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RESEARCH NOTE

Effect of land configuration and herbicides on weed management in early maturing pigeonpea

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ABSTRACT

A field experiment was conducted in the *Kharif* season of 2024 at Kota, Rajasthan with an objective to evaluate suitable land configuration and herbicidal weed management practices to effectively and economically manage weeds and achieve higher grain yield and net returns in early maturing pigeonpea cultivation. Among the land configurations, the raised bed land configuration with straw mulch was highly effective in suppressing weed emergence, reducing weed biomass, improving weed control efficiency (54%) and attaining higher pigeonpea growth and yield. The raised bed with straw mulch recorded the higher number of pods/plant, seeds per pod, seed yield and stover yield when compared to flatbed and raised bed methods. Among the herbicidal treatments, the post-emergence application (PoE) of propaquizafop-ethyl 2.5% + imazethapyr 3.75% ME (propaquizafop-ethyl + imazethapyr) (ready-mix) 125 g/ha at 20 days after seeding (DAS) recorded lowest weed density, weed biomass, nutrient (NPK) depletion by weeds and higher pigeonpea seed yield due to effective weed management than control and pendimethalin + imazethapyr. The next best treatment was pre-emergence application (PE) of pendimethalin 30% EC + imazethapyr 2% EC (pendimethalin + imazethapyr) (ready-mix) 800 g/ha. The integration of raised bed with straw mulch and propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha PoE at 20 DAS significantly reduced weed-crop competition and nutrient loss due to weeds and enhanced early maturing pigeonpea productivity.

Keywords: Early maturing pigeonpea, Land configuration, raised bed, Mulching, Pendimethalin + imazethapyr, Propaquizafop-ethyl + imazethapyr, Weed management

Pulses are rich source of protein, fibre, B-vitamins, isoflavones, and essential minerals like iron, calcium, and zinc. In Indian agriculture, it ranks just after cereals and oilseeds. India leads globally in pigeonpea (75%), chickpea (65%), and lentil (23%) production (FAO 2024). Pulses are mostly cultivated in rainfed, low-input areas prone to drought. India produced 27.69 million tonnes of pulses in 31.03 million ha. (Directorate of Economics and Statistics 2022). India is currently importing 2.5 million tons of pulses annually (Directorate of Pulses Development 2024). The per capita availability of pulses has dropped from 60 g/day (1951) to 44 g/day (2020), below the WHO recommendation of 80 g/day (Tiwari *et al.* 2022). The pulses production must grow by 2.14% annually to meet the projected demand of 39 million tonnes by 2050 (IIPR 2015).

Among the pulses, pigeonpea (*Cajanus cajan* (L.) Millsp.), commonly known as tur, arhar or red gram, is extensively consumed as part of the daily diet in many regions, especially in India. The crop serves food, fodder, fuel, and supports lac production. It is a short-day, photoperiod-sensitive legume with varied maturity (120–180 days) (Hussain *et al.* 2022), suitable for different agroclimatic conditions and is mostly cultivated in *Kharif* season. Pigeonpea is intercropped with cereals, pulses, and long-duration crops. It ranks fifth globally among pulses, second only to chickpea in India. India produces 3.52 million tons of pigeonpea from 4.20 million ha (FAO 2024). In India it is mainly cultivated in Maharashtra, MP, Karnataka, UP, Gujarat, Telangana and Andhra Pradesh. The yield of pigeonpea is severely affected due to weeds, the appropriate weed management strategy in early maturing pigeonpea along with proper land configuration methods is needed.

Conservation agriculture (CA) minimal tillage, residue retention, and crop diversification-offers a sustainable pigeonpea production. Permanent raised beds improve water use efficiency, reduce input costs, and support mechanization (Lichter *et al.* 2008). Mulching with straw helps conserve soil moisture, suppress weeds, and prevent erosion, especially when combined with reduced tillage (Busari *et al.* 2015).

Weeds are a major constraint, especially in the early growth phase (6–8 weeks), reducing pigeonpea

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yield by 20 to 80% (Talnikar *et al.* 2008, Rao and Chauhan 2015). Manual weeding, though effective, is costly and hence, herbicides are a practical solution (Rao *et al.* 2020). The pre-emergence application (PE) of pendimethalin, is commonly used but may cause resistance over time. The post-emergence application (PoE) of propaquizafop + imazethapyr provides broad spectrum weed control as imazethapyr is systemic and controls broad-leaved and grass weeds (Dixit and Varshney 2007), while propaquizafop targets grass weeds by translocation to growing points (Rao *et al.* 2018). This combination is highly effective in rainfed conditions. Thus, an experiment was conducted with an objective to evaluate suitable land configuration and herbicidal weed management treatments to effectively and economically manage weeds and achieve higher grain yield and net returns in early maturing pigeonpea cultivation.

The field study was conducted at Agricultural Research Station, Ummedganj, Kota, Agriculture University, Kota, during *Kharif* 2024. The experimental soil was clay loam, with a pH of 7.76, medium in organic carbon (0.45%), low in available nitrogen (220.4 kg/ha), medium in phosphorus availability (27.5 kg/ha), and high in potassium content (390 kg/ha). The factorial experiment was carried out using randomised block design (FRBD). The treatments comprise of two factors *i.e.,* land configuration and weed management treatments. In factor one there were three land configurations i.e., flat bed, raised bed, and raised bed with straw mulch and in factor two, there were three weed management treatments, *i.e.* control, pendimethalin 30% EC + imazethapyr 2% EC (pendimethalin + imazethapyr) (pre-mix) 800 g/ha PE, and propaquizafop ethyl 2.5% + imazethapyr 3.75% ME (propaquizafop-ethyl + imazethapyr) (pre-mix)125 g/ ha PoE at 20 days after sowing (DAS). Total nine treatment combinations were replicated thrice. The field preparation was done including one ploughing with a tractor-drawn disc plough, followed by two harrowing and planking to achieve a fine tilth. The field was levelled using a leveller prior to layout. Raised beds were prepared using a tractor-operated bed maker, with each bed 90 cm wide and separated by 30 cm furrows. The pigeonpea variety IPA 15-06 was sown at a seed rate of 20 kg/ha on 08.07.2025. Straw mulch, composed of pigeonpea stalks, was applied uniformly to designated plots to form a protective soil cover. Herbicides were applied as per treatment in earmarked plots of the experiment. Pendimethalin + imazethapyr was applied just after sowing of pigeonpea crop and propaquizafop-ethyl + imazethapyr was applied at 20 DAS. The herbicides were sprayed using knapsack sprayer using flat fan nozzle using 500 litre water/ha as per treatments in earmarked plots. A uniform basal dose of nitrogen and phosphorus (20:60 kg/ha) was applied at sowing using urea (46% N) and single super phosphate (16% P_2O_5). As pigeonpea is a legume, all fertilizer was applied at the time of sowing in furrows 8–12 cm deep. Sowing was carried out using a tractor-drawn seed drill, keeping a row spacing of 60 cm and sowing depth of 2–3 cm. Data were recorded on weed density of monocots, dicots, and sedges using a 0.5 m² quadrat placed randomly at four locations per plot, with density presented as number/m². Weed biomass was measured by oven-drying the collected samples at 70–75°C and expressed as kg/ha. Observation on phyto-toxicity on the pigeonpea crop on leaf i.e. wilting, vein clearing, necrosis, epinasty and hyponasty were made at 3, 5, 7, 10 days after herbicide application using the standard scale (0-10) using (Rao 2000). Representative samples of weed dry matter were taken from each plot at harvest were grounded and subjected to chemical analysis for N, P and K concentration with standard methods and expressed in per cent. Nutrient uptake (kg/ha) by weeds was calculated at harvest by formula given below.

$$\text{N/P/K uptake (kg/ha)} = \frac{\text{Nutrient concentration (\%) x Weed dry matter (kg/ha)}}{100}$$

The pods of the five randomly selected plants from each plot at harvest were counted and the average was expressed as number of pods/plant and the produce of seed + straw from each net plot area after complete sun drying was weighed for recording biological yield and expressed as (kg/ha), after threshing and winnowing, the weight of seed from each net plot area was recorded as kg/plot and was converted to kg/ha and the stover yield was obtained by subtracting the seed yield from biological yield per net plot and then converted in terms of kg/ha. Economics of different treatments were worked out in terms of net returns (Rs./ha) by subtracting the cost of treatment and the cost of cultivation from gross income obtained. Cost of cultivation and net profit were calculated on the basis of prevailing prices of produce and inputs. The B:C ratio was calculated by dividing net returns with cost of cultivation for each treatment to see the economic viability of treatments. The experimental data were subjected to statistical analysis, and wherever treatment effects were significant, F-tests and critical differences (CD) at 5% probability level were calculated and presented accordingly.

Effect on weeds

The experimental field was infested with a diverse weed flora comprising monocot, dicot, and sedge weed species, with monocot weeds being the most predominant, followed by dicots and sedges. The minimum weed density and biomass and maximum weed control efficiency (54.0%) at 60 DAS was observed in pigeonpea grown on raised beds with straw mulch over flatbed and raised bed (**Table 1**). This enhanced weed suppression under raised beds with mulch could be attributed to vigorous crop growth, reduced inter-row weed colonization space, and improved nutrient and moisture availability for the crop, which collectively contributed to a less favourable environment for weed proliferation. Similar observations were reported by Badvel *et al.* (2024).

All herbicidal weed management treatments were found significantly effective in reducing weed density and biomass accumulation, thereby resulting in higher weed control efficiency compared to the control plots. Among the treatments, propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha at 20 DAS recorded minimum weed density and biomass both at 60 DAS and at harvest, and subsequently recorded the maximum weed control efficiency (78.7 and 62.0%, respectively) when compared to both pendimethalin + imazethapyr (ready-mix) 800 g/ha and the untreated control. Notably, both herbicidal options showed comparable performance in reducing overall weed density and biomass. These results are in line with the findings of Goud and Patil (2014), who concluded that a pre-emergence herbicide followed by a post-emergence application provided effective and sustained weed control in pigeonpea. Throughout the study period, no signs of phytotoxicity (wilting, vein clearing, necrosis, epinasty, and hyponasty) were observed in any treatment.

Effect on nutrient content and uptake by weeds

Nitrogen (N), phosphorus (P) and potassium (K) content in weeds were not affected significantly by application of weed management and land configurations treatments. However, N, P and K depletion by weeds was significantly influenced by different land configurations treatments. The maximum N, P and K uptake by weeds (19.7, 9.78 and 12.1 kg/ha, respectively) was observed under flatbed, while the minimum and significantly lower nutrient depletion was recorded with the raised bed + straw mulch treatment (14.1, 7.06 and 8.30 kg/ha, respectively). In case of weed management, the minimum and significantly lower depletion of nitrogen (12.2 kg/ha), phosphorus (6.22 kg/ha) and potassium (7.05 kg/ha) by weeds was observed with the post-emergence application of propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha at 20 DAS, followed by pendimethalin + imazethapyr (ready-mix) 800 g/ha and control (**Table 5**). This reduction in N, P and K depletion by weeds under raised bed + mulch and propaquizafop-ethyl + imazethapyr (ready-mix) may be attributed to reduced weed growth, weed biomass, thereby limiting the competition for nutrients due to improved crop stand and soil conditions, which likely limited nutrient availability to weeds as reported by Singh *et al.* (2020).

Effect on early maturing pigeonpea

Number of pods/plant was significantly influenced by land configuration and weed

Table 1. Effect of land configuration and weed management treatments on weed density*, weed biomass* and weed control efficiency at 60 DAS

Treatment	Weed density (no./m^2)				Weed biomass (kg/ha)				WCE (%)
	Monocot	Dicot	Sedge	Total	Monocot	Dicot	Sedge	Total	
Land configuration									
Flat bed	6.10 (40.1)	5.08 (29.2)	3.90 (17.9)	8.87 (87.2)	20.4 (429)	22.3 (503)	8.27 (68.6)	31.4 (1001)	28.3
Raised bed	5.27 (31.9)	4.95 (25.7)	3.78 (15.5)	8.16 (73.1)	19.6 (391)	21.2 (455)	7.95 (63.3)	29.9 (909)	41.6
Raised bed + straw mulch	4.23 (20.5)	3.90 (17.5)	2.81 (8.61)	6.34 (46.6)	16.9 (287)	18.0 (326)	6.89 (47.8)	25.6 (660)	54.0
LSD (p=0.05)	0.89	0.72	0.65	0.64	0.98	1.23	0.56	1.08	7.95
Weed management									
Control	7.34 (55.7)	6.44 (42.3)	5.13 (27.2)	11.1 (125)	22.1 (501)	22.5 (513)	8.62 (74.2)	32.8 (1089)	-
Pendimethalin + imazethapyr (ready-mix) 800 g/ha PE	5.18 (26.8)	4.75 (22.4)	3.29 (10.7)	7.74 (60.0)	18.1 (327)	20.7 (431)	7.66 (58.7)	28.5 (817)	45.1
Propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha PoE at 20 DAS	3.07 (10.1)	2.74 (7.61)	2.06 (4.06)	4.54 (21.7)	16.6 (278)	18.3 (340)	6.82 (46.8)	25.7 (664)	78.7
LSD (p=0.05)	0.89	0.72	0.65	0.64	0.98	1.23	0.56	1.08	7.95

*Values are subjected to $\sqrt{x+0.5}$ transformed. Values in parentheses are original values.,

PE: pre-emergence application; PoE: post-emergence application; DAS: days after seeding; WCE: Weed control efficiency management options which also affected the early maturing pigeonpea yield (**Table 4**). The maximum number of pods/plant (159.9), seed yield (1.52 t/ha) and stover yield (4.88 t/ha) were recorded in raised bed with straw mulch and found superior over the raised bed and flatbed land configuration. The pigeonpea yield increased because of increased pods/ plant, this is due to the cumulative action of soil moisture, soil microbial population, aeration and nutrients in optimum quantity under raised bed with straw mulch, and raised bed compared to flatbed as observed earlier by Pandey *et al* (2014), Mankar *et al.* (2013). Among the weed management options, the maximum number of pods/plant, seed yield and stover yield were recorded with propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha which was superior over rest of the weed management options. The stover yield was statistically at par with pendimethalin + imazethapyr (ready-mix) 800 g/ha (**Table 2**). The minimum seed yield was in a control plot due to severe weed competition faced by the crop. The maximum seed yield was obtained from the combination of raised bed + straw mulch and propaquizafop-ethyl + imazethapyr 125 g/ha at 20 DAS. Raised bed + straw mulch resulted in statistically similar yield to flatbed planting along with propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha at 20 DAS and thus underscoring the importance of raised bed + straw mulching for weed control and improved crop performance. (**Table 3**).

Table 3 Interaction effect of land configuration and weed management on seed yield (t/ha) of pigeonpea

Treatments (land configuration/weed management) *	Flat bed	Raised bed	Raised bed + straw mulch
Control	1.10	1.12	1.41
Pendimethalin + imazethapyr (ready-mix) 800 g/ha PE	1.19	1.47	1.50
Propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha PoE at 20 DAS	1.37	1.54	1.64
LSD (p=0.05)		0.13	

PE: pre-emergence application; PoE: post-emergence application; DAS: days after seeding

Table 4 Interaction effect of land configuration and weed management on net returns (₹/ha)

Treatments (land configuration/weed management) *	Flat bed	Raised bed	Raised bed + straw mulch
Control	59876	59778	81541
Pendimethalin + imazethapyr (ready-mix) 800 g/ha	60369	81746	84313
Propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha at 20 DAS	75733	88586	95711
LSD (p=0.05)		9957	

PE: pre-emergence application; PoE: post-emergence application; DAS: days after seeding

Table 2. Effect of land configuration and weed management treatments on yield and economics of pigeonpea

Treatment	Pods/plant (no.)	Seed yield (t/ha)	Stover yield (t/ha)	Net return (x10^3 Rs/ha)	B:C ratio
Land configuration					
Flat bed	94.4	1.219	4.13	65.93	2.17
Raised bed	110.6	1.375	4.43	77.47	2.50
Raised bed + straw mulch	159.9	1.519	4.88	87.77	2.76
LSD (p=0.05)	11.4	0.07	0.28	5.81	0.18
Weed management					
Control	97.8	1.212	4.13	66.97	2.33
Pendimethalin + imazethapyr (ready-mix) 800 g/ha PE	124.9	1.386	4.56	77.69	2.46
Propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha PoE at 20 DAS	142.2	1.515	4.75	86.50	2.65
LSD (p=0.05)	11.4	0.07	0.28	5.81	0.18

*PE: pre-emergence application; PoE: post-emergence application; DAS: days after seeding

Table 5. Effect of land configuration and weed management treatments on nutrient content and uptake by weeds at pigeonpea harvest

Treatment	Nutrient content (%)			Nutrient uptake (kg/ha)		
	N	P	K	N	P	K
Land configuration						
Flat bed	2.57	1.28	1.55	19.7	9.78	12.1
Raised bed	2.50	1.27	1.46	17.4	8.75	10.2
Raised bed + straw mulch	2.49	1.24	1.45	14.1	7.06	8.3
LSD (p=0.05)	NS	NS	NS	2.17	1.01	1.85
Weed management						
Control	2.56	1.29	1.54	22.4	11.22	13.6
Pendimethalin + imazethapyr (ready-mix) 800 g/ha PE	2.54	1.26	1.51	16.5	8.15	9.85
Propaquizafop-ethyl + imazethapyr (ready-mix) 125 g/ha PoE at 20 DAS	2.46	1.25	1.42	12.2	6.22	7.05
LSD (p=0.05)	NS	NS	NS	2.17	1.01	1.85

*PE: pre-emergence application; PoE: post-emergence application; DAS: days after seeding

Economics

The net returns and benefit: cost ratio of pigeonpea were significantly influenced by the land configuration methods (**Table 2**). The raised bed + straw mulch recorded the maximum net returns and B:C ratio over the raised bed and flatbed configurations, the enhanced profitability was attributed to increased seed and stover yields, which resulted in maximum net returns (₹ 87,773/ha) and B:C ratio (2.76) as reported by Garud *et al*. (2018). With respect to weed management strategies, the application of propaquizafop-ethyl + imazethapyr 125 g/ha at 20 DAS resulted in the highest cost of cultivation, yet it also delivered superior economic returns and B:C ratio, followed by pendimethalin + imazethapyr (ready-mix). The increased profitability with propaquizafop-ethyl + imazethapyr was due to the improved seed and stalk yield, which resulted in higher net returns and B:C ratio. Similar trends were reported by Padmaja *et al.* (2013) and Singh *et al*. (2020). The maximum net return (₹ 95,711/ha) was recorded with the combination of raised bed + straw mulch and propaquizafop-ethyl + imazethapyr 125 g/ha at 20 DAS (**Table 4**).

It can be concluded that the sowing of pigeonpea on raised bed with straw mulch was most productive and profitable land configuration while among weed management options, propaquizafop-ethyl + imazethapyr 125 g/ha PoE at 20 DAS was most profitable with higher net returns and B:C ratio.

REFERENCES

Badvel A, Vadivel N, Sivakumar R, Natarajan S and Arunadevi K. 2024. Optimizing land configuration and weed management practices for enhanced productivity of pigeonpea. *Plant Science Today* **11**: 5468.

Busari, MA, Kulal, SS, Kaur, A, Bhatt, R and Dulazi, AA. 2015. Conservation tillage impacts on soil, crop and the environment. *International Soil and Water Conservation Research* **3:** 119–129.

Directorate of Economics and Statistics. 2022. Agricultural Statistics at a Glance 2022. Department of Agriculture and Cooperation, New Delhi. 40–44p.

Directorate of Pulses Development. 2024. Annual Report 2022-23, Directorate of Pulses Development, Bhopal (MP). 19p.

FAO, 2024. Food and Agriculture Organization. Rome. Accessed 2 April 2026.

Garud HS, Asewar BV, Pawar SU and Mirza IAB. 2018. Yield and economics of pigeonpea based intercropping systems as influenced by different land configurations. *Agricultural Science Digest-A Research Journal* **38**(4): 275–279.

Goud VV and Patil AN. 2014. Increase in growth and yield of pigeonpea with weed management. *Indian Journal of Weed Science* **46**(3): 264–266.

Hussain ME, Sharma S, Joel AJ, and Kilian B. 2022. Photoperiod Insensitivity in Pigeonpea Introgression Lines Derived from Wild *Cajanus* Species. *Agronomy* **12**: 1370.

IIPR, 2015. Vision, 2050. ICAR- Indian Institute of Pulses Research, Kanpur. 4p.

Lichter K, Govaerts B, Six J, Sayre KD, Deckers J, and Dendooven L. 2008. Aggregation and C and N contents of soil organic matter fractions in a permanent raised-bed planting system in the Highlands of Central Mexico. *Plant and Soil* **305**: 237–252.

Mankar DD and Nawlakhe SM. 2013. Effect of land configuration and phosphate management on growth and yield of semi-rabi pigeonpea. *Crop Research* **46**: 84–87.

Padmaja B, Reddy MM and Reddy D. 2013. Weed control efficiency of pre and postemergence herbicides in pigeonpea (*Cajanus cajan* L.). *Journal of Food Legumes* **26**: 44–45.

Pandey IB, Tiwari S, Pandey RK and Kumar R. 2014. Effect of bed configuration, fertilizer levels and placement method on the productivity of long duration Pigeonpea (*Cajanus cajan* (L) Millsp) under rainfed condition. *Journal of Food Legumes* **27**(3): 206–209.

Rao A N and Chauhan BS. 2015. Weeds and weed management in India - A Review. In: Weed Science in the Asian Pacific Region. Indian Society of Weed Science, Hyderabad, pp. 87–118.

Rao A N, Singh RG, Mahajan G and Wani, S.P. 2020. Weed research issues, challenges, and opportunities in India. *Crop Protection*. **134**: 104451.

Rao PV, Reddy AS, Rajamani S, Sreekanth M and Ramana MV. 2018. Effect of integrated weed management practices on yield and economics of Pigeonpea [*Cajanus cajan* (L.) Millsp.]. *International Journal of Pure Applied Bioscience* **6**(2):1275–1280.

Rao VS. 2000. *Principles of Weed Science*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

Singh AK, Singh RS, Singh AK, Kumar R, Kumawat N, Singh NK, Singh SP and Shanker R. 2020. Effect of weed management on weed interference, nutrient depletion by weeds and production potential of long duration pigeonpea (*Cajanus cajan* L.) under irrigated ecosystem. *International Journal of Current Microbiology and Applied Sciences* **9**(1): 676–689.

Talnikar AS, Kadam DR, Karande DR and Jogdand PB. 2008. Integrated weed management in Pigeonpea. *International Journal of Agricultural Sciences* **4:** 363–370.