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Weed Dynamics, Growth and Yield of Wheat Crop as Influenced by Different Tillage and Herbicide Management under Rice-Wheat Cropping System

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ABSTRACT

A field experiment on sandy loam was conducted during rabi 2004-05 and 2005-06 at the Research Farm of the Janta Vedic (P.G.) College, Baraut, District–Baghpat (U.P.) to ascertain the relationship among the seed-bed preparation, nutrient and weed management of wheat (*Triticum aestivum* L.) under six tillage practices (Strip till-drill (STD), Zero tillage (ZT), Surface seeding (SS), Reduced tillage (RT), Conventional line sowing (CLS) and Furrow irrigated raised bed planting system (FIRBS) in main plots and three weed control measures (Metribuzin (Sencor) @ 250 g/ha, Sulfosulfuron (Leader) @ 33.3 g/ha, Weedy check) in sub plots with three replicates. The amount of each herbicide per plot was measured and diluted to desired concentration. Furrow irrigated raised bed planting recorded taller plant, higher dry matter accumulation while, maximum leaf area index was recorded under reduced tillage followed by conventional line sowing and FIRBS. In respect of CGR and NAR furrow irrigated raised bed system estimated highest value of these indices followed by conventional line sowing at 30-60 and 60-90 DAS. Furrow irrigated raised bed planting system (FIRBS) recorded higher grain and straw yield significantly higher over the other tillage management. Conventional line sowing (CLS) also recorded significantly higher yield and yield attributes as compared to other tillage practices. The highest yield and yield attributes was obtained with the application of Sulfosulfuron @ 33.3 g/ha followed by Metribuzin @ 250 g/ha in present investigation.

Keywords: Tillage, FIRBS, Sulfosulfuron, weed density, grain yield

INTRODUCTION

Rice-wheat is the most commonly employed cropping system (Singh *et al.*, 2013) Rice-wheat cropping system occupies around 14 million hectares of land extending across the Indo-Gangetic Plain (IGP) and the rice-wheat sequence in India is estimated to occupy about 10.47 m ha (wheat (*Triticum aestivum* L.) is a predominant *rabi* crop of North- Western Plain Zone and Central Zone of India which occupy about 28.52 million ha area and the production 94.45 m tonnes during 2011-12 (Meena *et al.*, 2013 and Kumar *et al.*, 2014). The rice-wheat cropping system will also remain a pivot in future planning for food-sufficiency at the national level. Wheat production technology has systematically changed with the adoption of high yielding dwarf varieties. The agronomic packages like seed-bed preparation, fertilizer doses and weed management were markedly different for tall varieties from the presently grown dwarf ones. The introduction of dwarf, input responsive, high yielding mexican wheat varieties over an extensive area under the intensive cropping system in north-west India has changed the micro-climate in wheat crop ecosystem in favour of establishment of certain obnoxious grassy weeds like *Phalaris minor* Retz. (Canary grass) and *Avena ludoviciana* Dur. (wild oat). In addition to grassy weeds, broad leaf weeds like *Cirsium arvence*, *Convolvulus arvensis*, *Chenopodium album*, *Melilotus* spp. do also exist in wheat fields (Rathi *et al.*, 2008). It is thus clear that, the introduction of dwarf wheat varieties has increased the problem of weed competition.

The magnitude of crop-weed competition is greatly dependent on the supply of nutrients, type of seed-bed preparation and availability of the moisture. These factors, which are indispensable for maximization of

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wheat production, are also salubrious for the rank growth of weeds. Besides considerable reduction in grain yield, weeds deplete substantially the soil of its fertility to un-checked weed growth (Meena *et al.*, 2013 and Singh *et al.*, 2005). The nutrients drain by un- interrupted weed growth assumes added significance in the context of increasing cost of fertilizers. Thus a challenging target in wheat production has to be achieved with proper management of all inputs particularly fertilizers and pesticides. Gill and Brar (1975) observed reduction in grain yield of wheat to the extent of 19.5 q/ ha due to infestation of *Phalaris minor* Retz. alone. Singh *et al.*, 2012 reveled that , It is but obvious that for tapping the maximum yield potential of meticulously tailored dwarf wheat varieties and for judicious use of fertilizers, aggressive weed growth has to be checked in time.

The weeds in wheat fields can be checked either by physical methods including agronomic manipulations or by use of herbicides. With the rapid progress of industrialization and urbanization coupled with higher standards of literacy and living in a developing country like India, not only labour costs are ascending up, more and more people shun the drudgery of many agricultural operations including hand weeding. Thus chemical weed control offers, in such a situation, the most effective measures of weed management. In modern agriculture, the use of herbicides otherwise also has become an integral part of the crop production. With the availability of better farm machines and high potency herbicides together with economic pressure to reduce the production costs, there is need to develop alternate tillage practices for reducing the tillage operation for wheat sowing in conjunction with the use of herbicide for effective control of weeds.

MATERIALS AND METHODS

An investigation was conducted at the Research Farm of the Janta Vedic (P.G.) College, Baraut, Baghpat (U.P.) during winter *Rabi* 2004-05 and 2005-06. The experimental site was sandy loam (67.50 % coarse sand, 16.80% silt and 13.70% clay) in texture having moderate fertility and a pH of 7.0. The soils was low in available N (162.07 kg N/ha) and medium in available P (17.87 kg/ha) and rich in K (217.21 kg/ha). The experimental layout accommodated 18 treatments combinations imposed to wheat crop, comprising six tillage practices (Strip till-drill (STD), Zero tillage (ZT), Surface seeding (SS), Reduced tillage (RT), Conventional line sowing (CLS) and Furrow irrigated raised bed planting system (FIRBS) in main plots and three weed control measures (Metribuzin (Sencor) @ 250 g/ha, Sulfosulfuron (Leader) @ 33.3 g/ha, Weedy check) in sub plots with four replicates. The wheat variety 'PBW-373' was sown at a distance of 20 cm between lines under all the conventional and zero tillage with a seed rate of 100 kg/ ha. Rice variety Pusa-1121 was transplanted on 5 July 2005 and 26 June 2006 for residual effect of herbicide and tillage management. Conventional plots were prepared for sowing wheat after giving pre sowing irrigation and sowing was accomplished on Dec, 8 and 5 of 2004-05 and 2005-06, respectively, whereas, sowing in zero tilled plots was taken directly after harvesting Rice variety Pusa-1121 on same dates on residual moisture. Full dose of P and K was applied basal under all tillage methods, whereas, N was applied in splits at basal, crown root initiation (CRI) and earing stage of the wheat crop. Herbicide was applied at 30-35 days after sowing as a post, emergence. The amount of each herbicide per plot was measured and diluted to desired concentration. Data on weed flora, weed density and weed dry matter, various growth attributes, grain and straw yields of wheat were calculated as per the standard procedures.

RESULTS AND DISCUSSION

Weed Flora, Weed Density and Weed Dry Weight

Weed flora of the experimental field consisted of sixteen weed species; 5 grassy, 11 non-grassy and 1 sedge (Table 1). The *P. minor*, *M indica* and *Coronopus didymus* were dominant weeds in the experimental fields. These weeds species were predominant under untilled plots in comparison to tilled ones. The total weed density and weed dry weight were also higher under untilled conditions. During both the years, *Phalaris minor* was the dominant weeds in weedy checks which contributed 23% to the total weeds. *Phalaris minor* was also reported to be a dominant weed at different places under rice-wheat cropping system.

The differences in the weed density as well as weed dry weight due to tillage proved to be significant. The crop grown under FIRBS and conventional sowing option recorded lower weed density and weed dry weight before application of herbicide also observed that the furrow irrigated raised tilled bed planting system (FIRBS) of wheat cultivation proved reasonably good for the control of *Phararis minor.* Lower weed density under zero tillage before application of herbicide could be due to poor weed emergence because of improper aeration and light enrichment in the deeper soil, compaction of the soil inhibiting the germination of the weeds, and poor contact of weed seeds with moisture in case of seeds remaining on the surface. Due to poor weed density upto

Table 1: Weed flora of experimental field during wheat crop season

Botanical name	Family name	English name	Hindi name
Grassy weeds			
Phararis minor Retz.	Gramineae	Little seed canary grass	Gullidanda
Avena ludoviciana L.	Gramineae	Wild oat	Jangli Jai
Polypogon monspeliensis (L.) Desf.	Gramineae	Rabit foot grass	-
Cynodon dactylon (L.) Pers.	Gramineae	Bermuda grass	Doob
Paspalum conjugatum Bergius	Gramineae	Sour grass	-
Non grassy weeds			
Chenopodium album L.	Chenopodiaceae	Lambsquarters	Bathua
Anagallis arvensis L.	Primulaceae	Scarlet pimpernel	Krishan neel
Fumaria parviflora L.	Fumariaceae	Fumitory	Gajri
Lathyrus aphaca L.	Leguminaceae	Wild pea	Matari
Medicago denticulate Wild	Leguminaceae	Yellow trefoil	Chandansi
Melilotus indica (L.) All.	Leguminaceae	Yellow sweet clover	Pillisenji
Rumex acetosella L.	Polygonaceae	Red Sorrel	Khattapalak
Vicia sativa L.	Leguminaceae	Common vetch	Akra
Coronopus didymus L.	Crucifereae	Swin cress	Jangli baboon
Eclipta alba L.	Compositae	Yerba-de-tago	Bhangra
Ageratum conyzoides L.	Compositae	Troic ageratum	Mahakua
Sedges			
Cyperus rotundus L.	Cyperaceae	Purple nutsedge	Motha

30 days, these tillage options recorded lower weed dry weight. FIRBS recorded lower weed density followed by conventional line sowing than any other tillage options at all the stages of crop growth. Weed dry matter was significantly reduced by FIRBS and conventional line sowing at all the stages of crop growth (Table 2). Jat and Singh (2003) and Sharma *et al.* (2004) reported that FIRBS provided reasonably good control of *Phararis minor*. Mishra *et al.* (2005) reported that the problem of *Phalaris minor* was comparatively less as the weed seeds lying on the top of the raised beds failed to germinate as the top of bed dried out quickly.

A significant reduction was recorded due to application of both herbicides in weed density and weed dry matter at all the stages in comparison to weedy check. Metribuzin controlled grasses and broad-leaf weeds including deep rooted weeds, whereas the sulfosulfuron was slightly more effective in controlling the grassy weed. Rao and Bhardwaj (1986) reported that metribuzin was readily taken up by the plant roots through diffusion and translocated upward apoplectically. Its accumulation was highest in roots, stems and leaves and lowest in fruits and grams. Yadav *et al.* (2001) reported that sulfosulfuron herbicide had controlled the weeds like *Bromus* spp., Apera *spicaventi* and *Poa trivialis, Convolvulus arvensis, Poa annua, Rumex* spp., *Spergula arvensis, Lolium temulentum* etc. which are of grassy nature.

The weed control efficiency of both the herbicides was higher under FIRBS, conventional line sowing and reduced tillage in comparison to strip-till-drill, zero tillage and surface seeding that resulted in greater reduction in weed density as well as weed dry weight. This might be due to favourable condition available for plant growth under tilled plots with healthy grown plants having fast metabolic activity leading to fast translocation of herbicides to their site of action inside the plant body.

Growth Performance

The capacity of plant to produce crop dry matter depends not only upon the size of photosynthetic system, but also upon the efficiency and length of time for which it remains active and also the extent of crop weed competition for space, light, moisture and nutrient etc. Results showed that tillage practices had significant influence on plant height as compared to ZT and SS at all the growth stages in both the years of experiment.

Table 2: Weed density, weed dry matter and weed control efficiency of wheat crop as influenced by tillage and weed management

Treatments	Weed density at 60 DAS		Weed dry matter at 120 DAS		Weed control efficiency (%)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Tillage management						
Strip till-drill (STD)	482.50	467.30	203.17	198.10	61.38	61.38
	16.92	**16.61**	**11.98**	**11.83**		
Zero tillage (ZT)	512.30	524.43	219.57	213.63	61.46	61.44
	16.94	16.97	13.12	13.07		
Surface seeding (SS)	594.90	569.87	241.10	238.93	61.11	61.09
	18.50	**18.04**	12.43	12.27		
Reduced tillage (RT)	530.10	505.03	248.83	247.17	61.95	62.09
	17.51	**17.06**	**13.09**	**13.00**		
Conv. line sowing (CLS)	370.77	346.27	204.57	199.40	62.12	62.16
	14.69	14.17	11.82	11.66		
FIRBS	278.37	261.40	188.33	180.07	62.33	62.17
	12.76	**12.35**	**11.29**	**11.08**		
SEm ±	0.52	0.41	0.133	0.175	1.30	1.25
CD (P = 0.05)	1.63	1.30	0.420	0.565	NS	NS
Herbicide						
Metribuzin @ 250 g/ha	45.28	42.62	43.88	43.15	92.30	92.25
	6.71	6.52	6.64	6.59		
Sulfosulfuron @ 33.3 g/ha	37.52	34.37	40.62	39.50	92.88	92.91
	6.13	**5.86**	6.39	6.30		
Weedy check	1301.67	1260.17	568.28	556.00	0.00	0.00
	35.82	**35.21**	**23.82**	**23.56**		
SEm±	0.37	0.29	0.231	0.203	1.33	1.29
CD (P = 0.05)	1.07	0.87	0.674	0.595	3.90	3.74

* Values in bold letters are transformed

Furrow irrigated raised bed planting recorded taller plant which was significantly at par with conventional line sowing (Table 3). The crop sown in furrow irrigated raised bed system produced highest (29.18 and 30.53 g/plant) dry matter followed by conventional line sowing. Maximum leaf area index was recorded under reduced tillage followed by conventional line sowing and FIRBS at 90 DAS in both the years. However, surface seeding recorded minimum leaf area index in both the years. Crop sown in furrow irrigated raised bed system estimated highest CGR followed by conventional line sowing at 30-60 and 60-90 DAS in both the years. However, at 90-120 DAS, strip-till-drill (STD) recorded higher CGR and minimum CGR while, FIRBS recorded minimum CGR at 90-120 DAS in both the years (Singh *et al*., 2014). At early stage, reduced tillage, FIRBS and conventionally line sowing recorded highest RGR values than rest of the tillage options. At later stages 60-90 and 90-120 DAS, strip trill drill recorded highest RGR values followed by zero tillage and surface seedling while FIRBS recorded minimum values of RGR in both the years. FIRBS at 90-120 DAS recorded maximum NAR which was at par with strip till drill in both the years. Conventional line sowing and reduced tillage also recorded higher NAR whereas; zero tillage recorded minimum values in both the years. The grain yield was significantly influenced by tillage management (Table 4). Among tillage options, FIRBS and conventional line sowing recorded consistently higher grain and biomass yield than reduced tillage, zero tillage and surface seeding. Grain yield reduction by zero tillage, surface seeding and reduced tillage was mainly due to lower crop emergence and growth, and reduced ear fertility and also higher weed infestation, which could not be controlled even with herbicide application. Jat and Singh (2003) confirmed that deeply tilled plots produced maximum grain yield followed by conventional and zero tillage and increased the yield in the same fashion, where herbicide was applied. The application of Sulfosulfuron @ 33.3 g/ha produced taller plants followed by Metribuzin @ 250 g/ha, while

Table 3: Growth attributes of wheat crop as influenced by tillage management and herbicide use under rice-wheat cropping system

Treatments	Plant height (cm)		Dry matter accumulation (g/ plant)		Leaf area index (90 DAS)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Tillage management						
Strip till-drill (STD)	82.97	84.67	25.86	26.78	3.593	3.647
Zero tillage (ZT)	81.13	83.37	24.34	25.62	4.023	4.100
Surface seeding (SS)	82.23	84.23	24.27	26.04	2.983	3.020
Reduced tillage (RT)	81.27	83.23	25.68	26.70	5.447	5.520
Conv. line sowing (CLS)	85.77	87.27	27.40	28.77	4.687	4.800
FIRBS	86.90	88.63	29.18	30.53	4.650	4.703
SEm ±	1.04	0.92	0.312	0.322	0.063	0.056
CD (P = 0.05)	3.28	2.89	0.983	1.012	0.199	0.178
Herbicide						
Metribuzin @ 250 g/ha	83.88	85.87	26.48	27.61	4.243	4.310
Sulfosulfuron @ 33.3 g/ha	88.23	90.55	30.27	31.78	4.435	4.550
Weedy check	78.02	79.28	21.61	22.83	4.013	4.035
SEm±	1.54	1.30	0.438	0.540	0.079	0.066
CD (P = 0.05)	4.49	3.79	1.28	1.570	0.231	0.194

Table 4: Yield of wheat crop as influenced by tillage management and herbicide use under rice-wheat cropping system

Treatments	Grain yield (q/ha)		Straw yield (q/ha)		Biological yield (q/ha)	
	2004-05	2005-06	2004-05	2005-06	2004-05	2005-06
Tillage management						
Strip till-drill (STD)	30.43	31.28	42.18	42.98	72.61	74.26
Zero tillage (ZT)	28.89	29.59	39.89	40.43	68.78	70.02
Surface seeding (SS)	29.54	29.93	40.73	40.94	70.26	70.87
Reduced tillage (RT)	29.55	30.42	41.55	41.67	71.11	72.09
Conv. line sowing (CLS)	32.45	33.31	45.39	46.25	77.84	79.56
FIRBS	36.67	37.43	48.94	49.91	85.62	87.34
SEm ±	0.59	0.62	0.74	0.81	1.41	1.43
CD (P = 0.05)	1.89	1.96	2.38	2.54	4.47	4.50
Herbicide						
Metribuzin @ 250 g/ha	36.20	36.74	48.96	49.39	85.16	86.12
Sulfosulfuron @ 33.3 g/ha	39.54	40.43	53.21	54.00	92.75	94.43
Weedy check	18.03	18.81	27.17	27.71	45.20	46.52
SEm±	0.56	0.59	0.76	0.82	1.33	1.40
CD (P = 0.05)	1.65	1.73	2.25	2.39	3.89	4.09

weedy check recorded smaller plants during both the years. The maximum (30.27 and 31.78 g) dry weight at maturity was recorded with Sulfosulfuron @ 33.3 g/ha, which was significantly higher than Metribuzin @ 250 g/ha. Both herbicides produced more leaf area index than weedy check both the years except 30 DAS. Sulfosulfuron @ 33.3 g/ha recorded significantly higher RGR as compared to Metribuzin @ 250 g/ha and weedy check. Application of Sulfosulfuron @ 33.3 g/ha estimated highest CGR values followed by Metribuzin @ 250 g/ha. Herbicide, Sulfosulfuron recorded highest leaf area index. Sulfosulfuron @ 33.3 g/ha recorded maximum NAR than Metribuzin @ 250 g/ha.

The herbicide application significantly increased the grain and biomass yield due to reduction in weed density and weed dry weight (Table 1 and 2). That's why there would be less crop weed competition for space, light, moisture and nutrient etc which resulted in better crop establishment, reduced tiller mortality and ultimately increase in the grain and biomass yield. According to Chauhan *et al.* (2003) the application of metribuzin was found to decrease the weed population and weed biomass significantly when compared with weedy check and resulted higher grain yield. The similar was the result with application of sulfosulfuron in another experiment during same year. In wheat crop, 10-50 per cent loss in grain yield due to weeds was quite usual. Chauhan *et al.* (1998), Pradhan *et al.* (2005), Rathi *et al.* (2008), Mishra and Singh (2009) reported that weedy conditions in wheat resulted in 35-50 per cent reduction in grain yield.

CONCLUSION

Furrow irrigated raised bed planting recorded taller plant, higher dry matter accumulation in wheat (*Triticum aestivum* L.). Maximum leaf area index was recorded under reduced tillage followed by conventional line sowing and FIRBS of wheat (*Triticum aestivum* L.). Furrow irrigated raised bed system recorded highest CGR and NAR followed by conventional line sowing at 30-60 and 60-90 DAS. Significantly higher grain and straw yield was recorded under furrow irrigated raised bed planting system (FIRBS) over the other tillage management. The herbicide application significantly increased the grain and biomass yield due to reduction in weed density and weed dry weight. The highest yield and yield attributes was obtained with the application of Sulfosulfuron @ 33.3 g/ha followed by Metribuzin @ 250 g/ha in present investigation.

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