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Bio-efficacy of ready and tank mixed herbicides in chickpea

G.D. Sanketh, K. Bhanu Rekha*, T. Ram Prakash and K.S. Sudhakar

College of Agriculture, Professor Jayashankar Telangana state Agricultural University, Hyderabad, Telangana 500030, India

**Email: kbrekhaagron2006@gmail.com*

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ABSTRACT

A field experiment was conducted at Agricultural Research Institute, Main Farm, Professor Jayashankar Telangana State Agriculture University, Rajendranagar, Hyderabad, India during *Rabi* (winter season) 2020 to evaluate the efficacy of herbicides in chickpea (*Cicer arietinum* L.) variety *'JG-11'*. The experiment was conducted in RBD with three replications. The application of pendimethalin 30% EC + imazethapyr 2% EC (ready mix [RM]) 1.0 kg/ha as pre-emergence application (PE) followed by (*fb*) mechanical weeding at 30 days after seeding (DAS) recorded lowest weed density and biomass at 20 and 40 DAS. Pendimethalin 1.0 kg/ha PE *fb* mechanical weeding at 20 and 40 DAS, oxyfluorfen 140 g/ha PE *fb* mechanical weeding at 20 and 40 DAS, pendimethalin + imazethapyr (RM) 1.0 kg/ha PE *fb* mechanical weeding at 30 DAS registered 1.95, 1.94 and 2.08 t/ha seed yield, respectively as against seed yield of 1.11 t/ha in weedy check. The maximum net returns of ₹ 72093/ha were recorded in pendimethalin + imazethapyr (RM) 1.0 kg/ha PE *fb* mechanical weeding at 30 DAS with B-C ratio of 3.27, which was closely followed by oxyfluorfen 140 g/ha PE *fb* mechanical weeding at 20 and 40 DAS with net returns of ₹ 64980/ha and B:C ratio of 2.99.

Chickpea, the most important *Rabi* (winter season) pulse crop in India, accounts for about 44.5% of total pulse production from 35.1% of total pulse area. Its production is about 10.13 mt from an area of 8.4 mha with productivity of 1.07 t/ha during 2019-20 (Anonymous 2019). Among the constraints faced in chickpea cultivation, the most crucial one is competition from weeds as chickpea is not a weed competitive crop, due to slow growth especially at early stages. The yield losses in chickpea due to weeds range from 30-54% (Mukherjee 2007) if weed growth remains unchecked at critical period of crop weed competition. Weeds in chickpea are generally controlled by conventional methods (cultural manipulation either by hand weeding or hoeing) which is very effective but, it is laborious and expensive. Herbicides are effective but offer limited choice in chickpea, hence an attempt was made to study the efficacy of ready and tank mix herbicides in managing weeds in chickpea.

A field experiment was carried out at Agricultural Research Institute, Main Farm, Professor Jayashankar Telangana State Agriculture University, Rajendranagar, Hyderabad during *Rabi* 2020 to evaluate efficacy of ready mix and tank mix herbicides and herbicide mixtures in chickpea. The experiment consisted of 12 treatments and 3 replications (**Table 1)**. The soil of experimental site was clay in texture, slightly alkaline in reaction (pH, 8.2), high in organic carbon (0.98 %) available N, P and K were 290.5 (high), 17.4 (high) and 332.6 kg/ha (high) respectively.

Chickpea variety *'JG-11'* was sown on 6th November, 2020 in 30 cm inter-row spacing and 10 cm intra-row spacing using seed rate of 75 kg/ha and was harvested on 13th February, 2021. Recommended dosage of fertilizers 20 kg N/ha of which 50% was applied at basal along with 21.5 kg P/ha, 16.6 kg/ha and remaining 50% N was applied at 25 days after seeding (DAS). Pre-emergence herbicides application (PE) was done after sowing of crop and post emergence herbicides application (PoE) was done at 25 DAS. Herbicides were sprayed with knapsack sprayer using 500 liters of water per hectare. Weed density was recorded by using 0.25 m^2 quadrat at different intervals in all the treatments and then converted into number/m^2. Weeds were dried in oven till constant weight was attained and transformed to g/m^2 (weed biomass) by square root transformation. The data on weed density and biomass were subjected to square root transformation to normalize their distribution Gomez and Gomez 1984).

Effects on weeds

The experimental field was infested with *Physalis minima, Alternanthera sessilis, Abelmoschus* spp., *Corchorus acutangulus, Parthenium hysterophorus, Phyllanthus niruri, Euphorbia geniculata, Trianthema portulacastrum, Cynodon dactylon, Panicum* spp. and *Cyperus rotundus.* The weed density at 20 DAS (**Table 1**) was lowest with pendimethalin 30 % + imazethapyr 2% EC (RM) 1000 g/ha PE *fb* mechanical weeding at 30 DAS. Pendimethalin 1000 g PE followed by (*fb)* mechanical weeding at 20 and 40 DAS and oxyfluorfen 140 g/ha PE *fb* mechanical weeding at 20 and 40 DAS were equally effective. Weed density at 40 DAS (**Table 1**) was lowest in pendimethalin + imazethapyr (RM) 1000 g/ha PE *fb* mechanical weeding at 30 DAS and was at par with pendimethalin 1000 g/ha PE *fb* mechanical weeding at 20 and 40 DAS, oxyfluorfen 140 g/ha PE *fb* mechanical weeding at 20 and 40 DAS. At 60, 90 DAS and at harvest (**Table 1)** lowest weed density was recorded by topramezone 25.2 g/ha (PoE) *fb* mechanical weeding at 40 DAS. The data on weed density at 20,40, 60, 90 DAS and at harvest (**Table 1**) revealed that weed density was decreased in the effective treatments within 20 days of sowing due to application of pre-emergence herbicides and thereafter, between 20 and 40 DAS weed count decreased in all the treatments except, weedy check due to effect of post-emergence herbicide application coupled with mechanical weeding. Similar findings in chickpea were reported by Poonia and Pithia (2013) and Parihar *et al.* (2019). At 60, 90 DAS and at harvest the weed density increased in all the treatments except with topramezone 25.2 g/ha as (PoE) *fb* mechanical weeding at 40 DAS due to residual effect of topramezone which has half-life of >120 days (Lavanya *et al.* 2021).

The lowest weed biomass at 20 DAS, weed index (6.00 %) and highest weed control efficiency (88.09%) were registered with pendimethalin + imazethapyr (RM) 1000 g/ha PE *fb* mechanical weeding at 30 DAS which was equally effective as pendimethalin 1000 g/ha PE *fb* mechanical weeding at 20 and 40 DAS (**Table 1** and **2**). At 40 DAS, the lowest weed biomass was observed with pendimethalin + imazethapyr (RM) 1000 g/ha PE *fb* mechanical weeding at 30 DAS and pendimethalin 1000 g/ha as PE *fb* mechanical weeding at 20 and 40 DAS and oxyfluorfen 140 g/ha PE *fb* mechanical weeding at 20 and 40 DAS. At 60, 90 DAS and at harvest, the lowest weed biomass was recorded with topramezone 25.2 g/ha PoE *fb* mechanical weeding at 40 DAS. It may be inferred that weed biomass was less in effective treatments at 20 DAS because of pre-emergence application of herbicides in those

Table 1. Weed density and biomass in chickpea as influenced by weed control treatments

Treatment	Total weed density (no./m^2)					Total weed biomass (g/m^2)				
	20 DAS	40 DAS	60 DAS	90 DAS	At harvest	20 DAS	40 DAS	60 DAS	90 DAS	At harvest
Pendimethalin 1000 g/ha PE followed by (*fb)* mechanical weeding at 20 and 40 DAS	8.2 (67.0)	4.8 (22.0)	7.6 (57.3)	8.1 (65.8)	8.34 (68.66)	1.45 (1.10)	2.57 (5.62)	3.43 (10.73)	3.76 (13.12)	3.89 (14.16)
Pendimethalin + imazethapyr 1000 g/ha PE *fb* mechanical weeding at 30 DAS	7.2 (51.0)	4.7 (21.3)	6.7 (44.0)	7.3 (53.3)	7.68 (58.00)	1.28 (0.64)	2.35 (4.51)	3.28 (9.78)	3.61 (12.00)	3.79 (13.33)
Oxyfluorfen 140 g/ha PE *fb* mechanical weeding at 20 and 40 DAS	7.3 (52.0)	5.2 (25.6)	7.9 (60.6)	8.4 (70.6)	8.77 (76.00)	1.95 (2.81)	2.67 (6.15)	3.45 (10.91)	4.05 (15.43)	4.18 (16.43)
Imazethapyr 60 g/ha as (PoE) *fb* mechanical weeding at 40 DAS	11.2 (125.3)	9.0 (79.3)	13.1 (171.3)	13.9 (194.7)	14.10 (198.00)	3.07 (8.40)	3.66 (12.43)	5.89 (33.67)	6.17 (37.10)	6.33 (39.10)
Topramezone 25.2 g/ha (PoE) *fb* mechanical weeding at 40 DAS	11.5 (131.7)	5.5 (29.3)	5.5 (29.3)	5.3 (27.3)	5.25 (26.66)	3.09 (8.55)	2.91 (7.45)	2.93 (7.60)	1.79 (2.20)	1.70 (1.90)
Imazethapyr + imazamox 70 g/ha (PoE) *fb* mechanical weeding at 40 DAS	11.0 (121.0)	9.2 (84.0)	13.2 (173.6)	14.5 (211.3)	14.70 (215.33)	3.05 (8.28)	3.96 (14.7)	6.30 (38.67)	6.40 (39.97)	6.48 (40.97)
Propaquizafop + imazethapyr (62.5 + 60) g/ha PoE *fb* mechanical weeding at 40 DAS	11.5 (130.7)	7.2 (50.7)	8.9 (77.3)	13.1 (172.6)	13.22 (174.00)	3.11 (8.69)	3.05 (8.29)	5.06 (24.63)	5.39 (28.03)	5.48 (29.03)
Quizalofop-ethyl + imazethapyr (50+ 60) g/ha (PoE) *fb* mechanical weeding at 40 DAS	11.6 (133.3)	7.4 (54.0)	10.5 (109.3)	13.7 (186.8)	13.79 (189.33)	3.00 (8.02)	3.27 (9.69)	5.19 (25.90)	5.60 (30.37)	5.78 (32.37)
Acifluorfen + clodinafop-propargyl 245 g/ha (PoE) *fb* mechanical weeding at 40 DAS	11.7 (135.3)	8.7 (74.0)	12.6 (158.6)	13.8 (190.3)	13.89 (192.00)	3.06 (8.36)	3.61 (12.05)	5.71 (31.60)	6.04 (35.50)	6.12 (36.50)
Fluazifop-p-butyl + fomesafen 250 g/ha PoE *fb* mechanical weeding at 40 DAS	11.5 (130.7)	8.5 (71.2)	11.9 (139.9)	13.7 (189.0)	13.94 (193.33)	3.09 (8.56)	3.42 (10.70)	5.35 (27.60)	5.67 (31.18)	5.85 (33.18)
Mechanical weeding at 20 and 40 DAS	11.5 (130.9)	5.5 (29.9)	8.1 (64.0)	12.6 (160.0)	12.74 (161.33)	3.07 (8.43)	2.79 (6.78)	3.64 (12.27)	4.64 (20.57)	4.75 (21.57)
Weedy check	11.5 (130.2)	15.8 (250)	16.0 (255.6)	17.4 (302.6)	17.46 (304.00)	3.10 (8.63)	6.24 (37.88)	7.47 (54.77)	7.76 (59.20)	7.82 (60.20)
LSD (p=0.05)	1.95	2.30	2.30	0.54	0.51	0.17	0.35	0.47	0.58	0.61

Figures in parentheses are the original values; square root transformation ($\sqrt{x+1}$) used for statistical analysis

Table 2. Seed yield and economics of chickpea as influenced by weed control treatments

Treatment	WCE at 40 DAS	WI (%)	Seed yield t/ha	Haulm yield t/ha	Net returns `/ha	B:C
Pendimethalin 1000 g/ha PE followed by (*fb)* mechanical weeding at 20 and 40 DAS	85.17	6.0	1.95	2.18	64757	2.99
Pendimethalin + imazethapyr 1000 g/ha PE *fb* mechanical weeding at 30 DAS	88.09	0.0	2.08	2.62	72093	3.27
Oxyfluorfen 140 g/ha PE *fb* mechanical weeding at 20 and 40 DAS	83.76	6.5	1.94	2.08	64980	3.05
Imazethapyr 60 g/ha as (PoE) *fb* mechanical weeding at 40 DAS	67.19	39.1	1.26	1.42	32870	2.09
Topramezone 25.2 g/ha (PoE) *fb* mechanical weeding at 40 DAS	80.33	21.0	1.64	1.90	47828	2.41
Imazethapyr + imazamox 70 g/ha (PoE) *fb* mechanical weeding at 40 DAS	61.19	39.3	1.26	1.41	32018	2.04
Propaquizafop + imazethapyr (62.5 + 60) g/ha PoE *fb* mechanical weeding at 40 DAS	78.11	27.7	1.50	1.71	44416	2.46
Quizalofop-ethyl + imazethapyr (50+ 60) g/ha (PoE) *fb* mechanical weeding at 40 DAS	74.41	28.2	1.49	1.71	43577	2.42
Acifluorfen + clodinafop-propargyl 245 g/ha (PoE) *fb* mechanical weeding at 40 DAS	68.20	35.6	1.34	1.43	35651	2.15
Fluazifop-p-butyl + fomesafen 250 g/ha PoE *fb* mechanical weeding at 40 DAS	71.75	33.9	1.37	1.57	38235	2.27
Mechanical weeding at 20 and 40 DAS	82.10	16.4	1.73	1.97	55612	2.80
Weedy check	0.00	46.4	1.11	1.36	27937	2.01
LSD (p=0.05)		-	0.26	0.16	12617	0.41

Figures in parentheses are the original values; square root transformation ($\sqrt{x+1}$) used for statistical analysis; WCE- Weed control efficiency, WI- Weed index

treatments, thereafter between 20 and 40 DAS the weeds biomass has increased but the rate of increase was less in all the treatments compared to weedy check due to the effect of post-emergence application of herbicides coupled with mechanical weeding (**Table 1**) (Gupta *et al*. 2017). The results are in agreement with Indu *et al*. (2021). At 60, 90 DAS and at harvest the weeds biomass increased in all the treatments except topramezone 25.2 g/ha PoE *fb* mechanical weeding at 40 DAS because of the residual effect of topramezone. These results are in concurrence with those of Singh *et al.* (2020).

Effect on chickpea

Pendimethalin + imazethapyr (RM) 1000 g/ha PE *fb* mechanical weeding at 30 DAS gave significantly higher seed yield (2.08 t/ha) and was at par with pendimethalin 1000 g/ha PE *fb* mechanical weeding at 20 and 40 DAS and oxyfluorfen 140 g/ha PE *fb* mechanical weeding at 20 and 40 DAS which registered seed yield of 1.95 t/ha and 1.94 t/ha, respectively (**Table 2**). Pendimethalin + imazethapyr (RM) 1000 g/ha PE *fb* mechanical weeding at 30 DAS recorded maximum haulm yield (2.62 t/ha) which was followed by pendimethalin 1000 g/ha as PE *fb* mechanical weeding at 20 and 40 DAS (2.18 t/ ha). Improvement in seed yield and straw yield in these treatments was due to the significant reduction in weed density and biomass that resulted in less crop weed competition.

The economic analysis revealed highest benefit-cost ratio of 3.27 with pendimethalin + imazethapyr (RM) 1000 g/ha PE *fb* mechanical weeding at 30 DAS (3.27), which was equally superior to oxyfluorfen 140 g/ha PE *fb* mechanical weeding at 20 and 40 DAS (3.05) and pendimethalin 1000 g/ha PE *fb* mechanical weeding at 20 and 40 DAS (2.99). Net returns with highest with pendimethalin + imazethapyr (RM) 1000 g/ha PE *fb* mechanical weeding at 30 DAS due to higher seed yield on account of low crop weed competition as evident from the higher weed control efficiency and lower weed index.

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