects were found non significant when, application of soybean crop residue 2.0 t/ha. along with 100 percent recommended dose of fertilizer to wheat and chickpea was recorded maximum grain yield, gross and net monetary return, improve organic carbon content in soil which help to maintain soil health.

Keywords: Crop residual management, economics, soil fertility, soybean, yield

Introduction
Soybean being a legume, leaves 45 to 60 kg residual N/ha to the succeeding crop and creates favourable soil physico–chemical environment to the crop growth. It is also instrumental in sustaining soil organic matter status through substantial recycling of foliage/rhizosphere root biomass. (Dasharath Prasad *et al.*, 2016) [2]. Thus, in order to sustain the soil and crop productivity, the minimum soil disturbance, organic soil cover and crop diversification assume great importance (Rana *et al.* 2004, Gangwar *et al.* 2006) [9, 4]. In India, soybean is grown on 121.92 lakh ha area with a production of 112.25 lakh MT and productivity of 921 Kg/ ha. In Vidarbha, area under soybean is 19.21 lakh ha. with a production of 14.78 lakh MT and productivity of 778 kg /ha.(Anonymous, 2019) [1].
Crop residues (stover) have many potential uses by society food, feed, shelter, fuel, and soil amendment. Use of residues for purposes other than as a soil amendment may have serious negative consequences on crop productivity. (Wilhelm *et al.*, 1986) [14]. This review reveals that crop residues of common cultivated crops are an important resource not only as a source of significant quantities of nutrients for crop production but also affecting soil health.
When crop residues are returned to the soils, their decomposition can have both positive and negative effects on crop production as well as on the environment. Our aim as agricultural scientists is to increase the positive effects. Nitrogen benefits and nitrogen recoveries from residues show that a considerable potential exists from residues, especially leguminous residues, not only in meeting the N demands of the succeeding crops, but also in increasing the long-term fertility of the soils. Long term research provides invaluable insight for quantification of the impact of crop production practices on soil organic carbon. Thus, keeping in view above facts, the present study was undertaken to find out the effect of soybean crop residue incorporation on the yield of succeeding *rabi* crops and soil health.

Materials and Methods
A field experiment was carried out during *Kharif* and *rabi* 2003-04 to 2013-14 (10 years) at Agriculture Research Station, Buldana, Maharashtra (20°31'58 N latitude, 76°10'58 E longitude and an altitude of 646 m amsl). The mean annual rainfall of Buldana is 650 mm and more than 80% generally occurs during the south-west monsoon season (July–September). The soil was clayey in texture. The chemical analysis indicated that the soil was low in available nitrogen (186 kg /ha.), medium in available phosphorus (15.74 kg/ha.) and high in available potassium (281 kg /ha.). It was moderately alkaline in reaction (pH 8.00).

The organic carbon content was 0.29 percent. The field experiment was laid out in split–plot design with three replications. The main plot treatments comprised four crop residual management, *viz.* wheat with residue incorporation, wheat with no residue incorporation, chickpea with residue incorporation, chickpea with no residue incorporation and sub-plot treatment were fertilizers i.e.50,75 and 100 percent recommended dose of fertilizers for *rabi* crops. Soybean '*JS-335*' crop was sown in *kharif* season with all recommended package of practices for soybean residue only. The crop was harvested at maturity and the plots were threshed with thresher at low speed. The soybean residue was collected and spread on each residue incorporation plot @ 3.90 kg. per plot (2.0t/ha.). The harrowing was undertaken to incorporate the residue in the soil. The seed–bed was prepared and after irrigation. Irrigations were scheduled based on recommended IW/CPE ratio for each crop. Wheat '*AKW-1071*' and Chickpea *'JAKI-9218'* were sown in last week of November and harvested in the end of March to middle of April during every year. Recommended dose of fertilizer for wheat 120:60:60 Kg NPK/ha. and chickpea 25:50:00 Kg NPK/ha given to crop. The yield of chickpea was converted into wheat equivalent yield (WEY) based on prevailing market price for comparison of treatment. The returns were calculated on yearly basis and then averaged. Benefit: cost ratio (B:C ratio) of system was expressed as ratio of net returns and cost of cultivation. The change in soil fertility status was monitored after completion of experimentation. The soil sample were analyzed for organic carbon, available N,P and K by standard procedures. All the data pertaining to crop yields, system productivity and soil properties were statistically analysed using the F–test as per the procedure given by Gomez and Gomez (1984) [5]. LSD values at P=0.05 were used to determine the significance of difference between treatment means.

Results and Discussion

Wheat Equivalent grain yield

A) Crop residue management

On the basis of ten years study reflected that, incorporation of SCR significantly recorded the highest yield *viz* wheat (3154 kg/ha.) and chickpea (3077 kg/ha.) crops as compared to no residue incorporation treatments.

Fertilizer dose

Linear and significant grain yield increase was observed with increase in fertilizer dose in both the crops. The application of 100 percent dose of fertilizer to wheat and chickpea recorded significantly highest grain yield (3286 kg/ha.) than the 75 percent recommended dose of fertilizer (3016 kg/ha.) and 50 percent recommended dose of fertilizer (2448 kg/ha.)

Interaction

The pooled data revealed that (Table 1a) grain yield of wheat and chickpea was significantly increased due to combined effect of SCR incorporation and fertilizer doses applied to both the crops. Incorporation of SCR showed higher wheat and chickpea grain yield (3469 and 3559 kg/ha. respectively) with 100 percent RDF than with 50 percent RDF and at par with 75 percent RDF. Addition of SCR and its subsequent decomposition improved the organic matter status, soil health and released nutrients through the crop growth period that helped to increase the growth and yield of chickpea which ultimately resulted in higher chickpea grain yield as compared to no SCR treatment. These findings are closely associated with Usadadiya and Patel (2013) [13], Karunakaran and Behera (2013) [6].

Economics

Crop residue management

The incorporation of SCR recorded higher GMR, NMR than no residue incorporation in both the *rabi* crops. However, B:C ratio was recorded higher under no incorporation treatments. Among *rabi* crop crops, chickpea recorded highest GMR, NMR and B:C ratio as compared to wheat.

Fertilizer dose

The application of 100 percent recommended dose of fertilizer to both crop recorded overall higher GMR, NMR and B:C ratio as compared to 75 and 50 percent recommended dose of fertilizer.

Interaction

Data presented in Table 1b, 1c,1d revealed that, The GMR and NMR of wheat and chickpea was significantly increased due to incorporation of SCR on decomposition released nutrients to soil slowly throughout the growth period of chickpea and wheat plants resulted in increasing the value of yield, GMR,NMR and B:C ratio of chickpea and wheat. In both the crops, chickpea recorded significantly higher GMR (Rs.47812/-), NMR (Rs.29593/-) and B:C ratio with incorporation SCR along with 100 percent RDF as compared to rest of treatments. These results are closely resembled with those of Singh *et al.* (2008) [12], Karunakaran and Behera (2013) [6].

Fertility status

Crop residue management

Data presented in Table 2 revealed that, the incorporation of SCR recorded significantly higher organic carbon, available N, P and K than no SCR incorporation in both the *rabi* crops. However, results were found statistically non significant in P^H. Among the two *rabi* crops, chickpea recorded higher fertility values as compared to wheat crop.

Fertilizer dose

At the onset of experiment, soil organic carbon content was 0.29 percent However, available N, P and K status of experimental site were 186, 15.74 and 281 kg/ha. respectively. A gradual increase in soil organic as well as available N, P and K were noticed over the year. Continuous incorporation of SCR raised soil organic carbon content (0.96) and available N, P, K (243, 29.48, 419 kg/ha. respectively) after ten years.

This attributed to improvement is soil fertility status due to residue incorporation resulting in higher levels of crop productivity. These results are closely resembled with those of Singh *et al.* (2009) [11], Kumar and Goh (2000) [8].

Higher SOC in soybean based cropping systems and positive balance of SOC and available N and P over initial values in soybean based systems may be attributed to more litter fall and root biomass. N fixation by soybean, addition of higher dose of P to legume and favourable effect of underground root biomass of legumes in increasing P availability. Similar results were also reported by Dhiman (2010) [3] and Sharma *et al.* (2014) [10].

Table 1: Pooled grain yields (Wheat equivalent) and economics as influenced by different treatments. (2003-04 to 2013-14)

SN	Treatments	Grain yield (kg/ha)	Gross monetary return (Rs./ha.)	Net monetary return (Rs./ha.)	B:C ratio
A	Main Plot(Crop Residue)				
	WI-Wheat with incorporation	3154	43336	22569	2.09
	WN -Wheat with no incorpo^{n}	2816	38509	20747	2.23
	CI-Chickpea with incorporation	3077	41348	23832	2.39
	CN-Chickpea with no incorpo^{n}	2620	34914	20278	2.49
	SE ±	21	261	261	
	CD at 5%	71	886	901	
B	Subplot (Fertilizer dose)				
	F_1 – 50% RDF	2448	32920	16132	2.04
	F_2 -75% RDF	3016	41153	23512	2.38
	F_3 -100% RDF	3286	44507	25928	2.48
	SE ±	17	222	222	
	CD at 5%	51	665	768	
C	Interactions				
	SE ±	34	445	443	
	CD at 5%	102	1331	1536	

Table 1a: Interaction effect on grain yield of both crops.

Crop residual /Fertilizer dose	F1	F2	F3
WI - Wheat with incorporation	2724	3269	3469
WN -Wheat with no incorporation	2495	2862	3090
CI - Chickpea with incorporation	2450	3222	3559
CN - Chickpea with no incorporation	2123	2711	3027
SE ±	34		
CD at 5%	102		

Table 1b: Interaction effect on Gross monetary of both crops.

Crop residual /Fertilizer dose	F1	F2	F3
WI - Wheat with incorporation	37119	45219	47657
WN - Wheat with no incorporation	33945	39341	42232
CI - Chickpea with incorporation	32874	43670	47812
CN - Chickpea with no incorporation	28064	36361	40309
SE ±	445		
CD at 5%	1331		

Table 1c: Interaction effect on Net monetary of both crops

Crop residual /Fertilizer dose	F1	F2	F3
WI - Wheat with incorporation	17567	24456	25682
WN -Wheat with no incorporation	17393	21580	23255
CI - Chickpea with incorporation	15623	26282	29593
CN - Chickpea with no incorporation	13941	21859	25169
SE ±	443		
CD at 5%	1536		

Table 1d: Interaction effect on B:C ratio of both crops.

Crop residual /Fertilizer dose	F1	F2	F3
WI - Wheat with incorporation	1.94	2.16	2.18
WN -Wheat with no incorporation	2.14	2.26	2.20
CI - Chickpea with incorporation	1.98	2.51	2.66
CN - Chickpea with no incorporation	2.11	2.57	2.80

Table 2: Soil fertility status after harvest of crops as influenced by different treatments.

SN	Treatments	pH	Organic Carbon %	Available nutrients (Kg/ha.)		
				N	P	K
A	Main Plot (Crop Residue)					
	WI-Wheat with incorporation	7.92	0.91	238	28.12	422
	WN -Wheat with no incorpo^{n}	8.07	0.72	226	22.92	380
	CI-Chickpea with incorporation	8.08	0.96	243	29.48	419
	CN-Chickpea with no incorpo^{n}	7.93	0.86	233	25.84	405
	SE ±	0.09	0.03	2.8	0.96	5.9
	CD at 5%	N.S.	0.10	9.8	3.3	20.3
B	Subplot (Fertilizer dose)					

	F_1 – 50% RDF	8.00	0.83	233	25.95	403
	F_2 -75% RDF	8.06	0.86	234	26.60	408
	F_3 -100% RDF	7.95	0.89	238	27.23	409
	SE ±	0.06	0.013	0.9	0.48	4.9
	CD at 5%	N.S.	0.041	2.7	N.S.	N.S.
C	Interactions					
	SE ±	0.11	0.028	1.8	0.96	9.8
	CD at 5%	N.S.	N.S.	N.S.	N.S.	N.S.
	Initial Soil Status	7.98	0.29	186	15.74	281

Interaction

Interaction effect due to SCR incorporation and fertilizer doses were found non-significant in respect of P^H, organic carbon, available N, P and K.

It is therefore concluded that, maximum grain yield, gross and net monetary return were significantly higher in application of soybean crop residue along with 100 percent recommended dose of fertilizer to wheat and chickpea, which also increase organic carbon content in soil due to incorporation of crop residue in both *rabi* crops.

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