

## Sequential application of herbicides in wheat (*Triticum aestivum*) under peninsular Indian conditions

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### ABSTRACT

A field experiment was conducted during the winter (*rabi*) season of 2014 at a farmer's field in Muttagi Village, Vijayapur District, Karnataka, to study the effect of sequential application of pre (pendimethalin, metribuzin) and post-emergence (2,4-D, metsulfuron methyl) herbicides on weed growth, crop growth parameters and yield of wheat (*Triticum aestivum* L.) under irrigated situation. Unchecked weed growth caused 25.04% reduction in grain yield of wheat. Pre-and post-emergence herbicides applied in sequence proved more effective in reducing population and total dry matter of weeds and recording higher weed-control efficiency as compared to their sole application. Maximum grain yield of wheat was recorded from weed-free check (4.3 t/ha), which was at par with pendimethalin @ 1 kg/ha followed by metsulfuron-methyl @ 4 g/ha, pendimethalin @ 1 kg/ha followed by 2,4-D @ 2 kg/ha and pendimethalin @ 1 kg/ha followed by 1 intercultivation at 30 days after sowing. Higher grain yield was a reflection of higher plant height, effective tillers/m, total dry-matter production and higher N, P, K uptake by wheat in these treatments. Pre-emergence application of metribuzin @ 175 g/ha was phytotoxic (scale 3 at 14 days after spraying) to wheat crop.

**Key words** : Crop growth, Grain yield, Herbicide sequence, Phytotoxicity, Weeds, Wheat

Wheat is the most important staple food crop of North India, mainly grown in the states of Punjab, Haryana, Rajasthan and Western Uttar Pradesh. However, wheat cultivation is also becoming popular in canal command areas of peninsular India owing to the advent of short-duration cultivars, which are tolerant to terminal heat stress and a change in the food habit of people. Karnataka is the single major wheat-producing state in South India, having a production of 0.28 million tonnes from an area of 0.26 million ha (GoI, 2015). Weed incidence is one of the major barriers, responsible for the low productivity of wheat in South India. The short stature of dwarf wheat varieties coupled with high fertilizer and irrigation requirement creates favourable ecological conditions for heavy weed infestation. Moreover, black soils with their higher

water-holding capacity favour prolonged weed-seed germination and seedling growth. Narrow row spacing, labour scarcity and high labour wages make hand-weeding highly uneconomical in wheat and necessitates the use of herbicides. However, sole dependence upon post-emergence herbicides is inadequate under peninsular Indian conditions due to the dominance of broad-leaf species and recurrent flushes of weed emergence due to higher temperatures. Hence sequential herbicidal application might be a feasible solution, which can reduce early weed-crop competition as well as control the later flushes of weeds therefore ensuring higher wheat yields.

A field experiment was conducted during winter (*rabi*) season of 2014 at farmer's field in Muttagi Village, Vijayapur District, Karnataka, to assess the superiority of sequential application of herbicides in irrigated wheat. The soil of the experimental field was clayey in texture, low in available nitrogen and medium in available phosphorus and potash and slightly alkaline (pH 8.10). Two pre-emergence (pendimethalin 1 kg/ha and metribuzin 175 g/ha) and post-emergence (2,4-D 2 kg/ha and metsulfuron-methyl 4 g/ha) herbicides were applied singly (T<sub>1</sub>, T<sub>4</sub>, T<sub>7</sub> and T<sub>8</sub>) and in sequence (T<sub>2</sub>, T<sub>3</sub>, T<sub>5</sub> and T<sub>6</sub>), and were compared with weedy check and weed-free check. The treat-

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ments were tested in a randomized block design with 3 replications. The wheat variety 'UAS-304' was sown at 22.5 cm row spacing at 150 kg seed/ha on 6 November, 2014 and harvested on 1 March, 2015. Pendimethalin and metribuzin were sprayed at 1 days after sowing (DAS) and 2,4-D and metsulfuron-methyl at 25 DAS with a spray volume of 750 l/ha. All the experimental data were statistically analyzed and critical difference was worked out as per standard statistical procedure.

Differences in total weed count, weed dry weight, weed-control efficiency and weed index differed significantly due to weed-control treatments (Table 1). At harvesting, total weed count per m<sup>2</sup> was significantly lower with the treatment pendimethalin 1 kg/ha followed by (*fb*) metsulfuron methyl 4 g/ha (4.02) which was at par with pendimethalin 1 kg/ha *fb* 2,4-D 2 kg/ha, pendimethalin 1 kg/ha *fb* 1 intercultivation at 30 DAS, metribuzin 175 g/ha *fb* metsulfuron methyl 4 g/ha and metribuzin 175 g/ha *fb* 2,4-D 2 kg/ha. All weed-control treatments recorded significantly lower total weed population than the weedy check (7.99). The treatment pendimethalin 1 kg/ha *fb* metsulfuron methyl 4 g/ha, being at par with pendimethalin 1 kg/ha *fb* 2,4-D 2 kg/ha, metribuzin 175 g/ha *fb* metsulfuron methyl 4 g/ha and metribuzin 175 g/ha *fb* 2,4-D 2 kg/ha also recorded significantly lower total weed dry weight and higher weed-control efficiency at harvesting. Weed index, a measure of yield reduction due to weed competition, was significantly higher in weedy check (25.04%). Significantly lower weed index was recorded with pendimethalin 1 kg/ha *fb* metsulfuron-methyl 4 g/ha (4.04%) which was at par with pendimethalin 1 kg/

ha *fb* 2,4-D 2 kg/ha (4.71%), pendimethalin 1 kg/ha *fb* one intercultivation at 30 DAS (7.34%), metsulfuron-methyl @ 4 g/ha (9.91%) and 2,4-D 2 kg/ha (10.91%). Our results confirm the findings of Pisal *et al.* (2013) and Tomar *et al.* (2014).

At harvesting, plant height, effective tillers/m and total dry-matter production (Table 2) were significantly higher in weed free check (87.58 cm, 76.83 and 7.33 g/plant respectively) which was at par with the treatments pendimethalin 1 kg/ha *fb* metsulfuron methyl 4 g/ha, pendimethalin 1 kg /ha *fb* 2,4-D 2 kg/ha and pendimethalin 1 kg /ha *fb* one intercultivation at 30 DAS. A similar trend was observed with plant N, P and K uptake at harvesting. Similar findings were reported by Pal *et al.* (2016). Significantly higher grain yield (Table 2) was recorded under weed free check (4.35 t/ha) which was at par with the treatments pendimethalin 1 kg/ha *fb* metsulfuron methyl 4 g /ha (4.17 t/ha), pendimethalin 1 kg /ha *fb* 2,4-D 2 kg/ha (4.14 t/ha) and pendimethalin 1 kg /ha *fb* 1 intercultivation at 30 DAS (4.03 t/ha). The increase in yield in these treatments was to the tune of 28.15, 27.26 and 23.70% over weedy check respectively. This could be attributed to a better accumulation of plant biomass (source) which was later mobilized to the reproductive parts (sink) owing to lower crop-weed competition, which shifted the balance in favour of crop. These results are in conformity with the findings of Sharma (2009).

Crop-growth parameters, nutrient uptake as well as grain yield were significantly lower in the treatments: metribuzin 175 g/ha *fb* by 1 intercultivation at 30 DAS, metribuzin @ 175 g/ha *fb* 2,4-D @ 2 kg/ha and metribuzin

**Table 1.** Effect of herbicides on weed growth, weed-control efficiency and weed index in wheat

Treatment	Weed count (Nos./m <sup>2</sup> ) at harvesting			Total weed dry weight (kg/ha) at harvest	Weed-control efficiency (%) at harvest	Weed index (%)
	Monocot	Dicot	Total			
T <sub>1</sub> , Pendimethalin (PE) 1 kg/ha <i>fb</i> 1 IC	2.91 (8.00)	3.72 (13.33)	4.67 (21.33)	140.9	69.8	7.3
T <sub>2</sub> , Pendimethalin (PE) 1 kg/ha <i>fb</i> 2,4-D (PoE) 2 kg/ha	3.39 (11.00)	2.67 (6.67)	4.26 (17.67)	90.3	80.6	4.7
T <sub>3</sub> , Pendimethalin (PE) 1 kg/ha <i>fb</i> MM (PoE) 4 g/ha	3.29 (10.33)	2.40 (5.33)	4.02 (15.66)	84.0	81.9	4.0
T <sub>4</sub> , Metribuzin (PE) 175 g/ha <i>fb</i> 1 IC	3.23 (10.00)	3.72 (13.33)	4.87 (23.33)	145.4	68.9	22.6
T <sub>5</sub> , Metribuzin (PE) 175 g/ha <i>fb</i> 2,4-D (PoE) 2 kg/ha	3.67 (13.00)	2.91 (8.00)	4.63 (21.00)	104.3	77.6	22.0
T <sub>6</sub> , Metribuzin (PE) 175 g/ha <i>fb</i> MM (PoE) 4 g/ha	3.53 (12.00)	2.73 (7.00)	4.30 (18.00)	91.7	80.3	21.3
T <sub>7</sub> , 2,4-D (PoE) 2 kg/ha	4.10 (16.33)	3.07 (9.00)	5.08 (25.33)	133.3	71.4	10.9
T <sub>8</sub> , MM (PoE) 4 g/ha	3.94 (15.00)	3.03 (8.67)	4.92 (23.67)	124.9	73.2	9.9
T <sub>9</sub> , Weed-free check	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.0	100.0	0.0
T <sub>10</sub> , Weedy check	5.07 (25.33)	6.20 (38.00)	7.99 (63.33)	466.7	0.0	25.0
SEm±	0.26	0.18	0.21	7.0	1.4	2.9
CD (P=0.05)	0.80	0.54	0.65	20.8	4.2	8.8

IC, Intercultivation at 30 days after sowing (DAS); MM, metsulfuron-methyl; *fb*, followed by, PE, pre-emergence application, PoE, post-emergence application; data subjected to (x+0.5)<sup>1/2</sup> transformation and figures in parentheses are original values

**Table 2.** Effect of herbicides on crop phytotoxicity, crop growth, nutrient uptake and yield of wheat at harvesting

Treatment	Phytotoxicity at 14 DAS		Plant height (cm)	Effective tillers/m	Total dry matter production (g/plant)	Nutrient uptake by crop (kg/ha)			Grain yield (t/ha)
	PE	PoE				N	P	K	
T <sub>1</sub> , Pendimethalin (PE) 1 kg/ha fb 1 IC	0	-	82.3	70.2	6.9	71.5	12.7	80.6	4.03
T <sub>2</sub> , Pendimethalin (PE) 1 kg/ha fb 2,4-D (PoE) 2 kg/ha	0	0	84.6	72.8	7.1	73.7	12.9	81.6	4.14
T <sub>3</sub> , Pendimethalin (PE) 1 kg/ha fb MM (PoE) 4 g/ha	0	0	86.2	74.2	7.2	74.1	13.1	82.4	4.17
T <sub>4</sub> , Metribuzin (PE) 175 g/ha fb 1 IC	3	-	74.3	57.3	5.7	60.3	9.9	68.9	3.36
T <sub>5</sub> , Metribuzin (PE) 175 g/ha fb 2,4-D (PoE) 2 kg/ha	3	0	74.6	58.8	5.8	61.3	10.0	70.4	3.39
T <sub>6</sub> , Metribuzin (PE) 175 g/ha fb MM (PoE) 4 g/ha	3	0	75.1	60.2	5.9	62.6	10.1	71.0	3.42
T <sub>7</sub> , 2,4-D (PoE) 2 kg/ha	-	0	81.0	67.3	6.7	69.7	12.3	77.4	3.87
T <sub>8</sub> , MM (PoE) 4 g/ha	-	0	81.5	68.8	6.8	70.4	12.4	78.3	3.91
T <sub>9</sub> , Weed-free check	-	-	87.6	76.8	7.3	77.6	13.7	85.0	4.35
T <sub>10</sub> , Weedy check	-	-	71.4	54.5	5.0	56.0	8.5	61.3	3.26
SEm±	-	-	1.9	2.3	0.1	2.3	0.4	1.9	0.13
CD (P=0.05)	-	-	5.7	6.9	0.3	6.7	1.2	5.8	0.39

fb, Followed by; IC, intercultivation at 30 sowing; DAS, days after spraying; PE, pre-emergence application; PoE, post-emergence application

@ 175 g/ha fb metsulfuron methyl 4 g/ha. This was due to the phytotoxicity caused by pre-emergence application of metribuzin to wheat crop which ranged up to scale 3 (moderate crop injury, bleached leaves, few dead tillers, recovery at later stages) at 14 days after spraying. Singh *et al.* (2002) also reported Metribuzin toxicity to wheat.

Based on the findings of the present study, it may be inferred that sequential application of pendimethalin 1 kg/ha, followed by either metsulfuron methyl 4 g/ha or 2,4-D 2 kg/ha or an intercultivation at 30 days after sowing could be an efficient weed-control option in wheat under peninsular Indian conditions which would lead to higher crop growth and yield components and ultimately superior yields.

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