International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; SP6: 684-687

Ravi Kumar
M.Sc student, Dept. of Soil Science & Agricultural chemistry, COA, Sehore, RVSKVV, Gwalior, Madhya Pradesh, India

Vishwakarma AK
Principal Scientist, Division of Soil Chemistry & Fertility, ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh, India

Biswas AK
HOD and Principal Scientist, Division of Soil Chemistry & Fertility, ICAR-Indian Institute of Soil Science, Bhopal, Madhya Pradesh, India

Parmar BB
Associate Professor, Dept. of Soil Science & Agricultural chemistry, COA, Sehore, RVSKVV, Gwalior, Madhya Pradesh, India

Corresponding Author:
Ravi Kumar
M.Sc student, Dept. of Soil Science & Agricultural chemistry, COA, Sehore, RVSKVV, Gwalior, Madhya Pradesh, India

(Special Issue -6)
3rd National Conference
On
PROMOTING & REINVIGORATING AGRI-HORTI, TECHNOLOGICAL INNOVATIONS [PRAGATI-2019]
(14-15 December, 2019)

Effect of different levels of residue retention on crop performance of soybean under conservation agriculture

Ravi Kumar, Vishwakarma AK, Biswas AK and Parmar BB

Abstract
A field experiment was conducted to evaluate the effect of different levels residue and cropping sequence on soybean production at ICAR- IISS, Bhopal during 2018-19. The experiment was laid on randomized block design with four residue levels as treatments and six replications under soybean cropping system. So the finding of the study indicates that there is significant influence of different residue level retention on plant height as compared to control. Maximum plant height of soybean was recorded under treatment T_4 (90% residue) 31.78, 54, 60.43 and 60.73 cm at 30 DAS, 45 DAS, 60 DAS and at harvest respectively. The maximum number of branches in soybean of 4.00, 5.39 and 6.44 respectively were recorded under the treatment T_4 (90% residue) at different growth stages 45 DAS, 60 DAS and at harvest which was significantly superior over test of the treatments. The root length was found to be significantly superior in T_4 (90% residue) at 45 and 60 DAS which was on par with T_3 (60% residue) T_2 (30% residue). Similar trend was observed at harvest stage. At 30 & 45 DAS the maximum dry weight was noted under the treatment having highest residue level T_4 (90% residue) which was significantly. Higher the level of residue higher is the number of nodules/plant. At 45 DAS, all the treatments were at par with each other but at 60 DAS significantly higher number of nodules 50.67, 55.83 were recorded in treatment T4 (90% residue). The higher dry weight of nodules was recorded in treatments comprising of higher residue level retention as compared to without residue. The data recorded that number of seeds per pod was significantly higher in treatments comprising of higher level of residue retention as compared to lower level and control. The data that highest number of pod/plant was recorded under the treatment having maximum level of residue T_4 - 90% residue (43.22) which was on par with treatment T_3 - 60% residue (40.89) and significantly superior to treatments T_2 - 30% residue (37.67) and T_1 – control (35.44). The maximum seed index was recorded in treatment T_4-90% residue (10.35), which was on par with treatment T_3 - 60% residue (10.24) and these treatments were significantly superior over treatments T_2 - 30% residue (9.57) and T_1 – control (9.13). The results that number of seed per plant was significantly higher under the treatment T_4 - 90% residue (84.17) compare to treatment T_3 (80.94), T_2 (71.56) and T_1 (59.56) control. Among all treatments the maximum seed yield was recorded in treatment T_4-90% residue (1965 kg ha^{-1}) which was on par with treatment T_3 - 60% residue (1915) and these treatments were significantly superior over treatments T_2 - 30% residue (1746) and T_1 - control (1543 kg ha^{-1}). The different levels of residue significantly influenced the straw yield kg ha^{-1}. The maximum straw yield was recorded in treatment T_4-90% residue (2946 kg ha^{-1}). The data clearly shows that harvest index was found to be higher in the treatments comprising of different residue levels as compared to control but statistically they are non- significant to each other.

Keywords: levels, residue retention, crop performance, soybean, conservation agriculture

Introduction.
Conservation agriculture can be an important component for the overall strategy towards

enhancing productivity, improving environmental quality and preserving natural resources for food security and poverty alleviation. Tillage is one of the fundamental operations in agriculture because of its significant influence on soil properties, clearing weeds, environment and crop growth. Since continuous tillage strongly influence the soil properties which results in degradation of soil and loss of soil OC, it is important to adopt appropriate tillage practices to avoid degradation of soil structure, maintain crop yield as well as ecosystem stability (Karunakaran *et al.,* 2015) [4]. Conservation agriculture (CA) including reduced or no-tillage and crop residue retention, is known to be a self–sustainable system as well as an alternative to residue burning having improved soil properties and crop yields in Vertisols of semiarid region of central India (Somasundaram *et al.*, 2019) [6]. Conservation agriculture is the practice of cultivation which comprises of minimum soil disturbance, crop diversification and retention of crop residues. Conservation agriculture focuses mainly on management of soil, water and agricultural resources for achieving economic, ecological and socially sustainable agricultural production (Jat *et al.,* 2012) [3] Conservation agriculture is the group of crop management practices promoted to increase crop yields and to r educe soil degradation and develop system which is more resilient to weather –induced stresses including those caused by climate change and climate variability. At present, the world's focus is shifted to the conservation and sound tillage systems are an integral part of it. Therefore, various techniques of tillage are followed to enhance the soil and water conservation for increased production. Many research studies (Harold & Edwards 1972; Triplett & Van Doren 1977; Phillips *et al.*, 1980) [1, 5] Showed, that minimum tillage is very beneficial for the conservation of soil and water. Minimum tillage generally coincides with the retention of crop residues, and it can play major role in improving the sustainability of cropping. Crop residues act as a sink and source for the plant nutrients (Hubbard *et al.,* 1996) [2].

Materials and Methods

Experimental site and Treatment

The field experiment was laid out at the research farm of Indian institute of Soil Science (ICAR), Bhopal, (M.P.) under Conservation Agriculture in Soybean - Wheat cropping system in Vertisols. The experiment was laid out in randomized block design with four treatments, replicated six times.

The details are as below treatments

Treatment	(Residue levels)
T_1	0% Residue
T_2	30% Residue of the preceding
T_3	60% Residue of the preceding
T_4	90% Residue of the preceding

(Wheat residues were applied by harvesting at 30%, 60% and 90% on plant height basis while soybean residues were applied on weight basis.)

Result and Discussion

Pre harvest observations: Plant height (cm). The perusal of the data presented in table 3.1 revealed that there is significant influence of different residue level retention on plant height as compared to control. Maximum plant height of soybean was recorded under treatment T_4 (90% residue) 31.78, 54, 60.43 and 60.73 cm at 30 DAS, 45 DAS, 60 DAS and at harvest respectively, followed by treatments T_3 (60% residue), T_2 (30% residue) which differs significantly among each other, whereas the minimum plant height 26.17, 46.89, 50.61 and 54.06 cm was recorded under the treatment T_1 (control) at 30 DAS, 45 DAS, 60 DAS and at harvest respectively.

Table 3.1: Effect of different residue level retention on plant height and number of branches in soybean at different growth stages.

Treatments	Soybean plant hight				Number of branches in soybean		
	30 DAS	45 DAS	60 DAS	Harvest	45 DAS	60 DAS	Harvest
T1 (Control)	26.17	46.89	50.61	54.06	2.78	3.50	4.45
T2 (30% residue)	28.78	48.94	55.59	55.78	3.00	4.00	5.26
T3 (60% residue)	30.44	50.61	56.39	58.20	3.39	4.56	5.81
T4 (90% residue)	31.78	54.00	60.43	60.73	4.00	5.39	6.44
SEm±	0.35	0.664	0.38	0.56	0.10	0.08	0.14
CD (P=0.05)	1.05	2.001	1.15	1.69	0.32	0.24	0.41

Number of branches/plant in soybean

The number of branches of soybean crop was counted and recorded at successive growth stages of crops and the data are presented in the table 3.1 the effect of different residue levels on number of branches per plant shows significant difference as compared to control. The maximum number of branches in soybean of 4.00, 5.39 and 6.44 respectively were recorded under the treatment T_4 (90% residue) at different growth stages Table 3.1 which was significantly superior over test of the treatments and followed by the treatments T_3 (60% residue) and T_2 (30% residue).The minimum number of branches 2.78, 3.50 and 4.45 were found in control treatment. At 45 DAS the treatment T_1 and T2 were at par with each other, while at 60 DAS all treatments were found to be different from each other.

Root length/plant (cm)

Root length/plant (cm) of soybean crop is an important parameter which shows the compactness of soil and availability of moisture in root zone. The root length plant^{-1} was recorded at different growth stages as presented T able 3.2 It was found that maximum root length was recorded under treatment T_4 (90% residue) and lowest root length was recorded under control treatment (23.83cm, 21.00 cm), (28.17 cm, 23.17 cm), (29.17 cm, 25.33 cm) respectively. The root length was found to be significantly superior in T_4 (90% residue) at 45 and 60 DAS which was on par withT_3 (60% residue) T_2 (30% residue). Similar trend was observed at harvest stage (Table 3.2).

Table 3.2: Effect of different residue level retention on root length and dry weight at different growth stages.

Treatment	Root length/ plant (cm)			Dry matter weight/ plant (g)			
	45 DAS	60 DAS	Harvest	30 DAS	45 DAS	60 DAS	Harvest
T1 (Control)	21.00	23.17	25.33	2.95	5.68	8.43	13.43
T2 (30% residue)	22.17	24.67	26.00	4.30	7.07	8.80	13.47
T3 (60% residue)	23.50	26.17	27.83	6.10	8.32	11.38	16.38
T4 (90% residue)	23.83	28.17	29.17	7.25	11.38	12.88	18.72
SEm±	0.65	1.30	0.75	0.15	0.39	0.96	1.10
CD (P=0.05)	NS	NS	2.25	0.45	1.18	2.89	3.32

Dry Matter Weight

Dry weight/plant is one of the most important indicators of plant growth and development in all crops. Table 3.2 indicate the dry weight of soybean at different stages and replace dry weight with dry matter weight was significantly influenced by different levels of residue retention. At 30 & 45 DAS the maximum dry weight was noted under the treatment having highest residue level i.e., T4 (90% residue) which was significantly superior over other treatments, followed by treatments T3 (60% residue) and T2 (30% residue) and minimum was recorded under control Table 3.2 All the residue retention treatments differs significantly among each other and were significantly superior over control.

Number of nodules/plant

The number of nodules/plant was recorded treatment wise. It has been observed that there is positive effect of residue level on number of nodules per plant, i.e., higher the level of residue higher is the number of nodules/plant. At 45 DAS, all the treatments were at par with each other but at 60 DAS significantly higher number of nodules 50.67, 55.83 were recorded in treatment T4 (90% residue) followed by treatments T3 (60% residue) which were on par with each other and significantly superior over the treatments T1 & T2 which were on par with each otherTable3.3. Lowest number of root nodules per plant (46.33 and 47.83) was recorded under T1 (control) at 45 & 60 DAS.

Table 3.3: Effect of different residue level retention on number of root nodules and dry matter weight of nodules of soybean at different growth stages.

No. of nodules/ plant			Dry weight of nodules/plant (mg)	
Treatment	45 DAS	60 DAS	45 DAS	60 DAS
T1 (Control)	46.33	47.83	173.00	190.17
T2 (30% residue)	46.50	49.83	178.33	193.17
T3 (60% residue)	47.17	53.50	187.17	227.33
T4 (90% residue)	50.67	55.83	199.17	247.67
SEm±	1.53	0.96	2.69	9.12
CD (P=0.05)	NS	2.89	8.12	27.50

Dry weight of nodules in Soybean

The maximum level of residue increases the number nodules/plant and hence similar trend is envisaged in terms of dry weight of nodule/plant. The higher dry weight of nodules was recorded in treatments comprising of higher residue level retention as compared to without residue. A perusal of data presented in Table 3.3 revealed that highest dry weight of nodules/plant was recorded under the treatment T4 treatment (90% residue) (199.17 mg and 247.67 mg at 45 and 60 DAS, respectively) followed by the treatments T3 (60% residue) and T2 (30% residue) and significantly lowest dry weight of nodules/plant (mg) (173.00 and 190.17 mg) was recorded under T1 (control).

Post-harvest observations

The data on post-harvest observation were recorded and it indicated that the yield attributing parameters were significantly influenced by treatments of different residue level retention as compared to treatment without residue.

Number of seed

The number of seed per pod is a major yield attributing character of soybean crop. The number of seeds/pod of randomly selected plants were counted and analyzed statistically which are presented in Table 3.4. It is clear from the data recorded that number of seeds per pod was significantly higher in treatments comprising of higher level of residue retention as compared to lower level and control. Significantly higher number of seeds/pod were noted under the treatment T4 - 90% residue and T3 -60% residue (2.72) which were significantly superior to treatment T2 - 30% residue (2.56) and T1 (control) which were on par with each other.

Number of pods

The number of pods of randomly selected plants were counted and average number of pods/plant were statistically analysed and presented in table 3.4.It is evident from the data that highest number of pod/plant was recorded under the treatment having maximum level of residue T4 - 90% residue (43.22) which was on par with treatment T3 - 60% residue (40.89) and significantly superior to treatments T2 - 30% residue (37.67) and T1 – control (35.44).Treatments T3 and T2 were on par with each other and similarly treatment T2 and control were also on par with each other.

Table 3.4: Effect of different residue level retention on yield attributes or yield attributing character of soybean

Treatment	No. of seed pod^{-1}	Pods plant^{-1}	Seed index	No. of seed plant^{-1}	Seed yield kg ha^{-1}	Straw yield kg ha^{-1}	HI (%)
T1 (Control	2.56	35.44	9.13	59.56	1542.59	2364.81	39.48
T2 (30% residue)	2.56	37.67	9.57	71.56	1745.83	2662.04	39.61
T3 (60% residue)	2.72	40.89	10.24	80.94	1915.28	2887.04	39.88
T4 (90% residue)	2.72	43.22	10.35	84.17	1965.28	2945.83	40.02
SEm±	0.04	1.68	0.10	2.49	38.79	40.03	0.69
CD (P=0.05)	0.12	5.08	0.30	7.50	116.91	120.66	NS

Seed index
The seed index was calculated after threshing and sun drying of soybean seeds. The data was statistically analysed and presented in the table 3.4. It is evident that seed index was significantly influenced by treatments comprising of different residue levels as compared to without residue. The maximum seed index was recorded in treatment T4-90% residue (10.35), which was on par with treatment T3 - 60% residue (10.24) and these treatments were significantly superior over treatments T2 - 30% residue (9.57) and T1 – control (9.13).

Number of seeds
The numbers of seeds/plant of soybean have been presented in table 3.4 after statistically analysis. It is clear from the results that number of seed per plant was significantly higher under the treatment T4 - 90% residue (84.17) which was on par with treatment T3 - 60% residue (80.94). And these treatments were significantly superior over treatments T2 - 30% residue (71.56) and T1 - control (59.56).

Seed yield
The seed yield of crop has been calculated and after statistical analysis it was presented in table 3.4. As per the data recorded it is evident that the seed yield was significantly influenced by different residue level as compared to control. Among all treatments the maximum seed yield was recorded in treatment T4-90% residue (1965 kg ha-1) which was on par with treatment T3 - 60% residue (1915) and these treatments were significantly superior over treatments T2 - 30% residue (1746) and T1 - control (1543 kg ha-1).

Straw yield
The straw yield of crop have been calculated and presented in table 3.4. The different levels of residue significantly influenced the straw yield kg ha-1. The maximum straw yield was recorded in treatment T4-90% residue (2946 kg ha-1) which was on par with treatment T3 - 60% residue (2887) and these treatments were significantly superior over treatments T2 - 30% residue (2662) and T1 - control (2365 kg ha-1).

Harvest Index
The harvest index was computed by using the data of seed yield and biological yield. After statistical analysis the results were presented in the table 3.4. The data clearly shows that harvest index was found to be higher in the treatments comprising of different residue levels as compared to control but statistically they are non- significant to each other. The highest harvest index was recorded in treatment T4-90% residue (40.02%) followed by treatment T3 - 60% residue (39.88), T2 - 30% residue (39.61) and T1 - control (39.48).

Conclusion
Results from the present study suggested that residue retention under CA based soybean- wheat cropping system improved the plant growth parameters; yield attributes and yields as compared to treatment without residue retention. Therefore, by following CA based residue management practices, yield of soybean crop can be improved along with the advantage of sustained and higher productivity in vertisols of Central India.

References
1. Harrold LL, Edwards WM. Severe rainstorm test of no-till corn. Journal of Soil and Water Conservation.8. Triplett GB, Van Doren DM. Agriculture without tillage. *Sci. Aim.* 1972-1977; 236:28-33.
2. Hubbard VC, Jordan D. Nitrogen recovery by corn from nitrogen-15 labelled wheat residues and intact roots and soil. Soil Science Society of America Journal. 1996; 60(5):1405-1410.
3. Jat RA, Wani SP, Sahrawat KL. Conservation agriculture in the semi-arid tropics: prospects and problems. In Advances in agronomy, 2012; 117:191-273. Academic Press.
4. Karunakaran V, Behera UK. Conservation agriculture in soybean (*Glycine max*)-wheat (*Triticum aestivum*) cropping system--A review. Agricultural Reviews, 2015, 36(3).
5. Phillips RE, Thomas GW, Blevins RL, Frye WW, Phillips SH. No-tillage agriculture. Science, 1980; 208(4448):1108-1113.
6. Somasundaram J, Salikram M, Sinha NK, Mohanty M, Chaudhary RS, Dalal RC. Corrigendum to: Conservation agriculture effects on soil properties and crop productivity in a semiarid region of India. Soil Research, 2019; 57(2):200-200.