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Weed management in yellow sarson under conservation agriculture based rice - yellow sarson - greengram cropping system in lateritic belt of West Bengal

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Abstract
A field experiment was conducted during 2018-19 and 2019- 20 at Agriculture Farm, Institute of Agriculture, Visva-Bharati, Sriniketan, West Bengal to study the effect of tillage and weed management practices on weed growth and productivity of yellow sarson in direct seeded rice - yellow sarson - greengram cropping system under conventional and conservation tillage practices. The experiment comprising of four horizontal tillage strips and three vertical weed management strips was laid out in a strip plot design with three replications. Results revealed that conservational tillage (Zero tillage +residue) along with recommended herbicide (RH) (Pendimethalin at 0.75 kg ha^{-1}) + one hand weeding (HW) recorded the lower values of total weed density and dry weight at 60 DAS in both the years. Conservational tillage (Zero tillage +residue) along with recommended herbicide (RH) (Pendimethalin at 0.75 kg ha^{-1}) + one hand weeding (HW) also registered higher value of seed yield of yellow sarson over other treatments during both the years.

Keywords: Conservation agriculture, pendimethalin, residue, weed management, yellow sarson

Introduction
Yellow sarson is the most widely cultivated oilseed crop under rapeseed-mustard group in West Bengal. Crop weed competition is found to be a major constraint in achieving higher yield and weeds cause yield losses up to 45% in rapeseed-mustard (Singh *et al*., 2013) [11]. Conservation of non-renewable energy sources and efficient resource management in agriculture is increasingly being realized for cleaner and sustainable production (Kumar *et al*., 2019). So, there is an increased need for developing alternative agro-technique(s) that can substantially reduce the energy requirements in crop production (Saad *et al*., 2016). Conservation agriculture (CA) can be adopted as an alternative to modern day agriculture, which aims at sustainable, profitable crop growth and productivity through conservation of environmental resources by various ways (Corsi *et al*., 2012). Weed control in conservation agriculture poses a great challenge than in conventional agriculture because there is no weed seed burial by tillage operations. Crop residue when retained in ZT practice, suppress weed growth, maintain soil temperature, conserve soil moisture and organic matter and control air pollution caused due to residue burning (Sharma *et al.*, 2012) [10]. Achieving agricultural sustainability is significant at present times and this can be possible by improving biological functions of the agro ecosystem through minimum soil disturbance, continuous organic cover and crop diversification and one of the primary aims of conservation agriculture is to do that. Thus conservation agriculture is an alternate solution for today's limited natural resources and changing climate (Nichols *et al.*, 2015). Tillage, crop establishment method, machinery, agronomic practices *etc*. play crucial role in weed management in conservation agriculture (Laford *et al.*, 2009). High labor expenses and timely unavailability has increased the use of herbicides in CA. As single herbicide can't control wide spectrum of weeds, integrated weed management can be adopted to enhance sustainability of Conservation agriculture.

Materials and Methods
A long term conservation agriculture based experiment on direct seeded rice (DSR)-yellow sarson- greengram cropping system was initiated in 2015-16 at Agriculture Farm of Palli SikshaBhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, Birbhum, West Bengal. The experimental site is situated at about 23º40.051' N latitude and 87º39.615' E longitude with an average altitude of 57 m above the mean sea level.

This area falls in sub-humid red and lateritic agro-ecological zone of the tropics having rainfall ranging from 1100 to 1400 mm and air temperature being maximum of 37 °C and minimum of 14.8 °C (annual normal). The soil of the experimental field was sandy loam in texture with acidic in reaction (pH 5.80), low in organic C (0.41%). Every year, DSR was grown in *kharif* season (June–October) followed by yellow sarson during winter (November-March) followed by greengram (March-May). The experiment was laid out in a strip plot design with three replications. Four tillage practices comprising of conventional tillage (CT) (direct-seeded rice) — CT (yellow sarson) — CT (greengram), CT (direct-seeded rice) — zero tillage (ZT) (yellow sarson) — ZT (greengram), ZT (direct-seeded rice) — ZT (yellow sarson) — ZT (greengram), ZT + residue (R) (direct-seeded rice) — ZT + R (yellow sarson) — ZT + R (greengram) were allocated to the horizontal strip and three weed management practices, *viz.* recommended herbicides (RH) (pendimethalin at 1.0 kg ha^{-1} followed by bispyribac-sodium at 25 g ha^{-1} in direct-seeded rice, pendimethalin at 0.75 kg ha^{-1} each in yellow sarson and greengram), Recommended herbicides + hand weeding (HW) at 35 days after sowing (DAS), Unweeded control were assigned to the vertical strip. Glyphosate at 1.0 kg ha^{-1} was applied 15 days before sowing on the established weeds in zero tillage plots. Full amount of crop residue (100%) of direct seeded rice, yellow sarson and greengram from respective treatments of conservation tillage were retained in the plot itself. Crop varieties 'MTU-1010, 'B-9' and 'Samrat, were used for rice, yellow sarson and greengram, respectively. Direct seeded rice and greengram were sown with zero till ferti-seed drill machine and yellow sarson sown by manually. Line to line spacing of 20 cm for DSR and 30 cm each for yellow sarson and greengram was maintained with zero till drill. Seed rate taken into account was 50 kg $ha^{-1}$for direct seeded rice, 5 $kgha^{-1}$ for yellow sarson and 25 kg $ha^{-1}$for greengram. Recommended dose of fertilizer N,P_2O_5 and K_2O, 80:40:40 kg ha^{-1} in DSR and 80:40:40 kg ha^{-1}in yellow sarson and 20:40:40 kg $ha^{-1}$for greengram were applied. Full dose of nitrogen, phosphorus and potash was applied in greengram as basal dose. Herbicides were applied with the help of Hand operated knapsack sprayer fitted with a flat fan type nozzle. All other recommended agronomic practices were followed and plant protection measures were adopted as per need. Weed count was recorded by placing 50cm x 50 cm quadrates from the marked sampling area of 1.0 m^2 in each plot and after drying them in hot air oven at 70° C, weed dry weight was recorded. The data were subjected to a square root transformation to normalize their distribution. Rice was harvested during first week of October. Border rows from both the sides of the experimental plots were harvested first, then the net plot area (2 m × 2 m; 4 m^2 per plot) used for yield computation. All the produce was dried in the sunlight for a period of 8 days before threshing. The grain yield was adjusted to 12% moisture content and the straw yield was determined after air drying for a period of 14 days. Yellow sarson was harvested in the first fortnight of Feb by cutting at 0.45 m above the ground level. Harvested yellow sarson produce was bundled and left for sun drying until seed moisture content attains 8–10% and threshed and seed yield expressed in kg ha^{-1}.Greengram was harvest in last week of May and the produce was bundled and left for sun drying until seed moisture content attains 8–10% and threshed and seed yield expressed in kg ha^{-1}. The stover/stalk yield was determined by subtracting seed weight from the total biomass. Analysis of variance (ANOVA) was done to determine the treatment effects (Gomez and Gomez, 1984). The levels of treatment were compared by critical difference at 5% level of probability.

Results and Discussion

Effect on weeds

The most predominant grassy weeds in yellow sarson were *Digitaria sanguinalis*, *Cynodon dactylon* and *Echinochloa colona* among the grassy weeds, *Ageratum conyzoides*, *Spilanthes calva*, *Cleome viscosa*, *Indigofera hirsuta* among the broadleaved weeds under all the tillage practices during both the years. In addition to those, *Gnaphalium purpureum*, *Oldenlandia corymbosa* and *Solanum nigrum* were predominant broadleaved weeds observed under conventional tillage during both the years. Duary *et al*. (2015) [5] also reported similar weed flor a in yellow sarson. *Teja et al*. (2018) also reported that predominant weed flora associated with rapeseed mustard were *Echinochloa colona*, *Digitaria sanguinalis*, *Cynodon dactylon* and *Cyanotis axillaris* among monocots and *Ageratum conyzoides*, *Spilanthes paniculata*, *Polygonum plebeium*, *Gnapahalium purpureum*, *Chenopodium album*, *Physalis minima*, *Eclipta alba*, *Oldenlandia corymbosa*, *Cleome viscosa*, *Ludwigia parviflora*, *Solanum nigrum* and *Indigofera hirsuta* among dicots.

Both tillage and weed management practices significantly influenced the total density and dry weight of weed species associated with yellow sarsonat 60 DAS. Among the tillage management practices, significantly lowest total weed density and dry weight was recorded under conservation tillage at 60 DAS. Under conservation tillage (ZT+R- ZT+R-ZT+R) the minimum disturbance of soil might have contributed to the unfavorable conditions for germination at the surface which prevented the emergence of weeds (Sharma and Singh, 2014). The retention of previous crops residues under conservation tillage might have suppressed the weed growth by influencing light transmittance, soil temperature, soil moisture and enhancing weed seed predation (Nichols *et al*. 2015). In CA systems, the presence of residue on the soil surface may influence soil temperature and moisture regimes that affect weed seed germination and emergence patterns over the growing season (Sing *et al*., 2015).

Among the weed management practices, recommended herbicides (Pendimethalin at 0.75 kg ha^{-1}) + one hand weeding (HW) at 35 days after sowing (DAS) significantly registered the lowest density and dry weight of total weeds at 60 DAS (Table 1). Interaction effect on density and dry weight of total weeds at 45 DAS in yellow sarson indicated that conservation tillage along with recommended herbicides (Pendimethalin at 0.75 kg/ha) + one hand weeding (HW) registered lowest total weed density and dry weight at 45 DAS and it was at par with ZT-ZT-ZT + 1 HW and CT-ZT-ZT+1 HW at 60 DAS during both the years. These results were in conformity with the findings Baghel *et al*. (2018) [1], Walia *et al*. (2012) [13] and Ganie *et al*. (2013) [6].

Table 1: Effect of tillage and weed management practices on total weed density of yellow sarson at 60 DAS

Total weed density (No.m^{-2}) at 60 DAS								
	2018-19				2019-20			
Treatments	W_1	W_2	W_3	Mean	W_1	W_2	W_3	Mean
CT-CT-CT	38.00	9.33	104.67	50.67	70.00	16.67	142.00	76.22
CT-ZT-ZT	35.33	7.33	79.67	40.78	63.67	13.00	121.00	65.89
ZT-ZT-ZT	34.67	8.00	81.67	41.44	34.33	5.00	73.67	37.67
ZT+R-ZT+R-ZT+R	28.33	6.33	63.33	32.67	25.67	2.33	58.33	28.78
Mean	34.08	7.75	82.33		48.42	9.25	98.75	
	T	W	T ×W	W ×T	T	W	T×W	W×T
SE(m)+	0.76	1.01	1.34	1.55	1.23	1.39	1.81	1.98
CD(P=0.05)	2.62	3.97	5.27	4.78	4.24	5.46	7.11	6.11
(%)	5.48	8.47	5.69		7.05	9.23	5.42	

Effect on crops

Conservation tillage registered significantly highest seed yield over other tillage system in yellow sarson during both the years. As compared to conventional tillage, conservation tillage resulted 48.01 and 76.76% increase in seed yield of yellow sarson during 2018-19 and 2019-20, respectively. Higher yield with residue retention under conservation agriculture was also reported by Das *et al*. (2015) [9] and Nath *et al*. (2015) [9]. Retention of crop residue on the soil surface under no-till systems can suppress the weed seedling emergence, delay the time of emergence, and allow the crop to gain an advantage over weeds, and reduce the need for control (Nath *et al*., 2016). The presence of crop residue on the soil surface may influence soil temperature and moisture regimes that affect weed seed germination and it helps in reducing weed growth through reduced weed emergence and increase the crop yield (Sharma *et al*., 2013). Among the weed management practices, application of pendimethalin at 0.75 kg ha^{-1} at 1 DAS *fb* one hand weeding at 35 DAS registered highest seed yield among other treatments. The seed yield was recorded 47.64 and 47.89% lower under unweeded control as compared to recommended herbicide with one hand weeding in 2018-19 and 2019-20, respectively. Interaction effect indicated that conservation tillage (ZT+R-ZT+R-ZT+R) along with recommended herbicide combined with one hand weeding registered highest seed yield during both the years. It was observed that seed yield of yellow sarson under conservation tillage(ZT+R-ZT+R-ZT+R) in unweeded control was as good as conventional tillage with recommended herbicide with one hand weeding in 2019-20 and it was higher than conventional tillage along with recommended herbicide alone. In 2018-19, conservation tillage(ZT+R-ZT+R-ZT+R) along with unweeded control recorded at par value of seed yield with recommended herbicide alone under conventional tillage(CT-CT-CT).

Table 2: Seed yield of yellow sarson as influenced by tillage and weed management practices

Seed yield (kg ha^{-1}) of yellow sarson								
	2018-19				2019-20			
Treatments	W_1	W_2	W_3	Mean	W_1	W_2	W_3	Mean
CT-CT-CT	907	1058	379	781	830	992	346	723
CT-ZT-ZT	953	1168	631	917	874	1091	557	840
ZT-ZT-ZT	1062	1278	755	1032	1172	1351	824	1115
ZT+R-ZT+R-ZT+R	1112	1502	855	1156	1202	1687	944	1278
Mean	1008	1251	655		1019	1280	667	
	T	W	T ×W	W ×T	T	W	T×W	W×T
SE(m)+	23.30	17.69	41.05	39.97	21.92	18.09	34.72	33.81
CD(P=0.05)	80.63	69.46	126.49	123.18	75.85	71.02	106.99	104.17
CV(%)	6.64	6.33	5.77		7.19	6.30	7.38	

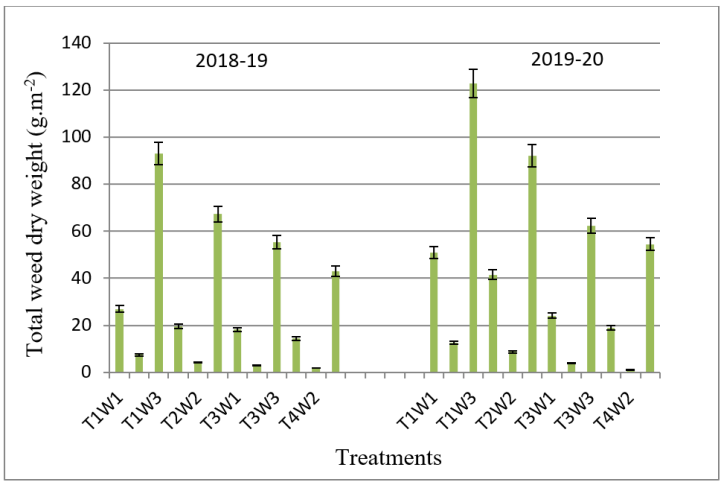

Fig 1: Total weed dry weight at 60 DAS as influenced by tillage and weed management practices in yellow sarson

Conclusion

The five years long term study indicated a significant effect of tillage and weed management on weed and seed yield of yellow sarson and we can conclude that after 5thyear cycle of cropping system, conservation tillage with recommended herbicides + one hand weeding at 35 DAS in yellow sarson may be advocated for effective weed management, higher productivity in conservation agriculture based direct seeded rice- yellow sarson-greengram cropping system in lateritic belt of West Bengal.

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