Original Research Article

Influence of crop establishment methods and weed management practices on growth and yield attributes of wheat

Abstract

An experiment was conducted in *Rabi* season of 2019-20 and 2020-21 at the Agricultural research farm of Institute of Agricultural sciences, Banaras Hindu University, Varanasi (UP). The experiment was conducted in split plot design with twenty four treatment combinations. Treatments consisted of six crop establishment methods *viz.* Conventional till wheat - residue removed, Conventional till wheat - residue incorporation at 20 days before sowing (30 cm height), Conventional till wheat - mulching (6 t ha^{-1}), Zero till wheat without residue and Zero till wheat – residue as mulch (6 t ha^{-1}), zero till wheat- residue retention (30 cm) were assigned to main plots and weed management practices viz. weed free (weeds were removed with the help of hand weeding during entire crop period), Weedy check, Pendimethalin (1 kg ha^{-1}, PE) *fb* sulfosulfuron + metsulfuron (30 + 2 g ha^{-1}, PoE) and Pendimethalin (1 kg ha^{-1}, PE) *fb* iodosulfuron + carfentrazone (2.5 + 20 g ha^{-1}, PoE) were allocated to sub plots. The experiment was replicated three times. Wheat variety 'MACS 6222' was sown under different crop establishment methods at row distance of 20 cm by opening slits with zero-till-drill machine. All the herbicides were applied as pre emergence at 2 DAS and post emergence at 35 DAS with the help of sprayer fitted with flat fan nozzle. The spray volume was 500 l ha^{-1}. Half amount of nitrogen and full dose of phosphorus and potash were applied as basal at the time of sowing, ¼ part of nitrogen was top dressed after first irrigation and remaining ¼ part of nitrogen was top dress at spike initiation stage. Four irrigations were given to crop as per need. Among crop establishment methods, zero tillage with residue mulching @ 6 t ha^{-1} and among the weed management practices, Pendimethalin (1 kg ha^{-1}, PE) *fb* iodosulfuron + carfentrazone (2.5 + 20 g ha^{-1}, PoE) recorded maximum plant height and yield attributes of wheat over rest of the treatments.

Keywords: residue, mulch, wheat yield, weed management.

Introduction:

Wheat (*Triticum aestivum* L.) is the most extensively farmed cereal crop worldwide. It has an area of 220.41 million hectares and produces 734 million tonnes (FAO, 2019). With current growth rates, the global human population will total 2.4 million people by 2050 (Smith P., 2015). This generates an alarming situation in order to alleviate the hunger crisis. Wheat is the staple feed for 20% of the world's population (Mc Fall, 2009; Xuan J., 2020), providing one-fifth of daily calorie intakes and 21% of dietary protein requirements worldwide (Shiferaw *et al*., 2013). Wheat production has a direct impact on global food security due to its widespread popularity, adaptation, and consumption. Smith, P. (2015). Wheat is second after rice in terms of acreage (45 million hectares) and production (107 million tonnes) in India. The indo-gangetic plains, which account for 15% of total geographic area and are a prominent area of the green revolution (Koshal *et al*., 2014), are responsible

for the production boom. This region alone accounts for 50% of overall production and 40% of the country's food grain requirements. These country's plains are one of the world's largest, with deep and alluvium fertile soil suited for double and triple cropping (Gangwar *et al*., 2006; Pal *et al*., 2009).

Farmers' practises of wheat sowing include repetitive tillage by cultivator and rotavator, which cannot be undertaken in a combine harvested paddy field, encouraging farmers to burn crop residue in the field to quickly remove crop residue. Burning agricultural residue is detrimental to the sustainability of any cropping system since it generates smokes that are bad for the environment, loses nutrients in straw, degrades soil health, and is economically unfeasible. In addition, residue burning in the field produced ash, which influenced the efficacy of pre-emergence herbicide treatment. These paddy wastes can be used in a variety of industries, including energy, packing material, and bedding material, as well as mulching, composting, feeding, and thatching. (Verma *et al*., 2008). To address this issue, zero tillage sowing practises clean the row zone, open the soil, place fertilisers and seed, and cover the seed in a single pass. It can also be used in residual field conditions to prevent residue burning. In this method, minimal soil disturbance with residue improves soil organic carbon sequestration, saves US $ 52 ha-1 in ploughing fuel, and yields 5 to 7 percent higher (Erenstein and Laxmi, 2008). Usman *et al.* (2010) discovered that RT had the lowest weed density and dry weed biomass with the highest grain yield of wheat, which was statistically equal to grain yield under ZT when compared to CT.

Farmers did manual weeding, which is not economical due to salary increases (Abbas *et al*., 2009) and also not practicable because weed eradication takes too long. Another challenge for timely weed management is migration of agricultural workforce from rural to urban areas. The issue of manual weed management has led farmers to seek alternate weed management solutions for sustainable crop production. Weed management with herbicide is the easiest and most viable method in this scenario (Moss S., 2019), which considerably improves weed control in modern agriculture (Kraehmer *et al*., 2014). Using a single herbicide without rotating it, and using greater doses encourages herbicide resistance in weeds.

Materials and method:

The present study was conducted in Rabi season of 2019-20 and 2020-21. The soil of field was sandy clay loam in texture, with slightly alkaline (pH 7.38) in reaction. The soil was low in organic carbon (0.38%) available nitrogen (232.25 kg ha^{-1}) and phosphorus (18.63 kg ha^{-1}) and medium in available potassium (178.54 kg ha^{-1}). Average values for bulk density 1.42 g cm^{-3}, particle density 2.62 g cm^{-3} and EC were 0.264 ds m^{-1}. The experiment was conducted in split plot design with twenty four treatment combinations. Treatments consisted of six crop establishment methods viz. Conventional till wheat - residue removed, Conventional till wheat - residue incorporation at 20 days before sowing (30 cm height), Conventional till wheat - mulching (6 t ha^{-1}), , Zero till wheat without residue and Zero till wheat – residue as mulch (6 t ha^{-1}) zero till wheat- residue retention (30 cm) were assigned to main plots and weed management practices viz. weed free (weeds were removed with the help of hand weeding during entire crop period), Weedy check, Pendimethalin (1 kg ha^{-1}, PE)

fb sulfosulfuron + metsulfuron (30 + 2 g ha^{-1}, PoE) and Pendimethalin (1 kg ha^{-1}, PE) *fb* iodosulfuron + carfentrazone (2.5 + 20 g ha^{-1}, PoE) were allocated to sub plots. The experiment was replicated three times. Wheat variety 'MACS 6222' was sown under different crop establishment methods at row distance of 20 cm by opening slits with zero-till-drill machine. All the herbicides were applied at 2 DAS of pre-emergence and post emergence at 35 DAS with the help of sprayer fitted with flat fan nozzle. The spray volume was 500 l ha^{-1}. Half amount of nitrogen and full dose of phosphorus and potash were applied as basal at the time of sowing, ¼ part of nitrogen was top dressed after first irrigation and remaining ¼ part of nitrogen was top dress at spike initiation stage. Four irrigations were given to crop as per need.

Experimental findings:

Plant height (cm)

In crop establishment practices, plant height were significantly influenced at all the stages except at 30 DAS. Among all crop establishment practices, zero till wheat with 100 % rice straw mulching (ZTW+SM_{100}) shows higher plant height at all stages during both the years of field observation. Conventional till wheat with 100 % mulching (CTW+SM_{100}) and zero tillage wheat with rice residue retention (30 cm) (ZTW+RR) was at par with the treatment ZTW+SM_{100}; whereas significantly higher than the conventional tillage practices with rice residue incorporation (30 cm) (CTW+RI), zero tillage wheat with no residue (ZTW-R) and conventional tillage wheat with no residue (CTW-R) during both the years, respectively. But at 30 DAS the difference of height was non-significant. Herbicide significantly influences the plant height at all the stage of field observation during both the years. Application of pendimethalin @ 1 kg a.i. ha^{-1} (PE) *fb* iodosulfuron + carfentrazone (PoE) @ 2.5 + 20 g a.i. ha^{-1} recorded higher plant height and remains at par with pendimethalin @ 1 kg a.i. ha^{-1} (PE) *fb* sulfosulfuron + metsulfuron (PoE) @ 30 + 2 g a.i. ha^{-1} over the weedy check plot during both year of observation at all stage of observation but none of practices comparable with weed-free treatment.

Effective tillers (per running meter)

Effective tillers were influenced by crop establishment practices parameter; zero till wheat with 100 % rice straw mulching shows more effective tillers compare to rest of crop establishment practices and lowest in conventional tillage wheat – no residue treatment; difference between the crop establishment practices were reached upto significant variation during both the years; respectively. Significantly more effective tillers in weed free than the weedy check but remains at par with pendimethalin @ 1 kg a.i. ha^{-1} (PE) *fb* iodosulfuron + carfentrazone (PoE) @ 2.5 + 20 g a.i. ha^{-1} and pendimethalin @ 1 kg a.i. ha^{-1} (PE) *fb* sulfosulfuron + metsulfuron (PoE) @ 30 + 2 g a.i. ha^{-1} during both the years; respectively.

Spike length (cm)

Spike length were influenced by crop establishment practices parameter; zero till wheat with 100 % rice straw mulching shows slightly higher spike length compare to rest of crop establishment practices and lowest in conventional tillage wheat – no residue treatment; difference between the crop establishment practices were not reached upto significant variation during both the years of finding. Weed free treatment were recorded slightly higher

spike length than the rest of practices and lowest in weedy check but the difference was remains non-significant during both the years.

Grains spike^{-1}:

Spike length were influenced by crop establishment practices parameter; zero till wheat with 100 % rice straw mulching shows slightly more spike length compare to rest of crop establishment practices and lowest in conventional tillage wheat – no residue treatment; difference between the crop establishment practices were not reached upto significant variation during both the years of finding. Among weed management practices in wheat crop weed free treatment were recorded slightly more spikelet per spike than the rest of practices and lowest in weedy check but the difference was remains non-significant during both the years.

1000 grain weight (g):

Crop establishment practices parameter influence the 1000 grain weight in table 2, which reveals that zero till wheat with 100 % rice straw mulching shows slightly higher grain weight compare to rest of crop establishment practices; whereas in weed management 1000 grains weight slightly more in weed free and lowest in weedy check but the difference in both establishment and weed management were remains non-significant during both the years.

Discussion:

The superiority of ZTW+SM_{100} in respect of plant height and crop growth parameters can be discussed in light of the fact that this treatment providing better suppression of weed *spp.*, optimum growing environment by mulching ensuring more availability of light, moisture and nutrients than other crop establishment treatments. lower weed density and dry weight of weed in tank mix application of pendimethalin @ 1 kg a.i. ha^{-1} (PE) *fb* iodosulfuron + carfentrazone (PoE) @ 2.5 + 20 g a.i. ha^{-1} because less competition faced by crop which enhance the availability of soil moisture, nutrient, space and light so growth parameter were improved. Results are corroborated with the research findings of Upasani *et al* 2014 and Yadav *et al*. (2022). Increase in yield contributing factor due to vigorous crop growth parameter by obtaining favourable condition. More dry matter accumulation by crop were translocate to formation of better yield attributing factor. Pendimethalin @ 1 kg a.i. ha^{-1} (PE) *fb* iodosulfuron + carfentrazone (PoE) @ 2.5 + 20 g a.i. ha^{-1} recorded highest than the weedy check plot; whereas superiority in the weed free plot were recorded. The reason behind it may be due to the lesser crop-weed competition by broad spectrum herbicide effectively reduce the weed density which facilitate better growing. It confirms the conclusion drawn by Verma et *al*. (2008) and Duary *et al*. (2021).

Conclusion:

Among crop establishment methods, zero tillage with residue mulching @ 6 tha^{-1} and among the weed management practices, Pendimethalin (1 kg ha^{-1}, PE) *fb* iodosulfuron + carfentrazone (2.5 + 20 g ha^{-1}, PoE) recorded maximum plant height and yield attributes of wheat over rest of the treatments.

Table 1: Effect of crop establishment and weed management practices on plant height (cm)

Treatments	30 DAS		60 DAS		90 DAS		At Harvest	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
Crop establishment practices								
R_1: Zero till wheat residue as mulch	22.84	23.87	59.65	62.63	89.42	93.89	93.08	97.74
R_2: Conventional till wheat residue as mulch	23.75	24.94	57.42	60.01	86.08	89.95	89.61	93.64
R_3: Zero till wheat - residue retention at 30 cm height	22.03	22.89	55.43	57.59	83.08	86.32	86.49	89.86
R_4: Conventional till wheat - rice residue incorporation at 20 days before sowing	21.39	22.22	53.85	55.95	80.72	83.86	84.02	87.30
R_5: Zero till wheat residue removed	22.11	22.49	52.93	53.83	79.33	80.68	82.59	83.99
R_6: Conventional till wheat - residue removed	22.34	22.72	51.52	52.40	77.23	78.54	80.40	81.76
SEm±	0.64	0.67	1.32	1.38	1.98	2.06	2.06	2.15
LSD (*p*=0.05)	NS	NS	4.16	4.33	6.24	6.50	6.50	6.76
Weed management								
W_1: Weed free	24.40	25.25	60.02	62.13	89.97	93.13	93.66	96.94
W_2: Pendimethalin (1 kg ha^{-1}, PE) *fb* iodosulfuron + carfentrazone (2.5 + 20 g ha^{-1}, PoE)	23.13	23.93	56.89	58.89	85.28	88.28	88.78	91.89
W_3: Pendimethalin (1 kg ha^{-1} PE) *fb* sulfosulfuron + metsulfuron (30 + 2 g ha^{-1}, PoE)	22.13	22.91	54.45	56.37	81.62	84.50	84.97	87.96
W_4: Weedy check	19.99	20.67	49.17	50.88	73.70	76.27	76.72	79.40
SEm±	0.43	0.45	0.41	0.42	0.61	0.64	0.64	0.66
LSD (*p*=0.05)	1.25	1.29	1.17	1.22	1.76	1.82	1.83	1.90

Table 2: Effect of crop establishment and weed management practices on yield attributes

Treatments	No. of effective tillers (per running meter)		Spike length (cm)		No. of grains spike^{-1}		1000 grain weight (g)	
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21
Crop establishment practices								
R_1: Zero till wheat residue as mulch	96.21	101.05	11.07	11.62	37.10	38.96	37.80	39.70
R_2: Conventional till wheat residue as mulch	93.00	97.19	10.65	11.13	35.71	37.32	36.39	38.03
R_3: Zero till wheat - residue retention at 30 cm height	90.11	93.62	10.28	10.68	34.47	35.82	35.13	36.50
R_4: Conventional till wheat - rice residue incorporation at 20 days before sowing	87.81	91.24	9.99	10.38	33.49	34.80	34.13	35.46
R_5: Zero till wheat residue removed	86.48	88.81	9.82	10.08	32.92	33.81	33.54	34.45
R_6: Conventional till wheat - residue removed	84.44	86.72	9.56	9.82	32.04	32.91	32.65	33.53
SEm±	1.95	2.00	0.25	0.26	0.82	0.86	0.79	0.87
LSD (*p*=0.05)	6.14	6.29	0.78	0.80	2.59	2.70	2.48	2.75
Weed management								
W_1: Weed free	96.76	100.47	11.14	11.56	37.33	38.76	38.04	39.49
W_2: Pendimethalin (1 kg ha^{-1}, PE) *fb* iodosulfuron + carfentrazone (2.5 + 20 g ha^{-1}, PoE)	92.23	95.76	10.55	10.96	35.38	36.74	36.06	37.44
W_3: Pendimethalin (1 kg ha^{-1} PE) *fb* sulfosulfuron + metsulfuron (30 + 2 g ha^{-1}, PoE)	88.69	92.09	10.10	10.49	33.87	35.16	34.51	35.83
W_4: Weedy check	81.02	84.10	9.12	9.47	30.58	31.74	31.16	32.35
SEm±	0.75	0.62	0.09	0.08	0.29	0.26	0.29	0.27
LSD (*p*=0.05)	2.14	1.77	0.25	0.23	0.82	0.76	0.82	0.77

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