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Available nutrients in soil are influenced by planting techniques and weed management options in wheat

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Abstract

There are continue disturbance of soil under conventional wheat system as repetitive tillage practices for crop establishment results negative impact like; more weed emergence, depletion of soil nutrients and economical losses; laborious and hazardous to environment by affecting sustainability of system and creating pollution. Zero tillage practices are avoiding soil disturbance for seedbed preparation; enhance the sustainability by conserving the resources. Residue retention or application as mulching act as soil condition modifier, reducing the weed population by soil covering and after decomposition release of organic acid in soil help increase the availability of nutrient. Such practices are kept in field experiment to evaluate the zero tillage wheat with variable rate of residue application as mulch in zero tillage and weed management practices. Result revealed that zero-till wheat with 6 ton ha⁻¹ rice residue as mulch application having higher available N, P, K, OC, SMBC with slightly lower pH and EC; while weed management practices shown Sulfosulfuron + metsulfuron @ 25+2 g a.i. ha⁻¹ higher availability of N, P, K, OC, SMBC with slightly lower pH and EC in experimental trial.

Keywords: Available nutrients, Crop establishment methods, OC and weed management practices

Introduction

In India, wheat accounts 36 per cent of country's total food grain production from an area of 30.72 million hectare during 2016-17 as per the data estimated by Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers Welfare (MoA&FW), India. With an average national productivity of 3172 kg ha⁻¹ there was a record production of 98.38 million ton wheat during 2016-17. It was 4.56 percent increment in yield and marginal in the crop acreage of 0.98 per cent from the previous year. The major practices in traditional way of wheat sowing as repetitive tillage for seedbed preparation and later on broadcasting of seed and basal application of fertilizer. As the increasing of cost of production due higher prices of fuels, labour scarcity etc. and with alarming situation of natural resources, there are avoiding the disturbance of soil by repetitive practices of tillage. A huge rice residue production in rice-wheat cropping system is also a major problem for making field free for sowing of crop. There is very short time period available for residue management as late harvesting of rice crop due to monsoon, duration of crop, labour shortage and viable options of immediately residue utilization. At last farmer burn the rice residue in the field which create pollution, hazardous to soil microbes and losses of nutrients. In zero tillage system there is no need of repetitive tillage of field for seedbed preparation and it can also perform the crop sowing practices in residue retention field by single opening of sleet. In single passes it can perform fertilizer placing with seed sowing and covering of seed. Rice residue application as mulch benefits as covering of help to reducing the weed emergence and addition of soil nutrients after decomposition and conserving the soil moisture. Apart from the above advantages the adoption of zero tillage sowing proved helpful in improving soil physical and chemical properties (Chaudhary *et al.*, 2015) [4].

Weeds are no doubt, major biotic constraints to increasing wheat production. Weed control, particularly during the initial stages of crop establishment is very essential in realizing higher yield. Oad *et al.* 2007 [12] reported that there are about 24 - 39.95 per cent economic yield losses

of crop due to weed while Patro and Ray (2016) [13] reported that uncontrolled weed growth throughout the crop growing period may cause a yield reduction of 29.12 to 62.14 percent. Further, use of single herbicide may not provide an effective control due to wide diversity of weed flora observed in the field. For better yield needed multiple weed control and nutrient management options. Effective weed control often requires a combination of cultural, mechanical and chemical control measures, such as an integrated weed management approach to delay herbicide resistance and reduce the herbicide load on the agro-ecosystem. Malik *et al.* (2013) [10] and Meena *et al.*, 2016 [11] reported the tank mix application of clodinafop + metsulfuron, mesosulfuron-methyl + iodosulfuron-methyl-sodium and clodinafop + metsulfuron with and without surfactant provided excellent control of *Phalaris minor*, *Avena fatua*, *Chenopodium album*, *Melilotus spp.*, *Medicago denticulata*, *Vicia sativa*, *Rumex spp.*, *Anagallis arvensis*, *Coronopus didymus*, *Lathyrus aphaca*, *Polygonum plebejum*, sedges and many other weeds with higher grain yield of wheat.

Materials and Methods

An experimental trial was performed into the split plot design with three replication at Agricultural Research Farm, Institute of Agricultural Sciences, Banaras Hindu University, Varanasi, situated at 25°15'26.9" N Latitude, 82°59'17.1" E longitude and at an altitude of 74.4 meters above the mean sea level (MSL) during *Rabi* season of 2016-17 and 2017-18. The experimental site had homogeneously fertile with uniform textural make-up and slightly sloppy topography. Soil of the experimental field was sandy clay loam in texture with moderate fertility had low organic carbon (0.461 & 0.473%) and low available nitrogen (196.75 & 198.8 kg ha⁻¹), and medium available phosphorus (15.63 & 16.02 kg ha⁻¹) and low in potassium (221.32 & 223.7.22 kg ha⁻¹). Apart from the above, soil also indicated slightly alkaline behaviour (pH 7.5 & 7.3). A field experiment with three crop establishment methods *viz.*, zero tillage wheat (ZTW) with 6 ton ha⁻¹ rice residue, zero tillage wheat (ZTW) with 3 ton ha⁻¹ rice residue and conventional tillage wheat (CTW) without mulching of rice residue are performed in main plot. Weed management practices are kept into sub plot with five weed management practices *viz.*, control (no any weed management practices), weed free (hand weeding at 20 and 40), Sulfosulfuron + mesosulfuron – 25+2 g *a.i.* ha⁻¹, Mesosulfuron + iodosulfuron – 12+2.4 g *a.i.* ha⁻¹, Clodinafop + metsulfuron @ 60+4 g *a.i.* ha⁻¹. Mulching of rice residue at 10 DAS after emergence of crop seedling and herbicide application in field was done at 35 DAS with hand operated knapsack sprayer having flat fan nozzle. experimental field was prepared as per treatments specification and sowing of the crop using seed rate @ 125 kg ha⁻¹ was done with the help of zero-till seed drill and manually line sowing after 2 harrowing and planking of field in conventional treatment at the row-to-row spacing of 22 cm on December 2 and November 29 in 2016-17 and 2017-18, respectively. Wheat variety HUW-234 known for its promising performance under irrigated conditions of Varanasi region of the Eastern Uttar Pradesh was used. A uniform dose of 120 kg N, 60 kg P₂O₅ and 50 kg K₂O ha⁻¹ was applied in all the treatments through urea (46% N), DAP (46% P₂O₅) and muriate of potash (60% K₂O), respectively. Half amount of nitrogen and a full dose of phosphorus and potash were applied as basal at the time of sowing, However, remaining half dose of N in the form of urea was top dressed in two

equal split such as after first irrigation and remaining nitrogen was a top dress at spike initiation stage. The need-based irrigations were also given to fulfil the water requirement of crop and to keep the crop in vigorous condition during both the years of investigation. At maturity, the crop was harvested manually with the help of sickle on April, 8 and 2 in 2016-17 and 2017-18, respectively. The soil samples (0-15 cm depth) from each plot with the help of augur were collected after harvest of the crop during both the years and analyzed using standard procedures. The statistical analysis of data was done using analysis of variance as described by (Gomez and Gomez, 1984) [6] and the comparisons were made at 5 per cent level of significance.

Results and Discussion

pH and EC

There are none of the crop establishment methods significantly influencing the pH and EC but ZTW with rice residue mulching are shown slightly lowering the pH over the CTW without mulching. The reason behind the lowering of pH in ZTW with mulching is no soil disturbance, decomposition of residue resulting as organic acid released; which accumulates on surface leads to leaching of basic cations to deeper depth. Such findings are supported by Carr *et al.*, 2013 [3]. In case of EC, CTW without residue having higher compared to ZTW with mulching. In conventional tillage opening of soil repeatedly and aeration in top layer of soil allowed more leaching from top layers. Such findings are supported by Kumar *et al.* 2018 [8, 9]; while at same time in ZTW having larger pore size and porosity facilitate to leaching of basic cations and finally reduces EC. This is supported to the finding of Kaushik *et al.*, 2018. In weed management practices there are higher pH and lower EC in weed free followed by Sulfosulfuron + mesosulfuron – 25 + 2 g *a.i.* ha⁻¹, Mesosulfuron + iodosulfuron – 12+2.4 g *a.i.* ha⁻¹ and Clodinafop + metsulfuron @ 60+4 g *a.i.* ha⁻¹; respectively but the differences are non-significant.

Available N (kg ha⁻¹)

There are none of the crop establishment methods significantly influencing the availability of nitrogen but in ZTW with 6 ton ha⁻¹ mulching are shown higher availability of nitrogen followed by ZTW with 3 ton ha⁻¹ and CTW without mulching; respectively. The reason may be large quantity of organic matter are added as mulching by rice residue, modifier of temperature and less soil disturbance in ZT. Such finding is also reported by Kaushik *et al.*, 2018. While in CTW having higher temperature due to uncovered soil, disruption of soil aggregates with exposition of protected organic matter to mineralization, faster residue decomposition and nitrogen liberation are the basic causes, to which greater nitrogen mineralization rates. Our results confirm the research findings of Issaka *et al.*, 2019 [7]. In weed management practices there are higher available of nitrogen in weed free followed by Sulfosulfuron + mesosulfuron @ 25 + 2 g *a.i.* ha⁻¹, Mesosulfuron + iodosulfuron – 12 + 2.4 g *a.i.* ha⁻¹ and Clodinafop + metsulfuron @ 60+4 g *a.i.* ha⁻¹; respectively. In weedy check there was minimum availability of nitrogen compare to other practices but none of the weed management practices found significantly. Higher N availability in the herbicidal treatment may be due to effectively reducing the weed population and also reducing the competitions for applied nutrients. This is supported to the finding of Raj and Syriac, 2018 [14].

Available P (kg ha⁻¹)

Neither crop establishment methods nor weed management practices are influenced significantly the available P in the soil. In crop establishment practices *ZTW* having mulching of rice residue at different rate are showing higher availability of phosphorus compare to *CTW* without residue application. There as on behind it may be accumulation of organic acid after decomposition of mulches; which solubilised phosphorus and increased its availability. Results are in line with the research finding of Kaushik *et al.*, 2018. Among the weed management practices minimum availability of phosphorus found in weedy plot and highest in weed free plot. In herbicide application the phosphorus availability higher in Sulfosulfuron + mesosulfuron @ 25+2 g *a.i.* ha⁻¹ followed by Mesosulfuron + iodosulfuron @ 12+2.4 g *a.i.* ha⁻¹ and Clodinafop + metsulfuron @ 60+4 g *a.i.* ha⁻¹; respectively. In weed free and herbicidal practices having lower weed population due to effectively management compare to the weedy check which make more availability of phosphorus. Such findings are also reported by Tomar and Tomar, 2014^[15]; Raj and Syriac, 2018^[14].

Available K (kg ha⁻¹)

Crop establishments and weed management practices are not creating significant differences on availability of potassium but application of 6 ton ha⁻¹ residue mulch in *ZTW* having higher potassium availability followed by 3 ton ha⁻¹ residue mulching in *ZTW* and *CTW* with no residue application. In *ZTW* availability of higher K probably due to the reduction of tillage along with residue mulching. Results are in line with the research finding of Kumar and Verma, 2018. Among the herbicide practices having higher available potassium in Sulfosulfuron + mesosulfuron – 25 + 2 g *a.i.* ha⁻¹ followed by Mesosulfuron + iodosulfuron – 12 + 2.4 g *a.i.* ha⁻¹ and Clodinafop + metsulfuron @ 60 + 4 g *a.i.* ha⁻¹; respectively.

This might be due to better weed control efficiency of herbicide application compare to no practices in weedy check. Supporting findings are also reported by Tomar and Tomar, 2014^[15]; Raj and Syriac, 2018^[14].

Organic carbon (%)

Neither crop establishment methods nor weed management practices significantly influenced the OC in the soil. Among crop establishment methods, *ZTW* with mulching recorded higher OC due to residue application of the rice crop and minimum soil disturbance. Less OC in the *CTW* might be due to tilling of soil increases organic matter decomposition and decreases carbon content by increasing organic matter oxidation. In case of *ZTW* crop roots remain intact in the root zone due to no disturbance of soil, which might facilitate enhancement of organic carbon input through their decay and also decomposition of mulching. Dixit *et al.*, 2019^[5] are supporting such finding. With respect to weed management treatments, higher OC was recorded in Sulfosulfuron + mesosulfuron – 25 + 2 g *a.i.* ha⁻¹ due to minimum weed density and dry weight compare to other treatment except weed free. The reason for higher organic carbon might be due effectively reduction in weed population.

Soil microbial biomass carbon (SMBC) (mg kg⁻¹ of soil)

Crop establishment methods and weed management practices are significantly (P=0.05) influenced the SMBC in the soil. Among crop establishment methods, *ZTW* rice residue recorded higher SMBC probably due to higher microbial and enzymatic activities, less disturbance of soil, better aeration and more organic matter content. Such findings are also supported by Dixit *et al.*, 2019^[5]. In case of weed practices Sulfosulfuron + mesosulfuron – 25+2 g *a.i.* ha⁻¹ having higher SMBC probably due to less weed dry weight and higher weed control than the other herbicidal application.

Table 1: Effect of crop establishment methods and weed management of wheat on pH, EC, available N, P, K, OC and SMBC in soil after harvesting (mean data of two years)

Treatments	Nitrogen (kg ha ⁻¹)	Phosphorus (kg ha ⁻¹)	Potassium (kg ha ⁻¹)	OC (%)	SMBC (mg kg ⁻¹ of soil)	pH	EC (dsm ⁻¹)
Crop establishment method							
Zero tillage-with 100% residue (6 ton h ⁻¹)	199.11	17.74	226.45	0.477	195.33	7.49	0.259
Zero tillage -with 50% residue (3 ton h ⁻¹)	197.35	17.08	225.96	0.474	192.98	7.50	0.264
Conventional tillage-no residue	195.06	16.77	223.91	0.466	190.47	7.52	0.266
SEM±	1.44	0.29	0.85	0.009	0.91	0.07	0.002
CD (P=0.05)	5.65	1.14	3.33	0.037	3.56	0.28	0.009
Weed management practices							
Sulfosulfuron + mesosulfuron @ 25+2 g <i>a.i.</i> ha ⁻¹	198.08	17.34	226.09	0.475	194.51	7.52	0.265
Mesosulfuron + iodosulfuron@ 12+2.4 g <i>a.i.</i> ha ⁻¹	196.91	17.32	225.38	0.473	192.93	7.49	0.265
Clodinafop + metsulfuron @ 60+4 g <i>a.i.</i> ha ⁻¹	196.26	16.99	225.08	0.469	191.89	7.48	0.259
Weed free	199.05	17.41	226.53	0.477	194.86	7.55	0.267
Weedy check	195.57	16.92	224.12	0.467	190.44	7.46	0.258
SEM±	1.65	0.30	1.25	0.006	1.91	0.07	0.003
CD (P=0.05)	4.82	0.88	3.63	0.018	5.59	0.22	0.009

Conclusion

Based on the results, it is suggested in the conclusion that zero-till wheat with 6 ton ha⁻¹ rice residue application as mulching and among herbicidal practices Sulfosulfuron + mesosulfuron – 25+2 g *a.i.* ha⁻¹ having higher available of N, P, K, OC and SMBC.

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