The Pharma Innovation Journal 2023; 12(12): 242-245

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(12): 242-245

www.thepharmajournal.com
Received: 21-10-2023
Accepted: 25-11-2023

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Effect of weed control and crop residue mulches on weeds and yield of chickpea in Kymore plateau and Satpura hills of Madhya Pradesh

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Abstract
A study titled "Effect of weed control practices alone and in combination with crop mulch on weed dynamics, yield and economics of chickpea" was conducted at Live Stock Farm, Department of Agronomy, JNKVV in *Rabi* 2019-2020. Four weed control practices *viz.* Pendimethalin (38.7% CS) 1 kg *a.i.*/ha as PPI, hand weeding 30 DAS, hand hoeing 30 DAS and Control as a main plot treatments and four crop mulches *i.e.* Wheat straw (5 t/ha), paddy straw (5 t/ha), Soybeanstraw (5 t/ha) and Control (No mulch) were assigned in sub-plot treatments and these were laidout in a split plot design with three replications. In experimental area, *Cichorium intybus* (30.36%), *Medicago truncatula* (20.72%) *Melilotus indica* (19.52%) *Anagalis arvensis* (19.52) *Chenopodium album* (9.88%) was dominant weed species. Weed intensity and dry biomass slightly reduces in hand hoeing at 30 DAS over weedy check. Among weed control method, minimum weed count and weed biomass of total weeds were recorded in one hand weeding at 30 DAS higher weed control efficiency followed by pendimethalin 1 kg /ha as PPI over hand hoeing and weedy check. Among residue mulch paddy straw at the rate of 5 t/ha, significantly minimize weed count and weed dry biomass resulted recieved higher weed control efficiency (61.34%) followed by wheat straw mulch (53.04%). Lower chickpea yield (868 kg/ha) was seen in the weedy check. Among weed control treatment, higher seed yield (1731 kg/ha) was recorded in one hand weeding at 30 DAS followed by pendimethalin 1kg /ha (1561kg/ha). Higher seed yield (1593 kg/ha) was recorded in paddy straw 5 t/ha followed by wheat straw mulch (1469 kg/ha).

Keywords: Weed control, crop residue mulches, yield, chickpea

Introduction
Chickpea, a *rabi* crop, ranks third among pulse crop in the world (FAO, 2019) [6]. In India, chickpea constitutes 38% of the cultivated area and 50% of the production, with 10.17 million hectares of cultivated area, 11.35 million tons of production and 1,116 kg/ha productivity. Madhya Pradesh ranks first among all states in terms of chickpea area (1.93 ha) and yield (2.48 tonnes) as well as productivity (1288 kg/ha) (Anonymous, 2021) [1]. Low chickpea yields are due to slow initial growth. Many flushes of weeds can reduce chickpea yield (Dubey *et al*., 2017). Due to slow initial growth chickpea is a weak plant. In irrigated areas, weeds tend to create severe competition for growth, causing a reduction in chickpea yield of up to 75% (Balyan and Bhan, 1984; Singh and Singh, 1992) [3, 14]. In Madhya Pradesh, *Chenopodium* sp., *Medicago truncatula*, *Cichorium intybus*, *Melilotus* sp., *Anagalis arvensis* are dominant weed species (Sahu at al. 2020, Yadav *et al*. 2023b) [11, 27]. Weed control in chickpeas is done by cultural, manual/mechanical and chemical methods. Studies have shown that application of pendimethalin as a pre emergence can reduce weeds such as grassy, broadleaf and sedge, thereby reducing dry biomass and weed index, improving weed control efficiency (Chavada *et al*., 2017) [4]. Mulching is the most effective non-chemical weed control method in crop cultivation (Mahmood *et al*., 2015) [10]. Because there is little data on the effectiveness of the 38.7% CS formulation of pendimethal as a PPI alone and in combination with mulch. Therefore an experiment was carried out to find the suitable weed control and crop straw mulches on weed growth and yield of chickpea.

Materials and Methods
In the *Rabi* seasons of 2019–20, a field experiment was carried out at the Live Stock Farm,

Department of Agronomy, JNKVV, Jabalpur. The location of the experiment is 411.78 m above mean sea level, with latitude of 23.18° N and a longitude of 79.99° E. The sandy loam soil at the experimental site has a neutral pH of 7.24, medium organic carbon content (0.61%), available N (365.20 kg/ha), and phosphorus (17.97 kg/ha) but high available K (308.12 kg/ha).

The 16 treatments were comprised into four main plot treatments *viz*, Pendimethalin (38.7% CS) 1 kg/ha as PPI; Hand Weeding at 30 DAS; Hand Hoeing at 30 DAS and Control (No weed control). Four crop mulches were also assigned in sub-plot treatments *viz*, Wheat straw (5 t/ha), Paddy straw (5 t/ha), Soybean straw (5 t/ha) and Control (No mulch). The experiment was laid out in a split plot design with three replications. Chickpea variety 'JG 14' was sown in row 30 cm apart, using 80 kg/ha seeds. The crop was fertilized with urea, single super phosphate (SSP), muriate of potash (MOP) with 20 kg N, 60 kg P_2O_5, and 20 kg K_2O/ha as a basal dressing, respectively. Using a hand backpack sprayer with a flat-fan nozzle and a 500 l/ha application volume, pendimethalin was sprayed as PPI before two days of sowing. After 12 days of sowing, straw mulch was applied at a rate of 5 t/ha. Density of weed and weed dry weight were recorded at 60 DAS with the help of 1 x 1m quadrat by throw at randomly at 2 places in each plot. Data thus recorded, were subjected to squire root transformation as $\sqrt{x+0.5}$. After removing the weeds, they were dried in a hot air oven at 60±10C for 48 hours. The dry weight of each species of weed was recorded, and the efficacy of weeds control was determined by calculating it using the initial dry weight recorded at 60 DAS. Finally, the seed yield was recorded under different treatments at harvest.

Results and Discussion

Associated weed flora

Major weed flora in chickpea was broad leaf weeds at 60 DAS. In the experimental plots dominant weed species were *Cichorium intybus* (30.36%), *Medicago truncatula* (20.72%) *Medicago truncatula* (20.72%) and *Melilotus indica* (19.52%) *Anagalis arvensis* (19.52) *Chenopodium album* (9.88%).

Effect on weeds

According to Table 1, it was determined that the total weed density and dry weight were lower (10.3 no./ m^2 and 6.6 g/m^2) in single hand weeding at 30 DAS. This is because all weeds were removed during manual weeding at 30 DAS followed by pendimethalin (38.7% CS) 1 kg a.i/ha. as PPI (11.2 no./m^2 and 7.9 g/m^2) because the density and dry weight of plants are reduced after manual plantings and the addition of pendimethalin before planting, compared to manual hoeing involving lines of existing plants to escape in mechanical removal and hence apparently not good for previous treatment. Similar findings were reported by Sahu *et al.* (2022) [13] and Jha *et al*. 2023 [9]. Residue mulch of paddy recorded least density and dry weight of total weeds (10.8 no./m^2 and 7.30 g/m^2), it was due to good suppression of weeds followed by wheat residue mulch (11.6 m^2 and 8.2 gm^2). Hand weeding once 30 DAS recorded higher weed control efficiency (68.9%) caused elimination of all within and between row weeds followed by PPI application of pendimethalin 1 kg *a.i.* /ha (56.5% WCE) and hand hoeing (41.9% WCE) and found superior than control. Application of paddy straw mulch (5 t/ha) received maximum WCE (60.7%) among the residue mulch due to uniform covering of inter and intra row space weeds was suppressed causes poor penetration of air and light weeds were not able to make their food material. Followed by wheat straw @ 5 t/ha.

Table 1: Effects of weed control and straw mulching on plant density, dry matter and total plant control efficiency at 60 DAS

Weed control practices	Weed count (No./m^2)	Weed dry biomass (g/m^2)	Weed control efficiency (%)
Pendimethalin 1kg ai/ha as PPI	11.2 (126.2)	7.9 (62.7)	56.5
Hand weeding 30 DAS	10.3 (105.8)	6.6 (44.8)	68.9
Hand hoeing 30 DAS	12.2 (149.7)	9.1 (83.8)	41.9
Weedy check	14.8 (220.7)	11.9 (144.1)	0.0
S.Em ±	0.31	0.16	-
CD (p=0.05)	1.02	0.53	-
Straw mulchs			
Wheat straw	11.6 (138.3)	8.2 (69.7)	51.6
Paddy straw	10.8 (119.3)	7.3 (56.7)	60.7
Soybean Straw	12.6 (161.6)	9.7 (97.1)	32.7
No mulches	13.4 (183.1)	10.4 (111.1)	22.3
S.Em ±	0.14	0.12	-
CD (p=0.05)	0.42	0.37	-

Note- Figures in parenthesis are original values

Effect on crop

Among the weed control treatments and straw mulches ware significantly affected the pods/plant. But seeds/pod and seed index were statistically not differed by different weed control treatments and straw mulches.

The maximum pods/plant (48.92) was recorded in hand weeding at 30 DAS as compare to other weed management methods. It was statistically at par with pendimethalin at 1 kg a.i. /ha as PPI (45.55) due to superior growth and development of crop plants under weed free environmental condition and produced more flowers as a result of better fertilization in flowers as well as superior seed development, which in turn favoured more pod formation, which was the minimum under weedy check plots (21.23) because of more weed pressure during critical period. Similar finding have been also given by Tiwari *et al* 2011 [17], Tiwari at al 2011a [18], Sneha (2019) [16] and Sahu *at al*. 2020 [12]. Among the straw mulches, paddy straw was applied as a mulch (5 t/ha) recorded maximum number of pods/plant followed by wheat straw mulch (39.90). Due to lower crop-weed competition during the critical period, improved weed suppression under these treatments led to improved crop growth and development, which in turn produced more pods/plant by increasing flower initiation and fertilization. Jagat *et al.*

(2009) [8], Yadav *et al.* 2023 and Yadav *et al.* 2023a [25, 26] also reported similar results. However, due to increased competition between crops and plants during the critical period, no mulch plots had lowest number of pods/plant followed by soybean straw mulch (5 t/ha).

The highest seed yield (1731 kg/ha) was noted in hand weeded plots followed by with pendimethalin 1 kg *a.i*/ha as PPI (1561 kg/ha) and prove significantly superior over hand hoeing and weedy check plots. Chickpea attained thriving growth in hand weeding due to elimination of all sort of weeds from inter and intra row spaces as well better aeration due to manipulation of surface soil and thus, more space, water, light and nutrients were available for the better growth and development of crop, which resulted into better yield attributes and consequently the highest yield.

Gore *et al*. (2015) [7], Sneha (2019) [16], Tomar *et al.* 2023 [19], Tomar *et al.* 2023 [20], verma *et al*. 2022 [22] and Oscar *at al*. 2023 [21] also reported that hand weeding was an efficient method of weed control for achieve the maximum yield of chickpea. Among the straw mulches, the maximum seed yield (1593 kg/ha) was recorded under paddy straw mulch (5 t/ha) followed by wheat straw mulch (1469 kg/ha). This may be due to least crop-weed competition during critical period and better accumulation of more photosynthesis in chickpea plants which led to more yield attributes and finally higher seed yield. When compared to no mulch treatment and soybean straw mulch, the prior treatments revealed to be noticeably better. In the case of later treatments, the opposite was true. Singh and Guru (2011) [15], Baghel (2018) [2], Verma *et al* 2023 [22], Verma *et al* 2023a [24] and Verma *et al* 2023b [23] also reported similar findings.

Table 2: Effects of weed control and straw mulching on yield characteristics and seed yield

Weed control practice	Pods/plant	Seeds/pod	Seed index (%)	Seed yield (kg/ha)
Pendimethalin 1kg ai/ha as PPI	45.55	1.74	15.20	1561.29
Hand weeding 30 DAS	48.92	1.80	15.06	1731.39
Hand hoeing 30 DAS	35.95	1.72	14.86	1322.22
weedy check	21.23	1.70	14.93	868.06
S.Em ±	1.49	0.06	0.85	86.42
CD (p=0.05)	5.25	NS	NS	304.86
Straw mulch (5 t/ha)				
Wheat straw	39.90	1.78	15.07	1468.75
Paddy straw	44.58	1.80	15.28	1592.50
Soybean Straw	35.58	1.69	14.87	1278.99
No mulches	31.58	1.69	14.83	1142.71
S.Em ±	0.97	0.04	0.22	56.45
CD (p=0.05)	2.84	NS	NS	165.73

Conclusion

Effective weed control is achieved by Once hand weeding at 30 DAS and pre-plant incorporation of pendimethalin 38.7% CS 1 kg a.i./ha, and paddy and wheat straw mulch 5 t/ha. Chickpea production has been proven to be higher when these practices are used.

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