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Influence of different resource Conservation practices on Biomass Production, Yield and nutrient uptake by soybean

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ABSTRACT
*The present investigation entitled, "*Influence of different resource conservation practices on biomass production, yield and nutrient uptake by soybean*" was undertaken during 2014-15 at Research farm, Dr. PDKV, Akola. The experiment was laid out in Randomized Block Design with nine treatments replicated three times. The objectives were to evaluate the effect of different resource conservation practices on carbon sequestration and its effect on soil properties. The cotton-soybean rotation was followed since 2011-12. The present experiment was superimposed on soybean during 2014-15. The treatments comprised of unfertilized control, chemical fertilizers alone and their combinations with organics viz., FYM and phosphocompost. The soil of experimental site was black belongs to Vertisols. The soil and plant samples were collected and analyzed for their different properties. The results revealed that the highest grain and straw yield viz., 12.50 q ha^{-1} and 15.51 q ha^{-1} of soybean and Significantly higher uptake of nitrogen (87.65 kg ha^{-1}), phosphorus (8.68 kg ha^{-1}) and potassium (24.71 kg ha^{-1}) was recorded in the treatment (T_2)RDF based on soil test (25% N through dhaincha loppings + RDF compensation, recommended dose of fertilizer to previous crop) in soybean followed by T_7 with soil test based RDF through FYM + remaining P through phosphocompost (100% N through FYM with compensation of P through phosphocompost and also Significantly higher biomass was obtained from leaf, root and nodules was recorded in the treatment (T_2)RDF based on soil test (25% N through dhaincha loppings + RDF compensation, recommended dose of fertilizer to previous crop) in soybean*
Key words: *Phosphocompost, FYM, vertisols, conservation practices, biomass, uptake*

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INTRODUCTION
Soybean builds up soil fertility by fixing a large amount of atmospheric nitrogen through its root nodules and also through leaf fall on the ground at maturity. It can be used as fodder, forage and can be made into hay, silage etc. Its forage and cake possess excellent nutritive value for livestock and poultry.
The primary factor having influence on soil health is organic matter fractions, which are under constant threat of depletion due to inadequate replenishment under rainfed farming system. The organic matter build up in tropical soil is not feasible, but its maintenance at a desirable level is essential. Use of organics, crop residues, green manures, agricultural wastes, biofertilizers as the components of conservation agriculture improve soil health by changing rhizosphere environment. To increase the productivity, quality and nutrient uptake, use of biofertilizer like Rhizobium and PSB may be good alternative if used for seed treatment or soil application. This will also help in maintaining soil health, sustain productivity of soybean.

MATERIAL AND METHODS
Collection and preparation of Plant samples for analysis
Root biomass:
Roots were taken after 85 days of sowing from a specific area (0.20m ×0.20m) to a depth of 30 cm with a narrow flat bladed shovel and hand saw. Root sample were passed through a series of sieves to collect the coarse roots (>4 mm), medium roots (2-4mm) and fine roots (0.50-1mm) without attempting to differentiate live and dead roots. Roots were dried at 65 ^{0}C at a constant temperature.

Leaf litter biomass:
Leaf litter was collected from 1 m^2 area between the two rows. The samples were collected by hand on nylon net at 65 days and after harvest of the crop. The leaf litter sample were cleaned with tap water and dried at 65 ^{0}C.
Rhizode position biomass: Carbon content in rhizode position from root exudates were assumed 10 % of above ground harvestable biomass of soybean. [11, 17].
Nodule count and biomass: Nodules count has taken at flowering stage, cleaned with tap water and dried at 65 ^{0}C.
Grain and Straw biomass: The straw were collected at harvested stage and dried at 65 ^{0}C.
Plant analysis:
The treatment wise plants were selected randomly from each plot at harvest of the soybean crop. The plants were carefully uprooted retaining most of the roots intact.
Plant material except root was chopped into small pieces and air dried under shed and then in oven at 65^{0}C, these plant samples were grinded with electrically operated grinder and then stored in air tight polythene bags and labeled properly. Which were analyzed for their major and micronutrient contents as given below.
Total Nitrogen: Total nitrogen was determined by digesting the plant sample in microprocessor based digestion system (KES-20L) using conc. H_2SO_4 and salt mixture and distillation with automatic distillation system [15].
Preparation of di-acid extract: Di-acid extract was prepared as per the method described by Jackson [7]. The plant samples were digested with di-acid mixture of conc. HNO_3 and $HClO_4$ in the ratio of 9:4. This extract was used to determine the total P and K from plant samples.
Total phosphorus: Total phosphorus was estimated from diacid digested sample by Vanadomolybdate phosphoric acid yellow colour method using UV based double beam spectrophotometer [7].
Total potassium: It was determined in diacid extract by using flame photometer as described by Piper [15].
Uptake of N, P and K: N, P and K uptake in kg ha^{-1} by crop (grain and fodder) was calculated on the basis of their nutrient concentration and dry weight of crop yield.
Yield studies: The plant biomass dry matter of each net plot were threshed, cleaned and weighed. Net plot yield and yield per hectare was calculated separately.
Statistical analysis: The data on different parameters were tabulated and analyzed statistically by the methods described by Panse and Sukhatme [14].

RESULTS AND DISCUSSION
Effect of different resource conservation practices on leaf litter biomass production by soybean
The data presented in Table 1 represents the effect of organic and inorganic sources on leaf litter biomass production by soybean. The leaf litter biomass was collected at 65 DAS and at harvest. The cumulative biomass was considered as total biomass production by soybean during the crop growth. The leaf litter biomass was higher at 65 days than at harvest. This might be due to less decomposition of leaf litter at this stage as compared to the harvest.

Table 1. Effect of different resource conservation practices on leaf litter biomass production by soybean

Tr.	Rotation		Leaf litter biomass (kg ha^{-1})		
	Cotton	Soybean*	65 DAS	After harvest	Cumulative biomass
	Treatment details				
T_1	RDF	RDF	126.47	322.07	448.54
T_2	25 % N (Dhaincha loppings) + RDF compensation	RDF	135.10	398.13	533.24
T_3	25 % N (Cotton stalk) composted + RDF compensation	RDF	116.50	284.40	400.90
T_4	25 % N (Wheat straw) + RDF compensation	RDF	109.31	192.43	301.74
T_5	25 % N (Bio mulch)+ RDF compensation	RDF	104.77	165.50	270.27
T_6	25 % N (Neemcake) + RDF compensation	RDF	117.50	293.53	411.04
T_7	100 % N (FYM) + compensation of P (phosphocompost)	RDF+PC	131.28	385.40	516.68
T_8	50 % N (FYM) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	115.56	282.27	397.83
T_9	50% N (Leucaena loppings) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	127.59	329.53	457.13
	SE (m) ±		3.72	41.27	40.62
	CD at 5%		11.15	123.75	121.77

* T_1-T_6 : RDF based on soil test; T_7-T_9 : RDF based on soil test through FYM + remaining P through phosphocompost.
The mean amount of cumulative biomass added to the soil by soybean was in the range of 270.27 to 533.24 kg ha^{-1}. The significantly highest cumulative biomass (533.24 kg ha^{-1}) was observed with the application of RDF based on soil test(25% N through dhaincha + RDF compensation to previous cotton) i.e.T_2 followed by RDF based on soil test through FYM + phosphocompost applied to both the crops i.e.T_7 (516.68 kg ha^{-1}), RDF based on soil test through FYM + P compensation through phosphocompost + N compensation through urea i.e.T_9 (457.13 kg ha^{-1}) and RDF applied to both the crops (448.54 kg ha^{-1}) which were at par with each other. The application of RDF based on soil test (25% N through bio mulch and compensation of RDF to previous cotton) resulted substantial decline in the cumulative biomass (270.27 kg ha^{-1}) i.e.T_5.

The higher leaf litter biomass production by soybean might be due to other benefits apart from N, P and K supply, such as secondary nutrients micronutrients, enhanced microbial activity and improved soil physical conditions by use of organic and inorganic sources. Kundu et al. [11] reported that the treatments receiving (NPK + FYM) showed significantly higher input of organic biomass to soil from soybean crop (1254 kg ha^{-1}) compared with control, NP, NK, NPK, N + FYM treatments. Similar results were reported by Ghosh et al. [5].

Effect of different resource conservation practices on root and nodule biomass of the soybean

The findings on root biomass and nodule biomass of soybean as influenced by various treatments are presented in Table 2.

Table 2. Effect of different resource conservation practices on root and nodule biomass of the soybean

Tr.	Rotation		Root biomass (kg ha^{-1})	Nodule biomass		
	Cotton	**Soybean***		Nodule weight (**g**$plant^{-1}$)	Nodule count per plant	Nodule biomass (kg ha^{-1})
	Treatment details					
T_1	RDF	RDF	298.38	0.16	23.67	67.63
T_2	25 % N (Dhaincha loppings) + RDF compensation	RDF	391.63	0.22	33.00	92.63
T_3	25 % N (Cotton stalk) composted + RDF compensation	RDF	285.00	0.14	21.20	57.37
T_4	25 % N (Wheat straw) + RDF compensation	RDF	222.20	0.13	19.33	53.06
T_5	25 % N (Bio mulch)+ RDF compensation	RDF	205.18	0.12	18.73	51.67
T_6	25 % N (Neemcake) + RDF compensation	RDF	306.33	0.15	22.53	62.97
T_7	100 % N (FYM) + compensation of P (phosphocompost)	RDF+PC	377.60	0.19	28.00	82.46
T_8	50 % N (FYM) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	280.50	0.14	20.20	57.27
T_9	50% N (Leucaena loppings) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	313.15	0.17	25.20	70.60
	SE(m)±		13.47	0.01	1.53	4.46
	CD at 5%		40.39	0.03	4.56	13.37

* T_1-T_6 : RDF based on soil test
T_7-T_9 : RDF based on soil test through FYM + remaining P through phosphocompost.

The application of RDF based on soil test (25% N through dhaincha lopping + RDF compensation to previous cotton) (T_2), recorded significantly higher root and nodule biomass of soybean (391.63 and 92.63 kg ha^{-1}, respectively) followed by RDF based on soil test FYM + phosphocompost (100% N through FYM and compensation of P through phosphocompost to previous cotton) i.e.T_7 and these treatment were found at par with each other. The application of RDF based on soil test (25% N through bio mulch and compensation of RDF applied to previous crop i.e.T_5 resulted substantial decline in the root biomass (155.18 kg ha^{-1}) and nodule biomass (51.67 kg ha^{-1}).

The similar trend was also noted in respect of nodule biomass, nodule count and nodule weight. The increase in root and nodule biomass with integrated use of inorganic fertilizers and organic manure might be due to direct incorporation of organic matter which provides congenial environment for better root growth and more plant residues addition. This might be due to balancing of organic and inorganic sources which resulted into adequate supply of macro and micronutrients which provides better environment for root and nodule development. The treatments of chemical fertilizers also recorded higher amount of root and nodule biomass, which might be due to the significance of fertilizer in helping root and nodule development in the soil. Haider et al. [6] reported the application of fertilizer N increased root weight over the control. The results are in conformity with the findings of Kundu et al. [11].

Effect of different resource conservation practices on grain, straw yield and nutrient uptake of soybean

The data presented in Table 3 indicated the grain, straw yield of soybean and nutrient uptake as influenced by various treatments. The application of RDF based on soil test (25% N through dhaincha lopping + RDF compensation to previous cotton) (T_2), recorded higher grain and straw yield of soybean (12.50 and 15.51 q ha^{-1}, respectively) followed by RDF based on soil test through PC (100% N through FYM and compensation of P through phosphocompost) (T_7), RDF based on soil test through PC (50% N through leucaena loppings and compensation of PC + N compensation through urea to previous crop) (T_9) and RDF based on soil test (T_1). However, these treatments were found at par with each other. The application of RDF based on soil test (25% N through bio mulch and compensation of RDF applied to previous crop i.e.T_5 resulted substantial reduction in the grain yield (9.42 q ha^{-1}) and straw yield (11.75 q ha^{-1}).

Table 3: Effect of different resource conservation practices on grain, straw **yield and** nutrient uptake of soybean:

Tr.	Rotation		Grain (q ha^{-1})	Straw (qha^{-1})	Total uptake (kg ha^{-1})		
	Cotton	Soybean*					
	Treatment details				N	P	K
T_1	RDF	RDF	11.38	13.89	79.23	7.50	21.87
T_2	25 % N (Dhaincha loppings) + RDF compensation	RDF	12.50	15.51	87.65	8.68	24.71
T_3	25 % N (Cotton stalk) composted + RDF compensation	RDF	10.65	13.77	74.54	6.96	20.97
T_4	25 % N (Wheat straw) + RDF compensation	RDF	9.78	12.96	68.50	6.26	19.33
T_5	25 % N (Bio mulch)+ RDF compensation	RDF	9.42	11.75	65.39	5.93	17.91
T_6	25 % N (Neemcake) + RDF compensation	RDF	10.90	13.80	76.07	7.12	21.19
T_7	100 % N (FYM) + compensation of P (phosphocompost)	RDF+PC	12.05	15.05	84.47	8.20	23.75
T_8	50 % N (FYM) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	10.42	13.19	72.74	6.73	20.25
T_9	50% N (Leucaena loppings) + P compensation (phosphocompost) + N compensation (Urea)	RDF+PC	11.55	14.24	80.56	7.68	22.32
	SE (m) ±		0.57	0.62	3.71	0.34	0.94
	CD at 5%		1.72	1.87	11.11	1.03	2.82

* T_1-T_6 : RDF based on soil test

T_7-T_9 : RDF based on soil test through FYM + remaining P through phosphocompost.

The integrated supply of nutrients found beneficial in recording higher grain and straw yield of soybean. This can be attributed to the fact that addition of organics through FYM which supply N, P, K and micronutrients in addition to the recommended dose of fertilizers. The results are in close conformity with the findings of Babhulkar et al. [2], Saini et al. [16] and Kundu et al. [11].

Nutrient uptake by soybean

In the present investigation, the results pertaining to nutrient uptake by soybean as influenced by different resource conservation practices are presented and discussed as below.

Nitrogen uptake:

Data pertaining to the effect of different resource conservation practices on uptake of nitrogen by soybean is presented in the Table 3. The application of RDF based on soil test (25% N through dhaincha + RDF compensation to previous cotton) (T_2), recorded significantly higher nitrogen uptake by soybean (87.65 kg ha^{-1}) followed T_7 (84.47 kg ha^{-1}), T_9 (80.56 kg ha^{-1}) and T_1 (79.23 kg ha^{-1}), which were found at par with each other. The lowest uptake of N by soybean (65.39 kg ha^{-1}) was observed with the application of 25% N through bio mulch + RDF compensation applied to previous cotton) i.e. T_5. This may be due to direct as well as residual effect of enriched manures and chemical fertilizers. This conform the findings of Kaur et al. (2008). Basak et al. [3] they observed that substantial increment of N uptake under integrated application of organic manure. The results are in conformity with finding of Navale et al. [12], Akbari et al. [1] and Talati [19].

Phosphorus uptake:

Data pertaining to the effect of different resource conservation practices on uptake of phosphorus by soybean is presented in the Table 3.The effect of various resource conservation practices on phosphorus uptake by soybean was found to be significant. Application of RDF based on soil test to soybean (25% N through dhaincha + RDF compensation to applied previous cotton) i.e. T_2 recorded significantly highest phosphorus uptake by soybean (8.68 kg ha^{-1}) followed by RDF based on soil test through FYM + phosphocompost (100% N through FYM and compensation of P through phosphocompost) (T_7), RDF based on soil test through FYM + phosphocompost (50% N through leucaena loppings + P compensation through PC + N compensation through urea (T_9), RDF based on soil test (recommended dose of fertilizer to previous cotton). However, these treatments were found at par with each other. The application of RDF based on soil test (25% N through bio mulch and compensation of RDF resulted substantial decrease in P uptake (5.93 kg ha^{-1}). Similar results were also reported by Nimje and Seth [13], Kacha et al. [12], Navale et al. [9], Dubey [4] and Joshi [8].

Potassium uptake

Data pertaining to the effect of different resource conservation practices on uptake of potassium by soybean is presented in the Table 3.Application of RDF based on soil test (25% N through dhaincha + RDF compensation to previous cotton) (T_2), recorded significantly higher potassium uptake by soybean (24.71 kg ha^{-1}) followed T_7 (23.75 kg ha^{-1}) and T_9 (22.32 kg ha^{-1}) which were found at par with each other. The application of RDF based on soil test (25% N through bio mulch and compensation of RDF to previous crop) resulted substantial decline in the K uptake (17.91 kg ha^{-1}). Similar results were also reported by Kacha et al. [9], Sharma [18], Navale [12] and Ved Prakash et al. [20].

SUMMARY AND CONCLUSION

Biomass production and yield of soybean

Significantly higher biomass was obtained from leaf, root and nodules in treatment T_2 and T_7 with the application of organics along with chemicals as compared to rest of the treatments. The application of FYM along with chemical fertilizers was found superior among all the treatments. However, inclusions of organics like phosphocompost and crop residues were also found beneficial in increasing the yield of soybean. The highest grain and straw yield viz., 12.50 q ha^{-1} and 15.51 q ha^{-1} of soybean was recorded in the treatment (T_2)RDF based on soil test (25% N through dhaincha loppings + RDF compensation, recommended dose of fertilizer to previous crop) in soybean followed by T_7 (12.05 qha^{-1} and 15.05 q ha^{-1}) with soil test based RDF through FYM + remaining P through phosphocompost (100% N through FYM with compensation of P through phosphocompost) in soybean.

Nutrient uptake by soybean

Significantly higher uptake of nitrogen (87.65 kg ha^{-1}), phosphorus (8.68 kg ha^{-1}) and potassium (24.71 kg ha^{-1}) was observed in the treatment RDF based on soil test (25% N through dhaincha loppings + RDF compensation, recommended dose of fertilizer to previous crop). Significantly lowest uptake of nitrogen, phosphorus and potassium was observed in RDF based on soil test (25% N through bio mulch + RDF compensation, recommended dose of fertilizer to previous crop).

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