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EFFECT OF WEED MANAGEMENT PRACTICES ON YIELD ATTRIBUTES AND WEED BIOMASS OF URDBEAN (*VIGNA MUNGO* L.) IN *VERTISOL*OF CHHATTISGARH PLAINS

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Abstract
Background: A field experiment was carried out during the *kharif* seasons of 2021 and 2022 at the Instructional-cum-Research Farm of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.). The experimental soil was clayey (Vertisol), neutral in pH, medium in organic carbon, low in available nitrogen and phosphorus, and high in available potassium.
Methods: The experiment was laid out in a randomized block design with three replications, comprising eight treatments: T_1–Imazethapyr 10% SL (55 g a.i. ha^{-1}), T_2–Fluazifop-p-butyl 13.4% (250 g a.i. ha^{-1}), T_3–Propaquizafop 2.5% + Imazethapyr 3.75% ME (ready-mix, 83.3 g a.i. ha^{-1}), T_4–Acifluorfen-sodium 16.5% EC + Clodinafop-propargyl 8% EC (ready-mix, 210 g a.i. ha^{-1}), T_5–Fomesafen 11.1% + Fluazifop-p-butyl 11.1% (ready-mix, 440 g a.i. ha^{-1}), T_6–Hand weeding at 20 and 40 DAS, T_7–Weed-free (hand weeding at 20, 40, and 60 DAS), and T_8–Unweeded control.
Results: The dominant weed flora at the site included *Echinochloa colona*, *Dinebra retroflexa*, *Parthenium hysterophorus*, *Celosia argentea*, and *Cyperus* spp. Among the treatments, T_5 (fomesafen + fluazifop-p-butyl) recorded the highest yield attributes, which were statistically at par with T_3 (propaquizafop + imazethapyr) and T_4 (acifluorfen-sodium + clodinafop-propargyl). These treatments also significantly reduced weed biomass compared to others. Furthermore, they exhibited higher weed control efficiency (WCE) and lower weed index than the unweeded control (T_8).

KEYWORDS: Fomesafen, fluazifop-p-butyl, urdbean, weed biomass and weed control efficiency and weed index.

INTRODUCTION

Urdbean (*Vigna mungo* L.), commonly known as blackgram, is an important *kharif* pulse crop primarily cultivated under marginal and sub-marginal conditions, often without proper weed management practices. It originated in South Asia and is widely grown in tropical and subtropical regions including India, Pakistan, Sri Lanka, Myanmar, and other Southeast Asian countries. In India, major urdbean-producing states include Madhya Pradesh, Andhra Pradesh, Bihar, Maharashtra, Punjab, Haryana, Tamil Nadu, Uttar Pradesh, West Bengal, and Karnataka. During 2019–2020, urdbean was cultivated over an area of 4533 thousand hectares with a production of 2081 thousand tonnes and an average productivity of 459 kg ha^{-1} (Indiastat). In Chhattisgarh, the crop occupied 75.44 thousand hectares with a production of 24.99 thousand tonnes and productivity of 331 kg ha^{-1} during the same period. Urdbean is nutritionally rich, containing about 24% protein, 59.69–63.00% carbohydrates, 1.4–1.6% fat, and 154 mg calcium per 100 g, along with essential amino acids, minerals, and vitamins.Weed competition is a major constraint in urdbean cultivation, with the critical period ranging from 20 to 40 days after sowing (DAS). Yield losses due to weeds can vary from 40 to 85%, as reported in different regions such as Pantnagar (Uttarakhand), Madhya Pradesh, and Punjab (Sharma and Yadav, 2006; Kushwah and Vyas, 2005; Parvender et al., 2006). Therefore, effective weed management, particularly through chemical means, is crucial for improving productivity.

MATERIALS AND METHODS

The experiment was conducted during the *kharif* seasons of 2021 and 2022 at the Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh). The experimental soil was clayey (Vertisol), neutral in reaction, medium in organic carbon, low in available nitrogen and phosphorus, and high in available potassium. The study was laid out in a randomized block design with three replications, comprising eight treatments: T_1–Imazethapyr 10% SL (55 g a.i. ha^{-1}), T_2–Fluazifop-p-butyl 13.4% (250 g a.i. ha^{-1}), T_3–Propaquizafop 2.5% + Imazethapyr 3.75% ME. (ready mix, 83.3 g a.i. ha^{-1}), T_4–Acifluorfen-sodium 16.5% EC + Clodinafop-propargyl 8% EC (ready mix, 210 g a.i. ha^{-1}), T_5–Fomesafen 11.1% + Fluazifop-p-butyl 11.1% (ready mix, 440 g a.i. ha^{-1}), T_6–Hand weeding at 20 and 40 DAS, T_7–Weed-free (hand weeding at 20, 40, and 60 DAS), and T_8–Unweeded control. Yield attributes were recorded at crop harvest. Weed biomass (grasses, broadleaf weeds, and sedges) was measured at 20, 40, and 60 DAS, as well as at harvest. Weed control efficiency (WCE) was calculated using the formula proposed by Mani et al. (1973):WCE (%) = $[(Wd_{(c)} - Wd_{(t)}) / Wd_{(c)}] \times 100$ where $Wd_{(c)}$ represents weed biomass in the unweeded control and $Wd_{(t)}$ represents weed biomass in treated plots.

Weed index (WI), indicating the percentage reduction in yield due to weed presence compared to the weed-free plot, was calculated as per Gill and Kumar (1969): WI (%) = [(X − Y) / X] × 100 where X is the yield from the weed-free plot and Y is the yield from the treated plot. The recorded data were tabulated and subjected to statistical analysis. Weed biomass data were transformed using square root transformation prior to analysis of variance. Treatment effects were tested using the 'F' test, and differences among treatments were compared using the critical difference (CD) at the 5% level of significance (Gomez and Gomez, 1984).

RESULTS AND DISCUSSION

Yield Attributes

Yield attributes were significantly affected by different weed management practices. However, parameters such as number of seeds per pod, pod length, and seed index did not show any significant variation among treatments.

The number of pods per plant was significantly higher under the application of fomesafen 11.1% + fluazifop-p-butyl 11.1% (ready mix) (440 g a.i. ha^{-1}) (T_5), recording values of 19.53, 20.53, and 20.03 during 2021, 2022, and on a mean basis, respectively (Table 1). This treatment was found to be statistically at par with propaquizafop 2.5% + imazethapyr 3.75% ME (T_3) and acifluorfen-sodium 16.5% EC + clodinafop-propargyl 8% EC (T_4). Among all treatments, the weed-free condition (T_7) recorded the highest number of pods per plant (22.53, 24.67, and 23.60 during 2021, 2022, and mean, respectively), followed by hand weeding twice at 20 and 40 DAS (T_6). In contrast, the unweeded control (T_8) resulted in the lowest number of pods per plant (13.67, 13.33, and 13.50 during 2021, 2022, and mean, respectively).The improved performance under effective weed control treatments may be attributed to reduced weed biomass and higher weed control efficiency, which enabled the crop to utilize available resources more efficiently and compete better with weeds. Similar findings were also reported by Chaithanya et al. (2021).

Weed Flora The weed flora in the experimental field was predominantly composed of *Echinochloa colona*, *Dinebra retroflexa*, *Parthenium hysterophorus*, *Celosia argentea*, and *Cyperus* spp., along with other minor weed species.

Table 1: Effect of different herbicides on yield attributes of urdbean

Treatment	No. of pods plant-1			No. of seed pod-1			Seed index (g)		Pod length (cm)		
	2021	2022	Mean	2021	2022	Mean	2021	2022	Mean		
T1	16.37	17.33	16.85	6.33	6.60	6.47	3.77	3.80	3.78	6.07	6.07	6.07
T2	14.73	15.00	14.87	6.20	6.40	6.30	3.73	3.77	3.75	5.67	6.03	5.85
T3	18.33	20.00	19.17	6.73	6.87	6.80	3.83	3.90	3.87	6.10	6.17	6.13
T4	18.17	19.20	18.68	6.47	6.77	6.62	3.80	3.83	3.82	6.07	6.10	6.08
T5	19.53	20.53	20.03	7.27	7.33	7.30	3.90	3.97	3.93	6.13	6.23	6.18
T6	19.67	21.33	20.50	7.27	7.67	7.47	3.97	4.00	3.98	6.20	6.27	6.23
T7	22.53	24.67	23.60	7.53	7.67	7.60	4.03	4.10	4.07	6.43	6.74	6.59
T8	13.67	13.33	13.50	6.40	6.43	6.42	3.67	3.60	3.63	6.00	6.01	6.01
SEm±	**0.84**	**0.93**	**0.88**	**0.42**	**0.44**	**0.43**	**0.17**	**0.19**	**0.18**	**0.36**	**0.19**	**0.28**
CD(P=0.05)	**2.54**	**2.81**	**2.65**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

T1-Imazethapyr 10 % SL (Dose-55 g *a.i.* ha^{-1}), T2- Fluazifop-p-butyl 13.4% w w^{-1} (Dose-250 g *a.i.* ha^{-1}), T3-Propaquizafop 2.5% w w^{-1} + Imazethapyr 3.75 % w w^{-1} ME (ready mix) (Dose-83.3 g *a.i.* ha^{-1}), T4- Acifluorfen-sodium 16.5% EC + Clodinafop-propargyl 8% EC (ready mix) (Dose-210 g *a.i.* ha^{-1}), T5- Fomesafen 11.1% w w^{-1} + Fluazifop-p-butyl 11.1% w w^{-1} (ready mix) (Dose-440 g *a.i.* ha^{-1}), T6-Hand weeding twice at 20 and 40 DAS
, T7- Weed free (HW at 20, 40 and 60 DAS), T8- Unweeded check.

Table 2: Effect of different herbicides on weed index of urdbean

Treatments	Weed index (%)		
	2021	2022	Mean
T1	35.1	32.4	33.7
T2	42.5	44.3	43.4
T3	24.6	21.1	22.8
T4	27.0	23.3	25.1
T5	20.3	17.4	18.8
T6	14.2	12.8	13.5
T7	0.0	0.0	0.0
T8	52.4	59.7	56.2

T1-Imazethapyr 10 % SL (Dose-55 g *a.i.* ha^{-1}), T2- Fluazifop-p-butyl 13.4% w w^{-1} (Dose-250 g *a.i.* ha^{-1}), T3-Propaquizafop 2.5% w w^{-1} + Imazethapyr 3.75 % w w^{-1} ME (ready mix) (Dose-83.3 g *a.i.* ha^{-1}), T4- Acifluorfen-sodium 16.5% EC + Clodinafop-propargyl 8% EC (ready mix) (Dose-210 g *a.i.* ha^{-1}), T5- Fomesafen 11.1% w w^{-1} + Fluazifop-p-butyl 11.1% w w^{-1} (ready mix) (Dose-440 g *a.i.* ha^{-1}), T6-Hand weeding twice at 20 and 40 DAS, T7- Weed free (HW at 20, 40 and 60 DAS), T8- Unweeded check.

Table 3: Effect of different herbicides on total weed biomass (g m^{-2}) in different time interval in urdbean

Total weed biomass (g m^{-2})												
Treatment	**20 DAS**			**40 DAS**			**60 DAS**			**At harvest**		
	2021	**2022**	**Mean**	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**	**2021**	**2022**	**Mean**
T1	**5.12** (25.74)	**4.73** (21.84)	**4.93** (23.81)	**4.97** (24.20)	**4.58** (20.52)	**4.78** (22.32)	**6.82** (46.00)	**6.35** (39.85)	**6.59** (42.87)	**7.53** (56.15)	**7.04** (49.11)	**7.28** (52.57)
T2	**5.08** (25.30)	**4.95** (24.02)	**5.02** (24.65)	**7.12** (50.25)	**7.54** (56.34)	**7.33** (53.26)	**9.69** (93.47)	**10.60** (111.93)	**10.15** (102.50)	**10.65** (112.96)	**11.21** (125.08)	**10.93** (118.94)
T3	**5.11** (25.64)	**4.92** (23.67)	**5.01** (24.64)	**4.62** (20.80)	**4.27** (17.75)	**4.44** (19.25)	**6.36** (39.92)	**5.87** (33.97)	**6.11** (36.89)	**6.95** (47.79)	**6.33** (39.62)	**6.64** (43.64)
T4	**5.11** (25.61)	**4.88** (23.36)	**5.00** (24.47)	**4.82** (22.78)	**4.30** (17.96)	**4.56** (20.30)	**6.58** (42.83)	**6.04** (35.94)	**6.31** (39.31)	**7.17** (50.95)	**6.54** (42.28)	**6.86** (46.52)
T5	**5.01** (24.55)	**4.81** (22.64)	**4.91** (23.59)	**3.47** (11.55)	**3.16** (9.47)	**3.31** (10.49)	**4.78** (22.35)	**4.53** (20.01)	**4.65** (21.16)	**5.20** (26.52)	**5.10** (25.48)	**5.15** (26.00)
T6	**5.13** (25.87)	**4.64** (21.05)	**4.89** (23.40)	**2.21** (4.37)	**1.49** (1.72)	**1.85** (2.92)	**2.04** (3.67)	**1.39** (1.44)	**1.72** (2.45)	**2.42** (5.38)	**1.73** (2.48)	**2.07** (3.80)
T7	**5.08** (25.33)	**4.49** (19.67)	**4.79** (22.41)	**0.71** (0.00)	**0.71** (0.00)	**0.71** (0.00)	**0.71** (0.00)	**0.71** (0.00)	**0.71** (0.00)	**0.71** (0.00)	**0.71** (0.00)	**0.71** (0.00)
T8	**4.87** (23.23)	**4.84** (22.95)	**4.86** (23.09)	**9.79** (95.30)	**10.26** (104.72)	**10.02** (99.95)	**13.34** (177.52)	**14.38** (206.37)	**13.86** (191.68)	**14.55** (211.27)	**15.18** (229.95)	**14.87** (220.51)
SEm±	**0.14**	**0.24**	**0.19**	**0.13**	**0.20**	**0.15**	**0.30**	**0.27**	**0.29**	**0.34**	**0.41**	**0.38**
CD(P=0.05)	**NS**	**NS**	**NS**	**0.38**	**0.62**	**0.44**	**0.91**	**0.82**	**0.86**	**1.04**	**1.26**	**1.13**

Figures in parenthesis are the original values. Data were transformed to square root transformation $\sqrt{X + 0.5}$ are in bold letters T1-Imazethapyr 10 % SL (Dose-55 g *a.i.* ha^{-1})
T2- Fluazifop-p-butyl 13.4% w w^{-1} (Dose-250 g *a.i.* ha^{-1})
T3-Propaquizafop 2.5% w w^{-1} + Imazethapyr 3.75 % w w^{-1} ME (ready mix) (Dose-83.3 g *a.i.* ha^{-1})
T4- Acifluorfen-sodium 16.5% EC + Clodinafop-propargyl 8% EC (ready mix) (Dose-210 g *a.i.* ha^{-1})
T5- Fomesafen 11.1% w w^{-1} + Fluazifop-p-butyl 11.1% w w^{-1} (ready mix) (Dose-440 g *a.i.* ha^{-1})
T6-Hand weeding twice at 20 and 40 DAS
T7- Weed free (HW at 20, 40 and 60 DAS), T8- Unweeded check.

Table 4: Effect of different herbicides on weed control efficiency (%) in different time intervals in urdbean.

Weed control efficiency (%)									
Treatment		**40 DAS**	**60 DAS**			**At harvest**			
2021	**2022**	**Mean**	**2021**	**2022**	**Mean**	**2021**	**2022**		
T1 75.4	80.7	78.2	74.1	80.7	77.6	73.2	79.1	76.3	
T2 47.9	47.4	47.7	47.3	45.8	46.5	45.4	45.6	45.6	
T3 78.2	83.7	81.1	77.5	83.5	80.8	77.2	83.1	80.3	
T4 76.7	83.0	80.1	75.9	82.6	79.5	75.4	82.2	79.0	
T5 87.9	91.0	89.6	87.4	90.3	89.0	87.3	89.0	88.2	
T6 95.5	98.5	97.1	97.9	99.3	98.7	97.6	98.9	98.3	
T7 100.0		100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
T8 0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

T1-Imazethapyr 10 % SL (Dose-55 g *a.i.* ha^{-1})
T2- Fluazifop-p-butyl 13.4% w w^{-1} (Dose-250 g *a.i.* ha^{-1})
T3-Propaquizafop 2.5% w w^{-1} + Imazethapyr 3.75 % w w^{-1} ME (ready mix) (Dose-83.3 g *a.i.* ha^{-1}), T4- Acifluorfen-sodium 16.5% EC + Clodinafop-propargyl 8% EC (ready mix) (Dose-210 g *a.i.* ha^{-1}), T5- Fomesafen 11.1% w w^{-1} + Fluazifop-p-butyl 11.1% w w^{-1} (ready mix) (Dose-440 g *a.i.* ha^{-1}), T6-Hand weeding twice at 20 and 40 DAST7- Weed free (HW at 20, 40 and 60 DAS), T8- Unweeded check.

At 20 DAS there is no significant difference among all the treatments for total weed biomass production. At 40, 60 DAS and at harvest the significant reduction in total weed biomass production was recorded (10.49, 21.16 and 26.00 g m^{-2} on mean basis) (Table 3) under herbicide application fomesafen 11.1% w w^{-1} + fluazifop-p-butyl 11.1% w w^{-1} (ready mix) (Dose-440 g *a.i.* ha^{-1}) (T5) which was followed by propaquizafop 2.5% w w^{-1} + imazethapyr 3.75 % w w^{-1} ME (ready mix) (Dose-83.3 g *a.i.* ha^{-1}) (T3) and acifluorfen-sodium 16.5% EC + clodinafop-propargyl 8% EC (ready mix) (Dose-210 g *a.i.* ha^{-1})(T4). Further, weed free (T7) has minimum total weed biomass production followed by hand weeding twice at 20 and 40 DAS (T6) whereas, unweeded check (T8) resulted maximum total weed biomass production. The lower weed biomass under herbicidal treatments might be the more detrimental effect of the herbicides for the control of weed flora. Almost similar results were also observed by Singh *et al*. (2014), Kumar and Chinnamuthu (2014), Punia *et al*. (2015) and Gelot *et al*. (2018).
Among different herbicidal treatments maximum weed control efficiency at 40, 60 DAS and at harvest were recorded under fomesafen 11.1% w w^{-1} + fluazifop-p-butyl 11.1% w w^{-1} (ready mix) (Dose-440 g *a.i.* ha^{-1}) (T5)(89.6, 89.0 and 88.2 % on mean basis)(Table 4) followed by propaquizafop 2.5% w w^{-1} + imazethapyr 3.75 % w w^{-1} ME (ready mix) (Dose-83.3 g *a.i.* ha^{-1})(T3) and acifluorfen-sodium 16.5% EC + clodinafop-propargyl 8% EC (ready mix) (Dose-210 g *a.i.* ha^{-1})(T4). Furthermore, weed free (T7) recorded significantly the highest weed control efficiency 100 % on mean basis

followed by hand weeding twice at 20 and 40. All herbicidal treatments were found significantly superior to unweeded check (T8) regarding weed control efficiency. Among different herbicidal treatments minimum weed index was recorded under fomesafen 11.1% w w^{-1}+ fluazifop-p-butyl 11.1% w w^{-1} (ready mix) (Dose-440 g *a.i.* ha^{-1}) (T5) (20.3, 17.4 and 18.8% in year 2021, 2022 and mean, respectively) (Table 2) followed by propaquizafop 2.5% w w^{-1} + imazethapyr 3.75 % w w^{-1} ME (ready mix) (Dose-83.3 g *a.i.* ha^{-1})(T3) and acifluorfen-sodium 16.5% EC + clodinafop-propargyl 8% EC (ready mix) (Dose-210 g *a.i.* ha^{-1})(T4). The higher WCE and lower WI were recorded under herbicidal treatments due to lower crop-weed competition which reduced weed biomass accumulation as compare to unweeded check (T8). The similar findings also reported by Verma and Kushwaha (2020).

CONCLUSIONS

Based on the results of the present field study, it can be concluded that among the different weed management practices, the application of fomesafen 11.1% + fluazifop-p-butyl 11.1% (ready mix) @ 440 g a.i. ha^{-1} applied as a post-emergence treatment at 20 DAS (T_5) significantly improved yield attributes, enhanced weed control efficiency, and reduced weed biomass and weed index.

However, the weed-free treatment (T_7) proved to be the most effective in achieving superior performance for all these parameters, whereas the unweeded control (T_8) recorded the poorest results in urdbean cultivation.

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