RESEARCH ARTICLE Legume Research- An International Journal, Volume 47 Issue 1: 126-131 (January 2024)

Improved Herbicide Efficacy through Sole and Sequential Application of Herbicides for Higher Productivity of Urdbean (*Vigna mungo*) in Indian Semi-arid Tropics

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10.18805/LR-4885

ABSTRACT

Background: Weeds are major factor that leads to increase crop-weed competition and adversely effects of on growth, quality and yield of urdbean during *kharif* season. In urdbean the critical period for crop weed competition was the first 25-30 days; yields can be reduced by 50-90%, if weeds were not controlled during this period. As a result, successful weed management strategies to achieve increased growth and yield. Due to the ease, lower cost, timeliness and success controlling weeds, the progressive transformation of agriculture involving intensive use of herbicides has gained traction in recent years.

Methods: During *kharif* season 2019, a field experiment was undertaken at the Agricultural Research Station of Ummedganj, Kota, comprising ten weed management strategies, laid out in a randomised complete block design with three replications.

Result: Two hand weedings at 20 and 40 DAS recorded significantly lower weeds dry matter, higher weed control efficacy, ultimately culminating in improved yield attributes and yield, compared to weedy check. This treatment was at par with pendimethalin 30% EC @ 1 kg a.i. ha^{-1} fb propaquizafop 2.5% w w^{-1} @ 33.3 g a.i. ha^{-1} + imazethapyr 3.75% w w^{-1} (pre mix) ME @ 50 g a.i. ha^{-1} at 20 DAS resulting in significantly higher pods $plant^{-1}$ (13.67), seeds pod^{-1} (6.33), test weight (28.47 g), grain (827 kg ha^{-1}), straw (1393 kg ha^{-1}), biological (2221 kg ha^{-1}) and harvest index (37.26%) of urdbean over the other chemical based treatment.

Key words: Crop-weed competition, Hand weeding, Urdbean, Weed management.

INTRODUCTION

Agriculture accounts for roughly 17.0% of national GDP and about 70% of the population is reliant on agriculture and allied activities for their livelihood (Anonymous, 2019). Pulses, which have a high amount of protein (20-25%) contribute about 14% of total protein supplements in the Indian diet. According to the Indian Council of Medical Research (ICMR), the minimum requirement for pulse is 70 gm $capita^{-1}$ day^{-1}, while only 35.8 grammes per person per day are available (Chopra, 2018).

Among pulses, urdbean (*Vigna mungo* L.) is one of India's most important crops grown on 4.48-million-hectare area, producing 2.83 million tonnes with an average productivity of 641 kg ha^{-1} (Directorate of Economics and Statics, 2018-19). It contains 48.0% carbohydrates, 22.3% protein, 154 mg calcium, 9.1 mg iron, 1.4 g fat, 0.37 g riboflavin and 0.42 mg thiamine in 100 gm^{-1} (Asaduzzaman *et al.,* 2010). During *kharif* (rainy) season, weeds are a major threat to urdbean productivity posing enormous competition for nutrients, water, light and space, especially during the early stages of crop growth. Because the crop is a poor weed competitor and yield losses ranging from 42-64% have been reported depending on the nature, density and duration of occurrence of crop-weed competition (Singh, 2011 and Choudhary *et al.*, 2012). Weeds not only diminish the grain production but also deplete the soil minerals (Kaur *et al.*, 2010). Hence, there is a need to find out the effective weed management practices to appreciate better growth and higher yield. Mechanical practices such as hand weeding (HW) and interculture operations are effective in controlling weed infestations under check but field operations are frequently hampered by labour shortages, high labour costs and incessant rains (Nath *et al.*, 2016). Then, chemical weeding becomes essential in such situations and can be a decent alternative to HW. Chemical weed treatments are a good alternative to manual and mechanical weeding since they provide a weed-free environment during the first 30-35 days of growth (Das and Yaduraju, 2012). Therefore, keeping

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How to cite this article: Dhayal, S., Yadav, S.L., Meena, V.K., Choudhary, M. and Priyanka (2024). Improved Herbicide Efficacy through Sole and Sequential Application of Herbicides for Higher Productivity of Urdbean (*Vigna mungo*) in Indian Semi-arid Tropics. Legume Research. 47(1): 126-131. doi: 10.18805/LR-4885.

Submitted: 28-01-2022 **Accepted:** 04-05-2022 **Online:** 09-05-2022

above facts in view, the present study was undertaken to assess the effect of different weed management strategies in *kharif* season with better efficacy and high productivity.

MATERIALS AND METHODS

During the *kharif* season 2019, a field experiment was carried out at the Agricultural Research Station, Ummedganj, Kota, to assess the impact of various weed management strategies on weeds dry matter, weed control efficiency and ultimately the final harvest. The study involved ten treatments; T_1- weedy check, T_2- two hand weeding at 20 and 40 DAS (day after sowing), T_3- pendimethalin 30% EC @ 1 kg ha^{-1} (PE, pre-emergence); T_4- propaquizafop 2.5% w w^{-1} @ 33.3 g a.i. ha^{-1} + imazethapyr 3.75% w w^{-1} (pre mix) ME(Micro emulsions) @ 50 g a.i. ha^{-1} at 20 DAS, T_5- acifluorfen-sodium 16.5% EC (Emulsifiable concentrate) @ 140 g a.i. ha^{-1} + clodinafop-propargyl 8% EC @ 70 g a.i. ha^{-1} at 20 DAS, T_6- fomesafen 11.1% w w^{-1} @ 220 g a.i. ha^{-1} + fluazifop-p-butyl 11.1% w w^{-1} @ 220 g a.i. ha^{-1} at 20 DAS, T_7- pendimethalin 30% EC @ 1 kg a.i. ha^{-1} fb propaquizafop 2.5% w w^{-1} @ 33.3 g a.i. ha^{-1} + imazethapyr 3.75% w w^{-1} (pre mix) ME @ 50 g a.i. ha^{-1} at 20 DAS, T_8- pendimethalin 30% EC @ 1 kg a.i. ha^{-1} fb acifluorfen-sodium 16.5% EC @ 140 g a.i. ha^{-1} + clodinafop-propargyl 8% EC @ 70 g a.i. ha^{-1} at 20 DAS, T_9- pendimethalin 30% EC @ 1 kg a.i. ha^{-1} fb fomesafen 11.1% w w^{-1} @ 220 g a.i. ha^{-1} + fluazifop-p-butyl 11.1% w w^{-1} @ 220 g a.i. ha^{-1} at 20 DAS and T_{10}- fluazifop-p-butyl 13.4% EC @ 250 g a.i. ha^{-1} at 20 DAS which were evaluated in randomized complete block design with three replications. The size of experimental plots was 3.8 m broad and 4.0 m long. Weeds dry matter data was obtained using 0.5 m^2 quadrat at 2/3 random places in each treatment plot, then transformed to the square root of transformation ($\sqrt{x + 0.5}$) to normalize their distribution. The collected weed samples were then dried in an oven for 48 hours at 70°C till the constant weight is attained. Treatment wise weed control efficiency (WCE) was computed by using the formula as describes by Umrani and Boi (1982) as:

$$WCE\ (\%) = \frac{DMC - DMT}{DMC} \times 100$$

Where,
WCE (%) = Weed control efficiency.
DMC = Weed dry weight in weedy check plot.
DMT = Weed dry weight in treated plot.

The harvest index (HI) was calculated by the following formula a referred by Donald and Hamblin (1976) and expressed in %.

$$Harvest\ index\ (\%) = \frac{Economic\ yield\ (kg\ ha^{-1})}{Biological\ yield\ (kg\ ha^{-1})} \times 100$$

Statistical analysis

All of the data was subjected to analysis of variance (ANOVA). At P=0.05, critical difference (CD) was used to compare the treatment means. In order to evaluate the link between distinct traits as stated by Panse and Sukhatme (1978), correlation experiments were conducted.

RESULTS AND DISCUSSION

The field experiment was considerately examination during crop growth stages to look the occurrence of different weed species at the particular stage (Fig 1). It was observed that three types of weeds were found in experiment trail *i.e.*, monocot, dicot and sedge weeds. Among the monocot weeds *Cynodon dactylon* and *Echinochloa crusgalli* were the most prominent weeds. The dicot weeds *viz., Digera arvensis* and *Celosia argentea* were prominent. *Cyperus rotundus* was the prominent sedge. Similar botanic compositions of weeds were also reported by Singh *et al.* (2022) and Poornima *et al.* (2018). The share of monocot, dicot and sedge weeds of total weeds were 34.00, 49.46 and 17.18%, respectively. Weed dry matter of monocot, dicot, others and total weeds at 30, 60 DAS and at harvest in urdbean given in Table 1 to 3 respectively.

Effect on weeds

The treatment T_2 (Two hand weeding at 20 and 40 DAS) recorded significantly lowest weeds dry matter accumulation of monocots {*Cynodon dactylon* (3.86, 4.30 and 3.08 kg ha^{-1}), *Echinochloa crusgalli* (4.73, 5.18 and 4.41 kg ha^{-1}), *Eleusine indica* (4.44, 4.56 and 3.13 kg ha^{-1}), *Commelina benghalensis* (3.33, 2.18 and 1.34 kg ha^{-1})}; dicot {*Digera arvensis* (4.18,4.38 and 3.03 kg ha^{-1}), *Celosia argentea* (3.24, 3.58 and 2.67 kg ha^{-1}), *Trianthema spp* (4.04, 4.26 and 2.97 kg ha^{-1}), *Parthenium hysterophorus* (2.91, 3.18 and 2.11 kg ha^{-1})}; sedge {*Cyperus rotundus* (3.23, 3.64 and 2.40 kg ha^{-1})}; others (5.42, 5.64 and 4.18 kg ha^{-1}) and total weeds (12.21, 13.01 and 9.44 kg ha^{-1}) followed by T_7 (Pendimethalin (PE) fb propaquizafop + imazethapyr) during 30, 60 DAS and at harvest of crop and in case of *Echinochlona crusagli* application of T_4, T_5 also found at par with T_6 at 30 DAS.

Whereas, dry matter accumulation of *Parthenium hysterophorus* under application of T_4 was remained at par with T_7 and in case of *Commelina benghalensis*, the application of T_{10} bring non-significant differences with T_7 at 60 DAS. While, in case of *Echinochloa crusgalli*, the application of T_{10} also caused non-significant differences with T_7 at harvest of crop.

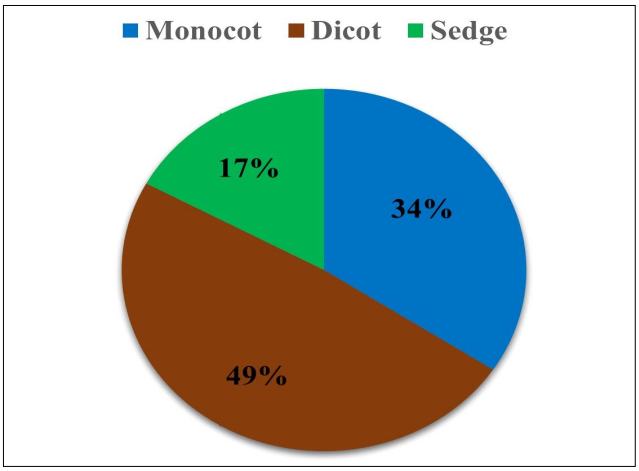


Fig 1: Occurrences of weed species (%) in urdbean as influenced by weed management practices.

Table 1: Effect of herbicides on dry matter accumulation (kg ha^{-1}) by different weeds at 30 DAS.

Treatments	Dicot			Sedge		Monocot				Other weeds	Total weeds
	Parthenium hysterophorus	*Digera arvensis*	*Trianthema spp*	*Celosia argentea*	*Cyperus rotundus*	*Echinochloa crusgalli*	*Eleusine indica*	*Cynodon dactylon*	*Commelina benghalensis*		
T_1	(41.00) 6.44*	(94.00) 9.72	(133.33) 11.56	(66.27) 8.17	(52.44) 7.27	(124.00) 11.13*	(116.67) 10.82	(59.56) 7.75	(32.67) 5.76	(244.67) 15.66	(964.60) 31.06
T_2	(8.00) 2.91	(17.00) 4.18	(15.83) 4.04	(10.00) 3.24	(9.93) 3.23	(22.00) 4.73	(19.27) 4.44	(14.40) 3.86	(3.33) 1.93	(28.83) 5.42	(148.60) 12.21
T_3	(27.67) 5.30	(40.67) 6.42	(61.33) 7.85	(34.33) 5.90	(30.57) 5.57	(62.00) 7.91	(62.33) 7.93	(40.44) 6.40	(10.83) 3.37	(101.33) 10.09	(471.51) 21.73
T_4	(17.90) 4.29	(32.33) 5.73	(54.67) 7.43	(28.50) 5.38	(22.22) 4.76	(45.33) 6.76	(46.00) 6.82	(33.56) 5.84	(9.60) 3.18	(71.00) 8.46	(361.11) 19.02
T_5	(18.63) 4.37	(35.33) 5.98	(56.67) 7.56	(29.13) 5.44	(22.60) 4.81	(47.33) 6.92	(47.67) 6.94	(37.33) 6.15	(10.67) 3.34	(73.33) 8.59	(378.70) 19.47
T_6	(18.37) 4.34	(34.67) 5.93	(56.33) 7.54	(29.00) 5.43	(22.33) 4.78	(46.33) 6.84	(46.33) 6.84	(34.67) 5.93	(10.27) 3.28	(73.00) 8.57	(371.30) 19.28
T_7	(14.00) 3.81	(22.67) 4.81	(43.33) 6.62	(18.90) 4.40	(17.33) 4.22	(35.00) 5.96	(25.57) 5.11	(25.33) 5.07	(7.97) 2.91	(49.00) 7.04	(259.10) 16.11
T_8	(14.83) 3.91	(23.80) 4.93	(45.33) 6.77	(20.33) 4.56	(18.02) 4.30	(37.00) 6.12	(26.53) 5.20	(28.89) 5.38	(8.53) 3.01	(52.33) 7.27	(275.61) 16.62
T_9	(14.27) 3.84	(22.93) 4.84	(44.33) 6.70	(19.67) 4.49	(17.56) 4.24	(35.67) 6.01	(25.93) 5.14	(26.22) 5.15	(8.50) 3.00	(51.67) 7.22	(266.74) 16.35
T_{10}	(22.93) 4.84	(36.67) 6.10	(57.00) 7.58	(31.00) 5.61	(20.33) 4.56	(38.67) 6.26	(27.67) 5.30	(27.00) 4.98	(10.73) 3.35	(79.67) 8.95	(351.66) 18.69
SEm±	0.91	1.18	2.69	0.74	0.90	4.30	1.34	2.06	0.40	1.89	5.98
CD (P=0.05)	2.71	3.49	8.00	2.21	2.68	12.77	3.99	6.11	1.20	5.61	17.77
CV (%)	7.99	5.65	8.21	4.48	6.69	15.08	5.24	10.89	6.18	3.96	2.69

*($\sqrt{x + 0.5}$) Subjected to square root transformation values and Data in parenthesis are original values.

Table 2: Effect of herbicides on dry matter accumulation (kg ha^{-1}) by different weeds at 60 DAS.

Treatments	Dicot			Sedge		Monocot				Other weeds	Total weeds
	Parthenium hysterophorus	*Digera arvensis*	*Trianthema spp*	*Celosia argentea*	*Cyperus rotundus*	*Echinochloa crusgalli*	*Eleusine indica*	*Cynodon dactylon*	*Commelina benghalensis*		
T_1	(55.00) 7.44*	(104.00) 10.22	(151.00) 12.31	(75.33) 8.71	(74.67) 8.67	(135.00) 11.64*	(126.33) 11.26	(78.33) 8.88	(37.00) 6.12	(255.00) 15.98	(1091.67) 33.05
T_2	(9.67) 3.18	(18.67) 4.38	(17.67) 4.26	(12.33) 3.58	(12.00) 3.64	(26.33) 5.18	(20.33) 4.56	(18.00) 4.30	(4.33) 2.18	(29.33) 5.64	(168.67) 13.01
T_3	(30.67) 5.58	(45.00) 6.75	(66.33) 8.17	(37.33) 6.14	(37.67) 6.18	(66.67) 8.20	(64.00) 8.03	(54.67) 7.42	(11.83) 3.51	(106.00) 10.32	(520.17) 22.82
T_4	(19.67) 4.49	(36.00) 6.04	(57.33) 7.60	(31.33) 5.64	(27.67) 5.30	(49.33) 7.06	(48.33) 6.99	(39.33) 6.31	(11.73) 3.33	(74.33) 8.65	(395.07) 19.86
T_5	(21.33) 4.67	(38.33) 6.23	(60.00) 7.77	(32.67) 5.76	(28.53) 5.39	(51.67) 7.22	(49.67) 7.08	(41.00) 6.44	(11.67) 3.49	(76.33) 8.76	(411.20) 20.29
T_6	(21.00) 4.64	(37.67) 6.18	(58.33) 7.67	(32.00) 5.70	(28.23) 5.36	(50.67) 7.15	(48.67) 7.01	(39.67) 6.34	(11.27) 3.43	(76.00) 8.74	(403.50) 20.10
T_7	(16.67) 4.14	(26.00) 5.15	(46.00) 6.82	(20.00) 4.49	(18.93) 4.41	(39.33) 6.31	(27.33) 5.27	(26.33) 5.18	(8.97) 3.07	(52.33) 7.27	(281.90) 16.80
T_8	(17.33) 4.22	(27.67) 5.30	(48.33) 6.99	(22.67) 4.81	(19.60) 4.48	(42.00) 6.52	(28.33) 5.37	(29.00) 5.43	(9.53) 3.17	(55.00) 7.45	(299.47) 17.32
T_9	(17.00) 4.18	(26.67) 5.21	(46.33) 6.84	(21.33) 4.63	(19.00) 4.41	(40.33) 6.39	(27.67) 5.31	(27.00) 5.24	(9.50) 3.16	(54.67) 7.42	(289.50) 17.03
T_{10}	(24.67) 5.01	(39.33) 6.31	(61.67) 7.88	(33.33) 5.81	(19.93) 4.52	(44.53) 6.71	(31.40) 5.65	(31.40) 5.65	(10.60) 3.50	(82.33) 9.10	(379.20) 19.51
SEm±	1.16	1.45	1.56	2.53	1.19	1.19	0.84	1.12	0.65	2.00	6.04
CD (P=0.05)	3.45	4.31	4.63	7.50	3.52	3.53	2.50	3.33	1.93	5.94	17.94
CV (%)	8.64	6.29	4.40	13.74	7.18	3.77	3.09	5.04	8.88	4.02	2.47

*($\sqrt{x + 0.5}$) Subjected to square root transformation values and data in parenthesis are original values.

Table 3: Effect of herbicides on dry matter accumulation (kg ha^{-1}) by different weeds at harvest.

Treatments	Dicot			Sedge		Monocot			Other weeds	Total weeds
	Parthenium hysterophorus	*Digera arvensis*	*Trianthema spp*	*Celosia argentea*	*Cyperus rotundus*	*Echinochloa crusgalli*	*Eleusine indica*	*Cynodon dactylon*	*Commelina benghalensis*	
T_1	(36.00) 6.04*	(85.00) 9.24	(119.00) 10.93	(49.12) 7.04	(49.00) 7.04	(105.00) 10.27*	(97.00) 9.87	(51.00) 7.17	(25.83) 5.13	(132.90) 11.54	(749.85) 27.39
T_2	(4.00) 2.11	(8.67) 3.03	(8.33) 2.97	(6.67) 2.67	(5.33) 2.40	(19.00) 4.41	(9.33) 3.13	(9.00) 3.08	(1.40) 1.34	(17.00) 4.18	(88.73) 9.44
T_3	(21.67) 4.70	(30.19) 5.54	(54.00) 7.38	(30.00) 5.52	(25.67) 5.11	(52.33) 7.27	(52.67) 7.29	(38.33) 6.22	(8.43) 2.99	(76.67) 8.78	(389.96) 19.76
T_4	(15.33) 3.98	(23.83) 4.93	(46.33) 6.84	(22.33) 4.78	(19.00) 4.41	(36.99) 6.12	(33.16) 5.80	(30.00) 5.52	(7.20) 2.77	(60.67) 7.82	(294.85) 17.18
T_5	(16.33) 4.10	(25.00) 5.05	(48.00) 6.96	(25.00) 5.05	(20.33) 4.56	(37.52) 6.17	(34.57) 5.92	(35.00) 5.96	(8.27) 2.96	(62.67) 7.95	(312.70) 17.70
T_6	(16.00) 4.06	(24.33) 4.98	(47.67) 6.94	(24.33) 4.98	(19.52) 4.47	(37.19) 6.14	(34.05) 5.88	(32.00) 5.70	(7.87) 2.89	(61.33) 7.86	(304.29) 17.46
T_7	(10.33) 3.29	(18.33) 4.34	(34.00) 5.87	(13.67) 3.75	(14.66) 3.89	(28.00) 5.34	(19.67) 4.49	(22.09) 4.75	(5.57) 2.46	(37.67) 6.18	(203.98) 14.30
T_8	(11.67) 3.49	(20.00) 4.52	(35.33) 5.99	(14.67) 3.89	(15.33) 3.98	(30.33) 5.55	(20.67) 4.60	(26.00) 5.15	(6.13) 2.58	(39.67) 6.34	(219.80) 14.84
T_9	(10.67) 3.34	(19.67) 4.49	934.67) 5.93	(14.00) 3.80	(15.00) 3.94	(29.93) 5.51	(20.33) 4.56	(24.33) 4.98	(6.10) 2.57	(38.00) 6.20	(212.70) 14.60
T_{10}	(18.00) 4.30	(26.33) 5.18	(50.00) 7.11	(25.67) 5.11	(17.43) 4.23	(31.00) 5.61	(25.33) 5.02	(28.56) 5.39	(8.33) 2.97	(67.67) 8.26	(298.33) 17.28
SEm±	0.99	1.29	1.31	0.87	0.85	1.90	1.89	1.33	0.36	2.89	7.16
CD (P=0.05)	2.95	3.82	3.90	2.57	2.52	5.66	5.62	3.95	1.08	8.59	21.26
CV (%)	10.77	7.93	4.76	6.65	7.31	8.10	9.45	7.78	7.39	8.43	4.03

*$\sqrt{(x + 0.5)}$ Subjected to square root transformation values and data in parenthesis are original values.

The highest weed dry matter observed in T_1 (Weedy check) (Table 1 to 3). Propaquizafop inhibit ACCase enzyme at the initial stage of fatty acid synthesis this leads to killing most of monocot weeds same time Imezathyper control dicot weeds by inhibiting of acetolactate synthase (ALS) and this leads to death of synthase (ALS) and this leads to death of weeds. These results were in harmony with Susmitha *et al.* (2019) and Sahu *et al.* (2019) findings.

Highest weed control efficiency (84.57, 84.54 and 88.14%) recorded by T_2 (Two hand weeding at 20 and 40 DAS) followed by the T_7 [Pendimethalin (PE) fb propaquizafop + imazethapyr] and T_9 [Pendimethalin (PE) fb fomesafen + fluazifop-p-butyl] during at 30, 60 DAS and at harvest (Table 4). Pendimethalin (PE) fb propaquizafop + imazethapyr was recorded highest WCE might be because of T_7 treatment was records lowest weed population during initial growing period and HW records lowest weed population at critical crop-weed competition as compared to all other treatments. Singh *et al.* (2022); Meena *et al.* (2022) and Poornima *et al.* (2018) were also found similar results.

Effect on yield attributes

The data can be recorded and analyzed for yield attributing characters of urdbean (Table 4). Among the different treatment maximum number of pods plant^{-1} (13.87), seeds pod^{-1} (6.43) was observed under two hand weeding at 20 and 40 DAS and which was found to be at par with pendimethalin (PE) fb propaquizafop + imazethapyr and pendimethalin (PE) fb fomesafen + fluazifop-p-butyl. Yield attributes of urdbean might vary due to differences in growth parameters such dry matter production and weed population. Plant height, number of branches per plant, number of leaves and LAI all contributed to DM production. Two hand weeding resulted in good aeration and nutrient availability to crop growth throughout vital crop growth phase due to increased availability of water, space, nutrients to the crop plant and reduce crop-weed competition during the critical crop growth stage. Panda *et al.* (2015) and Kumar *et al.* (2018) were also found the Similar results.

Effect on yield of urdbean

All the weed control treatments were found to be significantly superior over the weedy check treatment shown in Table 4. During the year, treatment T_2 (Two hand weeding at 20 and 40 DAS) recorded significantly more grain yield (859 kg ha^{-1}), straw yield (1434 kg ha^{-1}), biological yield (2292 kg ha^{-1}) and harvest index (37.47%) which was at par with T_7 (Pendimethalin (PE) fb propaquizafop + imazethapyr) and T_9 (Pendimethalin (PE) fb fomesafen + fluazifop-p-butyl) and significantly superior over rest of treatments. It could be attributed to manual weeding reducing weed population and dry weight, as well as inhibition of weed development owing to higher plant density and lower spacing. T_1 (Weedy check) treatment resulted in a lower grain yield (395 kg ha^{-1}). Under present study existence of high positive correlation (Fig 2) between pods/plant and seeds/pod (r = 0.927 and 0.967, respectively) on grain yield, also validate the said statement. Similarly, total weed dry matter at 30, 60 DAS and at harvest was also has negative correlation (Fig 3) with grain yield

Table 4: Effect of herbicides on yield attributes yield and harvest index and weed control efficiency.

Treatments	Yield attributes			Yield (kg ha^{-1})			Harvest index (%)	Weed control efficiency (%)		
	Pods plant^{-1} (Nos)	Seeds pod^{-1} (Nos)	Test weight (g)	Grain	Straw	Biological		30 DAS	60 DAS	At harvest
T_1	6.77	4.63	26.13	395	926	1321	29.90	0.00	0.00	0.00
T_2	13.87	6.43	29.03	859	1434	2292	37.47	84.57	84.54	88.14
T_3	10.17	5.47	26.27	503	1056	1559	32.36	51.09	52.34	47.92
T_4	11.33	5.67	26.87	630	1140	1770	35.53	62.54	63.79	60.64
T_5	11.07	5.60	26.77	565	1136	1701	33.00	60.73	62.31	58.25
T_6	11.13	5.63	26.80	610	1139	1749	34.84	61.48	63.02	59.39
T_7	13.67	6.33	28.47	827	1393	2221	37.26	73.12	74.18	72.75
T_8	13.43	5.87	27.59	661	1185	1847	35.81	71.40	72.56	70.64
T_9	13.53	6.17	28.33	775	1318	2094	37.05	72.34	73.49	71.61
T_{10}	10.13	5.37	26.17	483	1055	1538	31.47	63.80	65.25	60.23
SEm±	0.20	0.24	0.70	32.02	35.72	40.90	1.46	0.40	0.44	0.61
CD (P=0.05)	0.59	0.70	NS	95.13	106.13	121.53	4.33	1.18	1.30	1.81
CV (%)	2.97	7.13	4.42	8.79	5.25	3.92	7.33	1.14	1.24	1.79

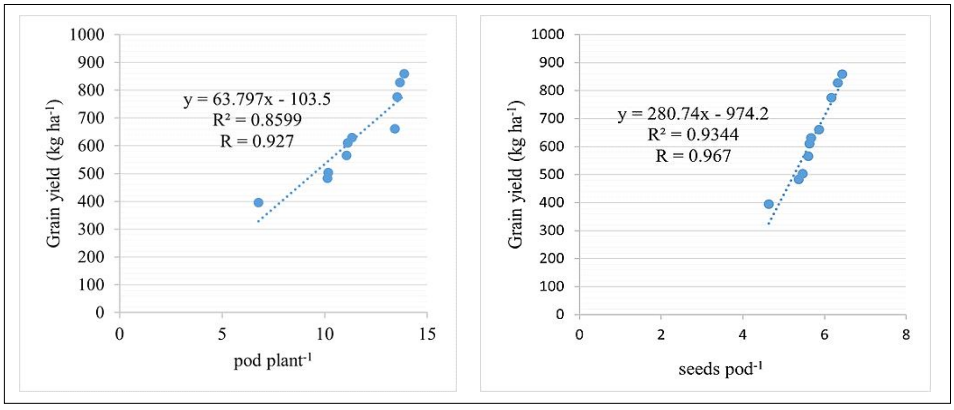


Fig 2: Correlation of grain yield and pod plant^{-1} and seeds pod^{-1} of urdbean crop.

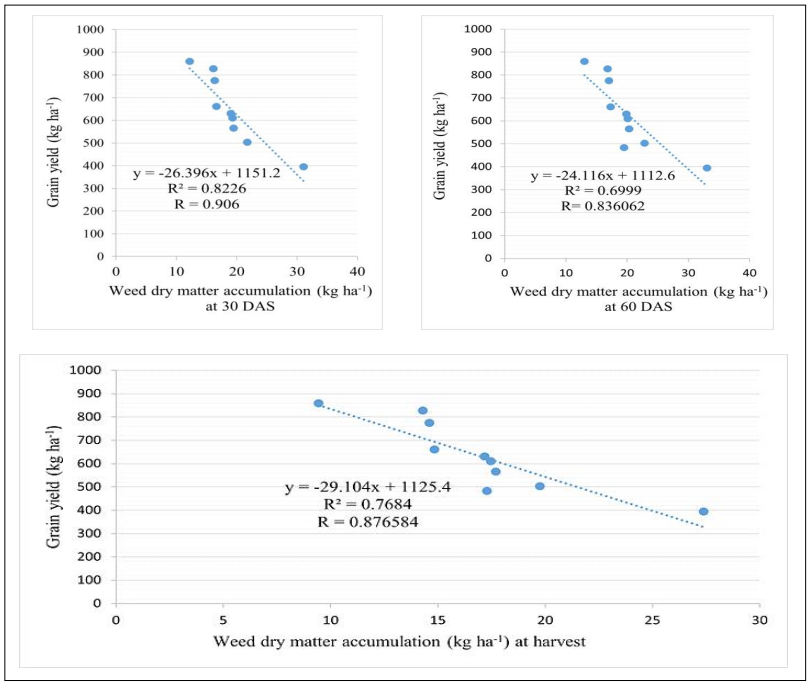


Fig 3: Correlation of grain yield and weed dry matter accumulation at 30, 60 DAS and at harvest.

(r = -0.906, -0.836 and -0.876) shown in Fig 3. These finding are in agreement with results of Singh *et al.* (2022) and Sandil *et al.* (2015).

CONCLUSION

The study results conclude that application of Pendimethalin 30% EC @ 1 kg a.i. ha^{-1} (PE) fb propaquizafop 2.5% w w^{-1} @ 33.3 g a.i. ha^{-1} + imazethapyr 3.75% w w^{-1} (pre mix) ME @ 50 g a.i. ha^{-1} at 20 DAS may be recommended for attaining better weed control and higher crop yield in *kharif* urdbean under semi-arid condition.

Conflict of interest

On the behalf of all authors state that it is an original article and the data presented have neither been published in part nor under consideration for publication in any other journal. All the authors declare no conflicts of interest regarding this article.

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