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Efficacy of Pre and Post Emergence Application of Imazethapyr and its Ready Mix Herbicides on Growth, Weed Dynamics and Productivity of Chickpea (*Cicer arietinum* L.)

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ABSTRACT

Background: Weeds are major constraints in chickpea production. This crop is highly susceptible to weed competition owing to slow initial growth thus weeds cause up to 75% yield loss.

Methods: Treatments comprised of imazethapyr 50 g/ha as PE (pre emergence), imazethapyr 70 g/ha as PE, imazethapyr 50 g/ha as PoE (post emergence), imazethapyr 70g/ha as PoE, imazethapyr + imazamox ready mix (RM) 50 g/ha as PE, imazethapyr + imazamox (RM) 70 g/ha as PE, imazethapyr + imazamox (RM) 50 g/ha as PoE, imazethapyr + imazamox (RM) 70 g/ha as PoE, pendimethalin 1 kg/ha PE, imazethapyr + pendimethalin (RM) 1 kg/ha PE, hoeing at 20 and 40 DAS and weedy check.

Result: Application of imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence recorded maximum plant dry matter accumulation at 60, 90, 120 DAS and at maturity stage and also higher CGR at 60-90, 90-120 and120 DAS - maturity of crop. Application of imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence was most effective in producing higher seed yield (1749 kg/ha), weed control efficiency (87.28%), net return (₹ 77,136), reduced weed management index 5.15 and 3.90 at 30 and 60 DAS respectively.

Key words: Imazethapyr, Readymix, Weed control efficiency, Weed dry matter, Weed indices.

INTRODUCTION

Chickpea is a major winter season pulse crops in India. It accounts for 65% of total world production. It is a good source of protein (20-22%), rich in fiber, minerals, β-carotene and lipid fraction is high in unsaturated fatty acids. Among pulses it shares about 46% of total pulse production in India and it is preferred to food legumes (Siddique *et al*. 2000) in some regions because of its multiple uses. Chickpea has high level of protein content moreover, with reducing cardiovascular, diabetic and cancer risks as well as contains potentially health-beneficial phytochemicals (Wood and Grusak, 2007). The area production and productivity of chickpea in India is 10.17 m ha, 11.10 m t and 1091 kg/ha during 2017-18 (Chaturvedi *et al* 2018). Weeds are major constraints in chickpea production. A large number of grassy, broad leaved and sedges weeds affect chickpea production in all parts of country. Usually farmers perform manual weeding in chickpea but due to escalating labour wages and non availability at peak time the crop remains unweeded which reduce crop yield to a great extent. Chickpea is highly susceptible to weed competition and weeds cause up to 75% yield loss (Chaudhary *et al*. 2005). Solh and Pala (1990) reported 40-87% yield loss in chickpea due to weeds. Hence chemical method of weed control offers good scope to harvest a good crop yield. Among herbicides, imazethapyr, an imidazolinone group of herbicide, is popular in many pulse crops as pre or post emergence application, however reports on its ready mix with other herbicides, are meagre. Efficacy of imazethapyr and its readymix with other imidazolinone group has been studied in blackgram but such information on chickpea is lacking Hence an attempt has been made to evaluate the optimum dose and time of application of imazethapyr and its ready mix for effective control of weeds in chickpea.

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MATERIALS AND METHODS

A field experiment was conducted at Birsa Agricultural University, Ranchi during winter season of 2017-18 and 2018-19 under rainfed condition. The soil of experimental field was sandy loam in texture with slightly acidic in nature (pH 6.2), medium in organic carbon (0.48%), available potassium (114 kg/ha) and low in available phosphorus (17.35 kg/ha) and nitrogen (180 kg/ha). The treatments comprised of imazethapyr 10% 50 g/ha as pre emergence (T1), imazethapyr 10% 70 g/ha as pre emergence (T2), imazethapyr 10% 50 g/ha as post emergence (T3), imazethapyr 10% 70 g/ha as post emergence (T4), imazethapyr 35% + imazamox 35% ready mix (RM) 50 g/ha

as pre emergence (T5), imazethapyr 35% + imazamox 35% (RM) 70 g/ha as pre emergence (T6), imazethapyr 35%+ imazamox 35% (RM) 50 g/ha as post emergence (T7), imazethapyr 35% + imazamox 35% (RM) 70 g/ha as post emergence (T8), pendimethalin (38.7% Stomp xtra) 1 kg/ha (T9), imazethapyr + pendimethalin (RM) 32% 1 kg/ha (T10), hoeing at 20 and 40 DAS (T11) and weedy check (T12). The experiment was laid out in randomized block design replicated thrice. The crop was fertilized with 25:50:25:20 kg N: P_2O_5:K_2O: S per hectare through urea, single super phosphate and muriate of potash. The seed rate was 70 kg/ha. The chickpea var. KWR-108 was sown on 17th October and 19th October and was harvested on 2nd and 5th April of 2017-18 and 2018-19 respectively. Observations on weeds like weed density, weed dry matter was recorded from randomly selected two spots size 0.50 m x 0.50 m from each plot. The weeds were cut from above ground and separated and counted as grassy, broad leaved and sedges weeds. The weeds were sun dried to remove excess moisture. Thereafter they were kept in oven and were dried at 60±5°C till constant weight and thus their dry weight was recorded. The weed density and weed dry weight was square root transformed before analysis. The observation on plant dry matter was recorded at 30, 60, 90, 120 DAS (days after sowing) and at maturity. The plant samples were collected from border rows of plots at 50 cm row length and were sun dried and kept in oven for drying at 60±5°C till constant weight thus their dry weight was recorded. The dry weight values were converted to per m^2 basis. The plant heights, primary branches, secondary branches, number of pods per plant, number of seeds per plant were recorded prior to harvest of crop. The crop was harvested from net plot area. Seed and straw yield were recorded at 12% moisture content. Different weed indices were calculated by using following formula as suggested by Mishra and Misra (1997).

Weed management index (WMI)

$$WMI = [(YT-YC)/YC] / [(WC-WT)/WC]$$

Where,
YT= Yield of treated plot.
YC= Yield of control (weedy check) plot.
WC= Weed dry weight in control (weedy check) plot.
WT= Weed dry weight in treated plot.

Agronomic management index (AMI)

$$AMI = [(YT-YC)/YC] - [(WC-WT/WC)]/ (WC-WT)/WC)$$

Where,
YT = Yield of treated plot.
YC= Yield of control (weedy check) plot.
WC= Weed dry weight in control (weedy check) plot.
WT= Weed dry weight in treated plot.

Weed persistence index (WPI)

$$WPI = (WT/WC) \times (WPC/WPT)$$

Where,
WT= Weed dry weight in treated plot.
WC= Weed dry weight in control (weedy check) plot.
WPC= Weed population in control (weedy check) plot.
WPT= Weed dry weight in treated plot.

Treatment efficiency index (TEI)

$$TEI = [(YT-YC)/YC] / (WT /WC)$$

Where,
YT= Yield of treated plot.
YC= Yield of control (weedy check) plot.
WT= Weed dry weight in treated plot.
WC= Weed dry weight in control (weedy check) plot.

RESULTS AND DISCUSSION

Effect on weed density

Perusal of data on weed density (Table 1) revealed that irrespective of doses, the pre emergence application of imazathapyr was most effective in controlling grassy, broad leaved as well as sedges weeds compared to its post emergence application at 30 DAS. Among ready mix herbicides, application of imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10) recorded significantly reduced grassy weeds density at 30 and 60 DAS, while it was similar to imazethapyr + imazamox (RM) 70 g/ha as post emergence (T8) at 30 DAS . Application of imazethapyr + imazamox (RM) 70 g/ha pre emergence (T6) recorded significantly reduced broad leaved weeds at 30 and 60 DAS, however, it was at par with imazethapyr 50 g/ha as pre emergence (T1), imazethapyr + imazamox 50 g/ha as pre emergence (T5), imazethapyr + imazamox (RM) 70 g/ha as pre emergence (T6), pendimethalin 1 kg/ha pre emergence (T9) and imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10). Among different herbicides, application of imazethapyr 50 g/ha as post emergence (T3) recorded significantly reduced sedges at 30 and 60 DAS. The total weed density reduced significantly by application of pendimethalin 1 kg/ha as pre emergence (T9) and imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10) at 30 and 60 DAS respectively.

Weed dry matter

Application of imazethapyr + imazamox (RM) 70 g/ha as pre emergence (T6) recorded 76.19 per cent reduced weed dry matter compared to weedy check (T12) at 30 DAS, however it was similar to imazathapyr 50g/ha as pre emergence application (T1), imazathapyr 70 g/ha as pre emergence (T2), imazethapyr 70g/ha as post emergence (T4), imazethapyr + imazamox 50 (T5) and Imazethapyr + pendimethalin (RM) 1 kg/ha pre emergence (T10) and hoeing at 20 and 40 DAS (T11). While at 60 DAS, imazethapyr + pendimethalin (RM) 1 kg/ha PE (T10) similar to pendimethalin 1 kg/ha pre emergence (T9) recorded 81.12 per cent reduced weed dry matter compared to weedy check (T12). Similar results was also observed by Singh *et al*. (2018).

Table 1: Effect of weed control treatments on weed density and weed dry matter in chickpea (Mean of 2017 -18 and 2018-19).

Treatments	Weed density (no./m^2)								Weed dry matter (g./m^2)		Weed control efficiency (%)	
	30 DAS				60 DAS				30 DAS	60 DAS	30 DAS	60 DAS
	Grasses	Broad leaf	Sedges	Total	Grasses	Broad leaf	Sedges	Total				
T1 Imazethapyr 50 g/ha PE	15.44(253)	13.00(184)	6.37(43)	21.68(480)	19.29(373)	16.56(275)	5.38(32)	26.04(680)	8.98(80.53)	6.80(45.94)	69.50	70.71
T2 Imazethapyr 70 g/haPE	15.18(248)	15.22(240)	5.98(43)	22.57(531)	17.87(333)	18.70(355)	5.41(32)	26.55(720)	10.66(115.95)	6.74(45.1)	57.81	71.21
T3 Imazethapyr 50 g/haPoE	17.65(325)	17.96(323)	5.45(29)	25.90(677)	19.45(416)	20.00(400)	2.94(11)	28.43(827)	11.41(132.4)	6.98(49.07)	51.69	68.56
T4 Imazethapyr 70 g/ha PoE	18.79(355)	19.35(389)	8.19(67)	28.27(811)	21.99(488)	20.55(432)	5.80(35)	30.66(955)	10.00(100.91)	8.23(68.36)	62.91	55.56
T5 Imazethapyr + imazamox 50 g/ha PE	18.37(381)	11.77(149)	7.08(51)	23.71(581)	19.21(381)	13.37(184)	5.13(29)	24.02(595)	9.54(92.75)	8.15(66.41)	66.47	57.51
T6 Imazethapyr + imazamox (RM) 70 g/ha PE	21.03(515)	9.96(99)	7.47(61)	24.80(675)	17.88(339)	11.99(144)	9.22(85)	23.63(568)	7.79(64.83)	6.45(41.74)	74.49	73.30
T7 Imazethapyr + imazamox (RM) 50 g/ha PoE	18.13(360)	22.91(547)	6.54(45)	30.34(952)	17.28(344)	26.43(701)	6.35(56)	32.91(1101)	11.38(130.8)	7.35(54.87)	52.29	64.42
T8 Imazethapyr + imazamox (RM)70 g/ha PoE	15.11(248)	21.58(485)	5.88(48)	27.37(781)	18.37(384)	28.89(856)	6.09(40)	35.06(1280)	11.13(130.11)	6.42(41.76)	53.74	73.11
T9 Pendimethalin 1 kg/ha PE	10.50(112)	11.12(141)	9.08(91)	18.34(344)	10.63(120)	12.98(168)	10.06(101)	19.72(389)	11.91(147.44)	5.63(32.53)	47.47	78.98
T10 Imazethapyr + pendimethalin (RM) 1 kg/ha PE	10.02(107)	12.07(157)	10.04(101)	18.79(365)	9.63(96)	12.31(155)	10.16(104)	18.79(355)	9.30(86.27)	4.47(20.07)	67.70	87.28
T11 Hoeing (20 and40 DAS	13.33(208)	17.18(296)	4.10(24)	22.94(528)	18.57(352)	22.42(528)	5.80(35)	29.74(915)	8.14(66.83)	7.27(52.47)	75.73	66.43
T12 Weedy check	29.58(904)	32.17(1035)	11.02(125)	45.31(2064)	29.38(865)	39.11(1531)	13.79(190)	50.82(2586)	16.48(272.37)	12.52(106.3)	-0.10	0.00
S.E. (m) ±	2.31	2.07	1.59	1.77	2.41	1.84	1.30	2.53	0.99	0.55	1.00	0.93
C.D. (P=0.05%)	6.76	6.08	4.67	5.19	7.06	5.41	3.81	7.43	2.89	1.62	2.94	2.74

Original values are in parentheses subjected to square root [√(x+0.5)] transformation.

Imazethapyr + imazamox (RM) 70 g/ha as pre emergence (T6) and imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10) recorded maximum weed control efficiency at 30 and 60 DAS. Reduction in weed density and weed dry matter accumulation by combined application of imazethapyr with imazamox or with pendimethalin might have accelerated the combined effect of inhibiting the growth of weeds. Similar finding has also been reported by Pandit *et al.* (2017) and Mahajan *et al.* (2020). The efficacy of readymix herbicides imazathapyr + pendimethalin and imazathapyr + imazamox in reducing weed density and dry weight has also been supported by Rana *et al.* (2019).

Dry matter accumulation and crop growth rate

Imazethapyr + pendimethalin (RM) 1 kg/ha pre emergence (T10) recorded significantly higher dry matter accumulation at all growth stages compared to rest of the treatments except at 30 DAS (Table 2). However, it was similar to imazethapyr 50 g/ha pre emergence (T1), imazethapyr 70 g/ha pre emergence (T2) and imazethapyr + imazamox (RM) 50 g/ha post emergence (T7) at 60, 90 and 120 DAS and also with imazethapyr 50 g/ha pre emergence (T1) at maturity stage of crop. The CGR continued to increase up to 90-120 DAS and it reduced at 120 DAS-maturity stages. The significantly higher CGR was recorded by imazethapyr + pendimethalin (RM) 1 kg/ha pre emergence (T10). However, it was similar to imazethapyr 50 g/ha pre emergence (T1) and imazethapyr 70 g/ha pre emergence (T2) at 60-90 DAS and 90-120 DAS.

Yield attributes, yield and economics

Application of imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10) recorded 53.53 and 47.87 and 64.33 per cent significantly higher number of seeds/plant (1.52), 100 seed weight (40.25 g) and higher number of branches (4.93/ plant), respectively compared to weedy check (T12) (Table 3).

Application of imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10) similar to imazethapyr 50 g/ha PE (T1) and imazethapyr + imazamox (RM) 70 g/ha as pre emergence (T6) recorded 340.57 per cent higher seed yield compared to weedy check (T12), while compared to common practice of hoeing twice (T11) it recorded 61.70 per cent higher seed yield. Application of imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10) being similar to imazethapyr 50 g/ha as pre emergence (T1), imazethapyr 70g/ha as pre emergence (T2), imazethapyr + imazamox (RM) 70 g/ha as pre emergence (T6) and pendimethalin 1 kg/ha as pre emergence (T9) recorded 122.08 percent higher net return (₹ 77136/ha) compared to common practice of hoeing twice (T11) (₹ 34732/ha). However, maximum B:C ratio was observed under imazethapyr 50 g/ha as pre emergence (T1).

Weed indices

Among different weed indices influenced by herbicides, the maximum weed control efficiency 74.49 and 87.28 per cent at 30 and 60 DAS respectively, was observed by application of imazethapyr + imazamox (RM) 70 g/ha as pre emergence (T6) and imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10) at 30 and 60 DAS respectively (Table 4). Imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10) recorded maximum weed management index at 30 and 60 DAS. Application of imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence (T10) also recorded maximum agronomic management index (0.87), treatment efficiency index (31.96) and also reduced weed persistence index (0.98) at 60 DAS. Rana *et al.* (2019) have also showed superiority of imazethapyr ready mix with imazamox or with pendimethalin in suppressing weed density and dry weight with enhanced crop yield compared to other weed control methods.

Table 2: Plant dry matter and crop growth rate (RGR) as influenced by nutrient and weed management practices (Mean of 2017-18 and 2018-19).

Treatments	Plant dry matter (g/m^2)					CGR (g/m^2/day)			
	30 DAS	60 DAS	90 DAS	120 DAS	Maturity	30-60 DAS	60-90 DAS	90-120 DAS	120-Maturity
T1 Imazethapyr 50 g/ha PE	4.24	6.87	15.01	43.25	64.26	0.08	0.29	0.92	0.7
T2 Imazethapyr 70 g/ha PE	3.76	6.77	14.8	42.64	63.37	0.09	0.29	0.91	0.69
T3 Imazethapyr 50 g/ha PoE	3.63	5.1	10.32	28.68	44.53	0.05	0.19	0.6	0.53
T4 Imazethapyr 70 g/ha PoE	2.98	4.71	10.3	25.92	44.46	0.05	0.2	0.51	0.62
T5 Imazethapyr + imazamox 50 g/ha PE	3.18	4.93	10.77	28.48	46.42	0.05	0.21	0.58	0.6
T6 Imazethapyr + imazamox (RM) 70 g/ha PE	4.45	6.91	16.22	46.74	69.35	0.07	0.33	1	0.75
T7 Imazethapyr + imazamox (RM) 50 g/ha PoE	2.91	4.64	10.13	26.32	43.74	0.05	0.2	0.53	0.58
T8 Imazethapyr + imazamox (RM) 70 g/ha PoE	3.08	4.83	10.56	30.42	45.53	0.05	0.2	0.65	0.5
T9 Pendimethalin 1 kg/ha PE	3.68	5.8	12.68	36.53	54.45	0.06	0.25	0.78	0.6
T10 Imazethapyr + pendimethalin (RM) 1 kg/ha PE	4.52	7.57	17.54	50.54	79.03	0.09	0.36	1.08	0.95
T11 Hoeing (20 and 40 DAS	3.58	4.96	10.83	31.21	46.69	0.04	0.21	0.66	0.52
T12 Weedy check	2.87	4.19	9.16	26.39	39.64	0.04	0.18	0.56	0.44
S.E. (m) ±	0.70	0.56	1.12	4.25	3.24	0.01	0.04	0.14	0.18
C.D. (P=0.05%)	NS	1.63	3.29	12.48	9.5	0.04	0.1	0.4	0.53

Table 3: Effect of weed control treatments on yield attributes, yield and economics of chick pea (Mean of 2017-18 and 2018-19).

Treatment	Plant popln. (no./m^2)	Plant height (cm)	Primary Br. per Plant	Secondary Br./ plant	No. of pods/ plant	No. of seeds/ plant	100 seed weight (g)	Yield (kg/ha) Seed	Yield (kg/ha) Straw	Gross Return (₹/ha)	Net Return (₹/ha)	B:C
T1 Imazethapyr 50 g/ha PE	48	49.60	5.87	7.67	63	1.45	35.27	1752	2460	96366	72646	3.06
T2 Imazethapyr 70 g/ha PE	52	55.87	6.47	7.67	72	1.37	39.48	1577	2568	86741	62831	2.63
T3 Imazethapyr 50 g/ha PoE	49	60.67	5.33	5.00	49	1.34	39.10	1411	2370	77616	53896	2.27
T4 Imazethapyr 70 g/ha PoE	50	52.80	5.40	3.73	43	1.40	36.80	1250	2119	68749	44839	1.88
T5 Imazethapyr + imazamox 50 g/ha PE	46	56.13	5.13	7.27	48	1.46	38.72	1283	2373	70541	47096	2.01
T6 Imazethapyr + imazamox (RM) 70 g/ha PE	43	56.47	5.00	7.67	62	1.45	37.95	1780	2699	97890	74365	3.16
T7 Imazethapyr + imazamox (RM) 50 g/ha PoE	53	59.60	4.00	5.80	46	1.34	26.45	1089	1828	59918	36473	1.56
T8 Imazethapyr + imazamox (RM) 70 g/ha PoE	47	59.27	3.40	5.60	39	1.38	37.18	1272	2439	69958	46433	1.97
T9 Pendimethalin 1 kg/ha PE	43	47.27	5.87	7.00	61	1.40	38.33	1489	2812	81875	56760	2.26
T10 Imazethapyr + pendimethalin (RM) 1 kg/ha PE	47	53.07	4.93	5.53	50	1.52	40.25	2128	3520	117053	77136	1.93
T11 Hoeing (20 and 40 DAS)	49	58.47	4.40	6.60	50	1.34	28.37	1316	2430	72377	34732	0.92
T12 Weedy check	47	61.93	3.00	4.07	30	0.99	27.22	483	2000	26582	3937	0.17
S.E. (m) ±	2.99	5.10	0.61	0.72	6.19	0.20	1.62	130	160	7171	7171	0.28
C.D. (P=0.05%)	NS	NS	1.80	2.10	18.15	0.58 NS	4.74	382	469	21030	21030	0.81

Table 4: Weed indices as influenced by nutrient and weed management practices (Mean of 2017-18 and 2018-19).

Treatments	Weed control efficiency (%)		Weed management index (WMI)		Agronomic management index (AMI)		Weed persistence index (WPI)		Treatment efficiency index	
	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS	30 DAS	60 DAS
T1 Imazethapyr 50 g/ha PE	69.50	70.71	3.85	3.68	0.70	0.71	1.47	1.12	8.91	9.08
T2 Imazethapyr 70 g/ha PE	57.81	71.21	4.05	3.19	0.58	0.71	1.73	1.09	5.69	7.92
T3 Imazethapyr 50 g/ha PoE	51.69	68.56	3.87	2.84	0.52	0.69	1.48	1.00	4.19	6.54
T4 Imazethapyr 70 g/ha PoE	62.91	55.56	2.54	3.02	0.63	0.56	0.94	1.18	4.51	3.99
T5 Imazethapyr + imazamox 50 g/ha PE	66.47	57.51	2.54	2.82	0.67	0.58	1.23	2.13	4.86	4.14
T6 Imazethapyr + imazamox (RM) 70 g/ha PE	74.49	73.30	3.70	3.72	0.75	0.73	1.12	1.23	16.85	10.56
T7 Imazethapyr + imazamox (RM) 50 g/ha PoE	52.29	64.42	2.37	1.92	0.52	0.64	1.09	0.82	2.89	4.78
T8 Imazethapyr + imazamox (RM) 70 g/ha PoE	53.74	73.11	3.18	2.24	0.54	0.73	1.24	0.56	4.32	7.21
T9 Pendimethalin 1 kg/ha PE	47.47	78.98	4.82	2.66	0.48	0.79	3.15	1.46	4.66	13.32
T10 Imazethapyr + pendimethalin (RM) 1 kg/ha PE	67.70	87.28	5.15	3.90	0.68	0.87	2.01	0.94	10.67	31.96
T11 Hoeing (20 and 40 DAS)	75.73	66.43	2.28	2.61	0.76	0.66	0.98	1.08	7.32	5.16
T12 Weedy check	-0.10	0.00	0.00	0.00	0.00	0.00	1.00	1.00	0.00	0.00
S.E. (m) ±	1.00	0.93	0.67	0.21	0.10	0.09	0.14	0.18	0.27	0.25
C.D. (P=0.05%)	2.94	2.74	1.97	0.61	0.29	0.27	0.40	0.53	0.80	0.73

Correlation study

Correlations of various weed parameters with yield of chickpea

Among different category of weeds a positive and significant correlation with total weeds density were observed (Table 5) by narrow and broad leaf weeds density at 30 (r= 0.91 and 0.94) and 60 DAS (r=0.90 and 0.98) at 1% level of significance; while sedges weeds density were weakl correlated (r= 0.49 and 0.55) with total weed density. The weed density of narrow and broad leaved weeds showed negative and highly significant correlation at 30 (r= -0.71 and -0.86) and 60 DAS (r= -0.82 and -0.85) with chickpea yield. The yield of chickpea was highly negatively correlated with weed dry matter at 30 (r= -0.77) and 60 DAS (r= -0.88).

Table 5: Correlations of various weed parameters with yield of chickpea (Mean of 2017-18 and 2018-19).

	NL at 30 DAS/m^2	BL at 30 DAS/m^2	S at 30 DAS/m^2	Total at 30 DAS/m^2	NL at 60 DAS/m^2	BL at 60 DAS/m^2	S at 60 DAS/m^2	Total at 60 DAS/m^2	DM at 30 DAS/m^2	DM at 60 DAS/m^2	Yield kg/ha
NL at 30 DAS/m^2	-										
BL at 30 DAS/m^2	0.73**	-									
S at 30 DAS/m^2	0.41	0.40	-								
Total at 30 DAS/m^2	0.91**	0.94**	0.49	-							
NL at 60 DAS/ m^2	0.89**	0.83**	0.22	0.91**	-						
BL at 60 DAS/ m^2	0.70**	0.98**	0.34	0.91**	0.82**	-					
S at 60 DAS/ m^2	0.57*	0.54	0.91**	0.64*	0.35	0.52	-				
Total at 60 DAS/m^2	0.81**	0.97**	0.38	0.96**	0.90**	0.98**	0.55	-			
DM at 30 DAS/m^2	0.66*	0.85**	0.61*	0.84**	0.67*	0.82**	0.69**	0.83**	-		
DM at 60 DAS/m^2	0.86**	0.78**	0.27	0.87**	0.94**	0.75**	0.37	0.84**	0.67*	-	
yield kg/ha	-0.71**	-0.86**	-0.20	-0.84**	-0.82**	-0.85**	-0.34	-0.87**	-0.77**	-0.88**	-

NL = Narrow leaf, BL = Broad leaf, S = Sedges.

**Significant at 1%; *Significant at 5%; n= 11; r=0.684 at 1%; r =0.553 at 5%.

Table 6: Correlations of plant dry matter and yield attributes with yield of chickpea (Mean of 2017-18 and 2018-19).

Variables	Plant dry matter (g/ m^2)	Primary branch/plant	Secondary branch/plant	No. of pods/plant	No. of seeds/pod	100 seed weight (g)	Yield (kg/ha)
Plant dry matter (g/m^2)	-						
Primary branch/plant	0.49	-					
Secondary branch/plant	0.51	0.52	-				
No. of pods/plant	0.65	0.85**	0.82**	-			
No. of seeds/pod	0.61	0.59	0.50	0.56	-		
100 seed weight (g)	0.53	0.64*	0.28	0.48	0.66*	-	
Yield (kg/ha)	0.88**	0.63	0.52	0.69*	0.87**	0.68*	-

**Significant at 1%; *Significant at 5%; n= 7; r=0.798 at 1%; r = 0.666 at 5%.

Table 7: Correlation of weed density, weed dry matter and yield attributes with yield of chickpea (Mean of 2017-18 and 2018-19).

Variables	Weed density 30 DAS	Weed density 60 DAS	DM at 30 DAS/ m^2	DM at 60 DAS/ m^2	Plant dry matter (g/m^2)	Primary branch /plant	Secondary branch /plant	No. of pods /plant	No. of seeds /pod	100 seed weight (g)	Yield (kg/ha)
Weed density 30 DAS	-										
Weed density 60 DAS	0.96**	-									
DM at 30 DAS/m^2	0.84**	0.83**	-								
DM at 60 DAS/m^2	0.87**	0.84**	0.67*	-							
Plant dry matter (g/m^2)	-0.54	-0.61*	-0.50	-0.69**	-						
Primary branch/plant	-0.71	-0.75**	-0.51	-0.48	0.49	-					
Secondary branch/plant	-0.59	-0.59	-0.53	-0.48	0.51	0.52	-				
No. of pods/plant	-0.70*	-0.72**	-0.56*	-0.61	0.65*	0.85**	0.82**	-			
No. of seeds/pod	-0.91**	-0.94**	-0.89**	-0.82**	0.61*	0.59*	0.50	0.56*	-		
100 seed weight (g)	-0.62	-0.66	-0.41	-0.58*	0.53	0.64*	0.28	0.48	0.66*	-	
Yield (kg/ha)	-0.84**	-0.87**	-0.77**	-0.88**	0.88**	0.63*	0.52	0.69**	0.87**	0.68**	-

**Significant at 1%; *Significant at 5%; n= 11; r=0.684 at 1%; r = 0.553 at 5%.

Correlations of plant dry matter and yield attributes with yield of chickpea

The plant dry matter accumulation was positively correlated with yield at 1% significance level (r=0.88) (Table 6). Among different yield attributing characters, number of pods was positively correlated with number of primary branches (r=0.85) and number of secondary branches (r=0.82) at 1% level of significance.

Correlation of weed density, weed dry matter and yield attributes with yield of chickpea

The data on correlation study (Table 7) revealed that weed density and weed dry matter accumulation were negatively correlated with plant dry matter (g/m^2), primary branch/plant, secondary branch/plant, no. of pods/plant, no. of seeds/pod, 100 seed weight (g) and yield of chickpea. Among different yield attributing parameters, primary branch/plant, no. of pods/plant, number of seeds/pod and 100 seed weight (g) were significantly correlated at 1% level of significance with seed yield of chickpea.

CONCLUSION

On the basis of experimental findings it can be concluded that imazethapyr + pendimethalin (RM) 1 kg/ha as pre emergence can be applied in chickpea for broad spectrum control of weeds resulting in higher seed yield and economic return.

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