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Effect of Weed Management Practices on Growth and Yield of Wheat (*Triticum aestivum* L.) under Irrigated Conditions

Nagender Gaddala[1], A. Pradhan[1*], P. K. Salam[2], T. Chandrakar[3] and D. P. Singh[4]

[1]Department of Natural Resource Management, [2]Department of Agronomy, [3]Department of Soil Science, [4]Department of Agri. Statistics, S. G. CARS, IGKV, Jagdalpur, India

**Corresponding author*

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A B S T R A C T

Wheat (*Triticum aestivum* L.) is one of the main cereal crop after rice in India. The maximum plant height, tillers per hill, leaf area index, crop growth rate, relative crop growth were noted higher when hand weeding twice at 45 and 65 days after sowing, which was significantly superior than remaining treatments. Yield attributing characters like spikes hill^{-1}, spike length, seeds per spike and test weight were higher under hand weeding twice at 45 and 65 days after transplanting and found to be at par with metribuzin @ @ 175 g a.i. ha^{-1}. The higher grain and straw yield of wheat were recorded with hand weeding twice at 20 and 40 days after sowing which was found significantly higher grain yield (21.38 q ha^{-1}) than other treatments except application of metribuzin @ @ 175 g a.i. ha^{-1} (18.16 q ha^{-1}). Two hand weeding (20 and 40 DAS) had minimum dry matter accumulation in case of *Chenopodium album* L. (7.73 and 1.21 g m^{-2}), *Leucas aspera* (Willd.) Link (1.24 and 0.0.99 g m^{-2}), *Digitaria sanguinalis* (L.) Scop. (1.55 and 1.50 g m^{-2}), *Spilanthes acmella* Murr (0.78 and 1.77 g m^{-2}), *Vicia hirsute* (L.) Gray (0.92 and 1.00 g m^{-2}), *Medicago denticulata* Willd. (0.78 and 0.71 g m^{-2}) and others (1.40 and 0.59 g m^{-2}) than remaining weeds at 45 and 65 DAS, respectively, and found significant over rest of treatments. *Chenopodium album, Leucas aspera, Spilanthus acmella, Vicia hirsute, Digitaria sanguinalis and Medicago denticulata* had higher weed control efficiency (WCE) ranging from 50.6 to 96.4% under two hand weeding (20 and 40 DAS) and lowest (9.5%) weed control efficiency was noticed with *Digitaria sanguinalis* under one hand weeding at 20 DAS.

Introduction

Wheat (*Triticum aestivum* L.) is one of the main cereal crop after rice in India belonging to the family Poaceae, with annual stature and self-pollination. Globally, it is the most important food grain and ranks second in total production as a cereal crop behind maize; the

third being rice. In wheat, yield losses by weeds may range from 10 to 82% depending upon type of weed species, the extent of severity, duration of weed infestation, competing ability of the crop plants under different agro-ecological conditions (Rao, 1994). With the introduction of high yielding dwarf varieties having heavy demand of inputs, the problem of weed infestation has increased manifolds as if created favourable conditions for invasion as well as luxuriant growth of weeds particularly of *Phalaris minor* and *Avena spp*. Throughout wheat growing area in our country (Gill *et al.,* 1984; Singh and Tripathi, 1986) short stature of dwarf wheat with erectile leaf orientation allows more light penetration through the canopy making the weeds more competitive (Gill and Mehra, 1981). The studies of Brar and Walia (2008) revealed that severe competition of grassy weeds like *Phalaris minor* caused 30-80% reduction in grain yield of wheat. Different weeds species are known to utilize a significant amount of inputs particularly nutrient and water, rendering them in short supply to the associated crop. Moreover, they have an upper hand in using natural recourse specie carbon dioxide. This categorically advocated the need for efficient management of weeds. The most common methods used by farmers for weed management are tillage system, crop rotation and herbicide application (Ball, 1992). Besides, the traditional and mechanical methods, manual operations are costly and time taking that necessitates the use of selective herbicides and other weed management for efficient control of weed flora.

In India, it is the second most cultivated staple food crop after rice and grown on an area of 29.14 million hectares with total production of 106.21 million tonnes and productivity of 35 q ha^{-1} (Anonymus, 2019). In Chhattisgarh, wheat occupies 0.177 (m ha) with a production of 0.261 (million tonnes) and average productivity of 13.37 q ha^{-1} (MOAFW, India, 2017). Introduction of high yielding dwarf genotypes, improved fertilizer and irrigation facilities coupled with scientific research have led India to the prestigious position in the world in wheat production (92.29 million tonns in 2015-16). To meet the requirement of the burgeoning population, India will need 109 million tons of wheat by 2020 AD (Nagrajan, 1997). In order to meet the projected demands the present productivity of wheat has to be raised to the level of 4.29 t ha^{-1}, as the possibility of expansion in horizontal direction is remote.

Manual (removal of weed manually by labor) and physical methods of weed control (by using tractor drawn implements) are very effective in India, however, they have certain limitations like unavailability of labours during peak period under intensive farming, high labour cost; regeneration of weeds which require frequent operation. Metribuzin can be applied pre-, post- or pre-plant incorporated (PPI) and the time of application can severely influence its effectiveness in controlling weeds and crop tolerance to the herbicide. The level of weed control and crop injury with this herbicide can be extremely erratic depending on soil characteristics (e.g. soil texture and pH) and conditions such as soil moisture or precipitation at or near the time of application (Runyan *et al.*, 1982, Ratliff and Peeper, 1987, Matic and Black, 1990, Ladlie *et al.*, 1976).

Materials and Methods

A field experiment was carried out in *Inceptisols* of Midland AICRPDA, during *rabi* 2020-21 Instructional cum Research Farm, S.G. College of Agriculture and Research Station, I.G.K.V., Kumhrawand, Jagdalpur, Chhattisgarh, India lies at 19°5'17.79"N latitude and 81°57'44.99"E longitude with an altitude of 552 meters above mean sea level.

The average annual rainfall and temperature of the area were recorded about 1621 mm and 24.6^{0}C**,** respectively during 2020-21. The experimental site was characterized by low in available N (138.07 kg ha^{-1}) and available P (7.84 kg ha^{-1}); high available K (358.85 kg ha^{-1}), 6.7 pH, 0.18 EC (dS m^{-1}), 0.52% organic carbon. The treatment comprised of one hand hoeing (30 DAS) (T_1), metribuzin @ 175 g a.i. ha^{-1} at 20 DAS (T_2), two hand weeding (20 and 40 DAS) (T_4), control (Absolute control) (T_5) under RCBD (Randomize Complete Block Design) with four replication. Test variety GW- 273 was sown at 20cm × 5cm geometry and sowing was done on 3rd December, 2020 with applying 80:60:40 kg NPK ha^{-1}. The statistical analysis was subjected as per the guidelines of Gomez and Gomez (1984).

Results and Discussion

Growth parameters

The increase in plant height, tillers per plant, nodes per plant, number of root per hill, root length, root volume, was observed slower up to 60 DAS; thereafter it increased two fold till 60, after that growth was sluggish till harvest (Table). Two hand weeding at 20 and 40 DAS attained higher plant height (18.24, 23.45, 34.29, 74.21, 76.63 and 87.39 cm at 15, 30, 45, 60, 75, 90 and at harvest, respectively) as compared to other treatments except metribuzin @ 175 g a.i. ha^{-1} which was comparable throughout growth period. Hand hoeing at 30 DAS and one hand weeding at 20 DAS) were equally significant in attaining plant height of wheat regardless the stages of observation. The highest LAI was obtained from two hand weeding at 20 and 40 DAS (0.446, 0.721, 1.130, 1.312 and 1.491 at 30, 45, 60, 75 and 90 DAS) in all stage of observation being at par with metribuzin@175 g a.i. ha^{-1} (0.410, 0.619, 1.103, 1.240 and 1.381 at 30, 45, 60, 75 and 90 DAS). However, hand weeding at 20 DAS and hand hoeing 30 DAS (0.402, 0.575, 1.042, 1.152 and 1.323 and 0.407, 0.583, 1.034, 1.113 and 1.326 at 30, 45, 60, 75 and 90 DAS) were similar in attaining leaf area index.

Dry matter partitioning

The highest leaf dry weight and stem dry weight were observed under two hand weeding at 20 and 40 DAS (0.48, 0.166, 2.56, 1.70 and 2.20 g per plant at 30, 45, 60, 75 and 90 DAS) which was significantly superior and found comparable to metribuzin was applied @175 g a.i. ha^{-1} (0.08, 0.46, 0.159, 2.49, 1.65 and 2.07 at 30, 45, 60, 75 and 90 DAS). The higher LAI with from two hand weeding at 20 and 40 DAS was due two time suppressed the weed population created proper growing environment throughout crop period. Similar findings are in closer conformity with the finding of Bhardwaj *et al.,* (2004) and Bharat and Kachroo (2007).

Yield attributes

Number of panicles hill^{-1}

The data in respect to number of spike hill^{-1}, spike length (7.82 cm), seeds per spike (35.15) are presented in Table 1. The significantly highest number of spikes per hill^{-1} (3.50) was obtained by two hand weeding at 20 and 40 DAS followed by metribuzin @ 175 g a.i. ha^{-1} (3.05) and found comparable with hand weeding twice (20 and 40 DAS). The least spikes hill^{-1} was observed in control plot, which was improved number of spikes hill^{-1} by imposing either one hand weeding at 20 DAS (3.34) or one hand hoeing (2.75) at 30 DAS both were on par with each other. Owing to maximum number of tillers recorded in two hand weeding at 20 and 40 DAS, the highest number of spike was produced under the same treatment. Abbas *et al.,* (2009) found similar results in obtaining spikes hill^{-1}. The data on

1000 seeds weight was recorded non-significant as presented in Table 4.10. The maximum weight of 1000 seed was notice with two hand weeding at 20 and 40 DAS (43.98 g) followed by metribuzin @ 175 g a.i. ha^{-1} (41.58 g)as details in Table 1. This was close conformity with the finding of by Siddiqui *et al.,* (2010) and Kumar *et al.,* (2013) in which they correlated with weed suppression through hand weedings.

Yields of wheat

The data related to yields of wheat consist of grain yield, straw yield and harvest index (HI) are presented in Table 2. The grain yield of wheat was increased significantly with the weed management practices over the control plot (10.79 q ha^{-1}). The maximum average grain yield was recorded with two hand weeding at 20 and 40 DAS (21.38 q ha^{-1}) which was statistically at par with metribuzin @ 175 g a.i. ha^{-1} (18.60 q ha^{-1}). One hand weeding at 20 DAS (15.16 q ha^{-1}) was found comparable to one hand hoeing at 30 DAS (15.36 q ha^{-1}) were statically similar with each other. The yield attributing characters provided better opportunity for higher yields.

Table.1 Effect of weed management practices on yield attributes of wheat

Treatment	No. of spike $hill^{-1}$	Spike length (cm)	Seeds per spike	1000 seed wt (g)
T_1: Hand hoeing at 30 DAS	2.75	6.36	27.68	39.11
T_2: Metribuzin @ 175 g a.i. ha^{-1}	3.05	7.48	33.77	41.58
T_3: One hand weeding (20 DAS)	3.40	6.44	29.80	40.82
T_4: Two hand weeding (20 and 40 DAS)	**3.50**	**7.82**	**35.15**	**43.98**
T_5: Control (Absolute control)	2.01	4.87	25.38	38.78
SEm±±	**0.19**	**0.51**	**2.20**	**2.23**
CD (P=0.05)	**0.57**	**1.39**	**5.58**	**NS**

Table.2 Effect of weed management practices on yields and harvest Index of wheat

Treatment	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Harvest Index (%)	B:C	WCE (%)
T_1: Hand hoeing at 30 DAS	15.36	37.87	29.55	1.41	62.91
T_2: Metribuzin @ 175 g a.i. ha^{-1}	18.60	43.26	31.79	1.62	78.36
T_3: One hand weeding (20 DAS)	15.16	38.15	28.00	1.41	66.39
T_4: Two hand weeding (20 and 40 DAS)	**21.38**	**45.63**	**33.07**	**1.74**	85.66
T_5: Control (Absolute control)	10.79	25.63	23.88	1.12	-
SEm±	**1.09**	**2.33**	**0.45**	**0.04**	**2.77**
CD (P=0.05)	**3.11**	**5.90**	**1.34**	**0.12**	**8.07**

Table.3 Dry weight of weeds as influenced by different weed management practices

Treatment	*Chenopodium album*		*Leucas aspera*		*Digitaria sanguinalis*		*Spilanthus acmella*		*Vicia hirsuta*		*Medicago denticulate*		Others	
	45 DAS	65 DAS	45 DAS	65 DAS	45 DAS	65 DAS	45 DAS	65 DAS	45 DAS	65 DAS	45 DAS	65 DAS	45 DAS	65 DAS
T1:Hand hoeing at 30 DAS	3.10	2.67	1.48	1.46	1.59	2.62	0.87	2.19	1.58	1.68	1.21	1.47	1.54	1.65
	(10.66)	(6.67)	(2.36)	(1.83)	(2.03)	(6.38)	(0.30)	(4.40)	(2.10)	(2.47)	(1.24)	(1.67)	(6.05)	(2.19)
T2:Metribuzin @ 175 g a.i. ha-1	3.41	1.42	1.43	1.06	1.55	1.83	0.95	1.98	1.21	1.32	0.87	1.24	1.26	0.63
	(13.37)	(1.55)	(2.46)	(0.64)	(2.05)	(2.96)	(0.41)	(3.42)	(1.44)	(1.41)	(0.31)	(1.04)	(3.50)	(0.71)
T3:One hand weeding (20 DAS)	4.09	1.40	2.00	1.18	1.89	2.03	1.01	2.04	1.25	1.47	1.10	1.33	1.85	0.64
	(20.00)	(1.56)	(4.27)	(0.89)	(3.72)	(3.78)	(0.52)	(3.71)	(1.63)	(2.25)	(0.78)	(1.33)	(9.05)	(0.70)
T4:Two hand weeding (20 and 40 DAS)	**2.78**	**1.30**	**1.24**	**0.99**	**1.55**	**1.50**	**0.78**	**1.77**	**0.92**	**1.00**	**0.78**	**0.71**	**1.40**	0.59
	(7.73)	**(1.21)**	**(1.45)**	**(0.50)**	**(2.25)**	**(1.76)**	**(0.12)**	**(2.84)**	**(0.49)**	**(0.51)**	**(0.12)**	**(0.00)**	**(4.82)**	(0.55)
T5:Control (Absolute control)	6.68	3.56	3.03	2.38	2.09	3.71	2.41	3.59	1.85	2.93	1.43	4.99	3.87	1.61
	(44.42)	(13.06)	(8.87)	(5.21)	(4.11)	(14.79)	(5.62)	(12.43)	(4.51)	(8.14)	(1.56)	(24.5)	(14.54)	(5.91)
SEm±	**0.22**	**0.03**	**0.20**	**0.15**	**0.11**	**0.12**	**0.06**	**0.06**	**0.11**	**0.08**	**0.03**	**0.20**	**0.05**	**0.01**
CD (P=0.05)	**0.65**	**0.10**	**0.60**	**0.45**	**NS**	**0.38**	**0.18**	**0.20**	**0.31**	**0.38**	**0.10**	**0.62**	**NS**	**0.04**

The minimum grain yield was recorded by control plot which was increased upto 49.53% under two hand weeding showed remarkable increased in grain yield due to two time weed suppression. These findings were similar to Kulsoom and Khan (2015). Similar trend was followed by straw yield and harvest index. The highest straw yield was obtained via two hand weeding at 20 and 40 DAS (45.63 q ha^{-1}) which was significantly higher than rest of treatments except metribuzin @ 175 g a.i. ha^{-1} (43.26 q ha^{-1}). The lowest straw yield was recorded 25.63 q ha^{-1} under control treatment. Similar outcomes were obtained from the research work of Kumar *et al.,* (2013). The maximum harvest index (HI) was found significant by two hand weeding at 20 and 40 DAS (33.07%) and then metribuzin @ 175 g a.i. ha^{-1} (31.79%) being on par to two hand weeding. This was due to uniform distribution of crop plants over fields after proper weed suppression. The minimum HI was recorded in control plot which was about 27.78 and 24.88% lower than two hand weeding and metribuzin @ 175 g a.i. ha^{-1}, respectively. The highest B:C ratio was recorded when two hand weeding at 20 and 40 DAS (1.74) and then metribuzin @ 175 g a.i. ha^{-1} (1.62) which was comparable with two hand weeding over other weed control treatments (Table 2).

Dry matter of weeds

Two hand weeding (20 and 40 DAS) had minimum dry matter accumulation in case of *Chenopodium album* L. (7.73 and 1.21 g m^{-2}), *Leucas aspera* (Willd.) Link (1.24 and 0.0.99 g m^{-2}), *Digitaria sanguinalis* (L.) Scop. (1.55 and 1.50 g m^{-2}), *Spilanthes acmella* Murr (0.78 and 1.77 g m^{-2}), *Vicia hirsuta* (L.) Gray (0.92 and 1.00 g m^{-2}), *Medicago denticulata* Willd. (0.78 and 0.71 g m^{-2}) and others (1.40 and 0.59 g m^{-2}) than remaining weeds at 45 and 65 DAS, respectively, and found significant over rest of treatments. Whereas metribuzin @ 175 g a.i. ha^{-1} was second most suited weed management practices in suppression of weed flora which was comparable to that of two hand weeding (20 and 40 DAS) at both stage of observations (Singh *et al.,* 2015) as shown in Table 3. The increment in dry matter of weeds in obvious from data because all weed managements were applied upto 40 DAS, later flushes came in the field with slower pace (Singh *et al.,* 2004).

Weed Control Efficiency

The data pertaining to weed control efficiency, the weed control efficiency was found significant with different weed management practices at 45 and 65 days after spray (DAS) as shown in Table 4.16. In general, *Chenopodium album, Leucas aspera, Spilanthus acmella, Vicia hirsute, Digitaria sanguinalis and Medicago denticulata* had higher weed control efficiency (WCE) ranging from 50.6 to 96.4% under two hand weeding (20 and 40 DAS) and lowest (9.5%) weed control efficiency was noticed with *Digitaria sanguinalis* under one hand weeding at 20 DAS. Application of metribuzin @ @ 175 g a.i. ha^{-1} gave higher weed control efficiency at both observations (45 and 65 DAS) in response to all the weeds and fond comparable to thatof hand weeding twice (45 and 65 DAS). Singh *et al.,* (2015) noticed the highest weed control efficiency of 56.84% and 60.80% after weed free plot (51.22% and 55.00%) during 2011 and 2012, respectively under hand weeding (Table 3).

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