



Influence of Pre and Post Emergence Herbicides on Weed Dynamics, WCE and Yield of Pigeon Pea under Rainfed Conditions

Yusufali A. Nimbargi¹, Narayan S. Mavarkar¹, Pandit S. Rathod^{1*}, Ganapathi¹ and M. S. Nandish¹

¹College of Agriculture, Shivamogga, Zonal Agricultural Research station, Kalaburagi, India.

Authors' contributions:

This work was carried out in collaboration among all authors. All authors were designed the research work. Author YAN conducted the study and, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2021/v33i1930598

Editor(s):

(1) Prof. Faruk Toklu, University of Çukurova, Turkey.

Reviewers:

(1) Vívian Ebeling Viana, Federal University of Pelotas, Brazil.

(2) Ashirbanchan Mahapatra, ICAR - National Rice Research Institute, India.

Complete Peer review History: <https://www.sdiarticle4.com/review-history/67204>

Received 10 February 2021

Accepted 16 April 2021

Published 09 September 2021

Original Research Article

ABSTRACT

A field experiment was conducted at ICAR-KVK, Kalaburagi, during *Kharif* seasons of 2018-19 and 2019-20 to adjudge the efficacy of pre and post emergence herbicides against diverse weed flora in pigeonpea ecosystem. The experiment was laid out in RCBD with 11 treatments comprising of different pre-emergent herbicides viz., Pendimethalin, Pendimethalin 30 EC + Imazethapyr 2 EC and post-emergence premix product herbicides such as Imazamox 35 WG + Imazethapyr 35 WG, Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME and their different dosages with cultural methods were compared with weed free check and weedy check treatments. Among the different pre and post emergent herbicides tested against different weed flora, post emergent application of Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME @ 2000 ml ha⁻¹ at 20-25 days recorded significantly lower weed density, weed dry weight, highest weed control efficiency (91.36%) and lowest weed index (8.78%) and higher grain yield (1209 kg ha⁻¹), net returns (₹ 43,036 ha⁻¹) and benefit cost ratio (2.35) followed by Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME @ 1500 ml ha⁻¹ at 20-25 DAS, Imazamox 35 WG + Imazethapyr 35 WG at 100 g ha⁻¹ at 20-25 DAS and HW at 20 and IC 40 and 60 DAS.

Keywords: Pigeonpea; pre-emergence; post-emergence; weeds; weed dry weight.

1. INTRODUCTION

India is the largest producer of pigeonpea contributing 90 per cent to the world's production. The per capita availability of pulses in India is hardly 47 g/person/day against WHO's recommendation of 80 g/person/day so to meet this gap there is urgent need to evolve appropriate strategies for increasing production and productivity of pulses to meet the protein requirement of ever increasing population.

The productivity of pigeonpea is constrained by various biotic and abiotic factors, resulting in drastic reduction in yields and harvesting miserably poor yields (600-700 kg ha⁻¹) in comparison to its potential yield (2500 to 3000 kg ha⁻¹). Among the biotic constraints, weeds pose serious threat as compared to insect pests and diseases in realization of potential yields. Weeds alone causes up to 50 to 60 per cent yield losses by competing for natural resources like light, nutrients, water and space. Weeds may be mechanically managed by one hand weeding at 20 days after sowing (DAS) followed by intercultivation at 40 and 60 DAS. The aim of weed control is to manage the vegetation in such a way that it encourages the growth of plants beneficial to our interest at a particular place and time, and should suppress the remaining, particularly unwanted species. Pigeonpea being a widely spaced and slow growing crop during early stage, provides ample opportunity for weeds to grow which causes severe crop-weed competition for water, space, nutrients and sunlight during *kharif* season and reducing the crop yield drastically. The critical period of crop weed competition is during the first 6 to 8 weeks after sowing. Losses in grain yield caused by the weeds in pigeonpea are reported to the extent of 32 to 68 per cent in the peninsular zone [1].

The weeds can be effectively controlled by engaging different methods like cultural, physical/mechanical, biological and chemical. However, physical/mechanical methods of weed control was achieved by hand weeding at 20 DAS and intercultivation (twice) at 40 and 60 DAS and weeds can be effectively controlled, but because of high labour wages, continuous rainfall and non-availability of labours at peak period of crop weed competition, sometimes these methods may not be effective and economical. Now a days, very less number of herbicides is available for controlling many weed

species effectively in pigeonpea. Therefore, farmers are switching towards post emergence herbicides viz., imazethapyr, bentazone, propaquizafop, quizalofop-p-ethyl, clorimuron etc., but their weed control spectrum is narrow. Henceforth the ready/pre mixture herbicides are being used for weed control in pulses particularly in pigeonpea.

2. MATERIALS AND METHODS

The experiment was conducted at the ICAR-KVK Kalaburgi (Karnataka) during the *Kharif* season of 2018-19, and 2019-20. The soil of the experimental site was sandy clay loam in texture, neutral in reaction (pH 7.8) with an electrical conductivity of 0.17 dSm⁻¹. The soil organic carbon content was low (0.51%). The soil was low in available nitrogen (187 kg ha⁻¹), medium in available phosphorus (23.4 kg ha⁻¹) and available potassium (289 kg ha⁻¹). The experiment was laid out with 11 treatments, PE herbicides viz., pendimethalin and post-emergence premix product herbicides such as Imazamox 35 WG + Imazethapyr 35 WG, Pendimethalin 30 EC + Imazethapyr 2 EC, Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME and their different doses with cultural methods were compared with weed free check and weedy check treatments. The pigeonpea variety GRG-811 (160-165 days) was sown at 90 x 30 cm during second week of June and harvested during second week of December during both the years. The recommended fertilizer dose (25:50:0 kg/ha as N: P₂O₅ and K₂O) was applied at the time of sowing through urea and diamonium phosphate. All agronomic practices were adopted as per requirement of the crop. Pre emergence herbicides application were sprayed on next day after sowing and post emergence sprayed at 20-25 days after sowing using 500 litres of water per hectare. The knapsack sprayer with flat fan nozzle was used for spraying post emergence herbicides.

The observations at 30, 60, 90, 120 DAS and at harvest such as the number of weeds and weed dry weight was recorded using 0.25 m⁻² quadrants from randomly marked place in each plot. The weeds were grouped into monocots, dicots, sedge and total weeds were expressed as number 0.5 m⁻². The data was subjected to $\sqrt{x+0.5}$ transformation. The weed control efficiency and weed index was worked out by using formula:

$$\text{WCE (\%)} = \frac{\text{WCC} - \text{WCT}}{\text{WCC}} \times 100$$

Where,

WCE= Weed control efficiency

WCC = Dry weight of weeds in unweeded control plot

WCT = Dry weight of weeds in treated plot

$$\text{Weed index (\%)} = \frac{X - Y}{X} \times 100$$

Where,

X – Seed pigeonpea yield in weeds free check plot (kg ha⁻¹)

Y – Seed pigeonpea yield in treated plot (kg ha⁻¹)

The seed yields of pigeonpea were recorded and, the statistical analysis and interpretation of data were done using the Fisher's method of analysis of variance technique as described by Panse and Sukhatme [2].

3. RESULTS AND DISCUSSION

3.1 Weed Flora

The important grassy weeds observed in the experimental plot were *Agropyron repens*, *Cynodon dactylon*, *Celosia argentea*, *Digitaria ciliaris*, *Dinebra retroflexa*, Sedges like *Cyperus rotundus* while common broadleaf weeds observed were *Abutilon indicum*, *Acalypha indica*, *Acanthospermum hispidum*, *Amaranthus spinosus*, *Aristolochia bracteata*, *Commelina benghalensis*, *Cyanotis cucullata*, *Digera arvensis*, *Eurphobia hirta*, *Euphorbia geniculata*, *Legascea mollis*, *Leucas aspera*, *Parthenium hysterophorus*, *Phyllanthus niruri*, *Physalis minima*, *Portulaca oleracea*, *Sida actua*, *Tridax procumbens*, and *Xanthium strumarium* were noticed.

3.2 Weed Density

Different weed control treatments had significant influence on monocot, dicot, sedges and total weed density at all the growth stages. The pooled data of two years indicated that, post emergence application of Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 2000 ml ha⁻¹ at 20-25 DAS recorded significantly lower number of monocot (1.12, 1.35, 1.07, 0.98 and 1.07 at 30, 60, 90, 120 DAS and harvest, respectively), dicots (3.15, 3.03, 2.99, 2.88 and 2.76 at 30, 60, 90, 120 DAS and harvest, respectively) and sedges (1.29, 1.41, 1.35, 1.22 and 1.15 at 30,

60, 90, 120 DAS and harvest, respectively) weed populations as compared to rest of the treatments at all the growth stages of the crop. Propaquizafop is an herbicide of arylophenoxy propionates family. It is a systemic herbicide which is quickly absorbed by the leaves and translocated from the foliage to the growing points of the leaves and roots of the sprayed weeds. The similar results were reported by Channabasavanna et al. [3] who reported that propaquizafop 10% EC controlled monocot weeds and sedges efficiently. The treatment has another chemical that is imazethapyr, which is very effective on the dicot and some monocot weeds. Imazethapyr is an herbicide of the imidazolinones class. It is a broad spectrum herbicide which is inhibition of acetolactate synthase (ALS inhibitor) that is a key enzyme in biosynthesis of amino acids like leucine, isoleucine and valine. Similar results were found by Asma et al. [4] who reported that, post emergence application of propaquizafop + imazethapyr arrested the weed biomass production remarkably and proved superior to alone application of propaquizafop, fenaxaprop-ethyl and imazethapyr.

However, it remained on par with Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 1500 ml ha⁻¹ at 20-25 DAS, Imazamox 35 WG + Imazethapyr 35 WG at 100 g ha⁻¹ at 20-25 DAS and HW at 20 DAS and IC at 40 and 60 DAS. Weedy check recorded significantly higher number of monocot, dicot and sedges weed populations Tables 1, 2, 3 and 4.

3.3 Total Weed Dry Matter

The pooled results of the experiments showed Table 5 that, total dry matter of weeds in weedy check (11.73, 13.74, 11.63, 11.51 and 10.93 at 30, 60, 90, 120 DAS and harvest, respectively) was maximum because of higher weed intensity and higher dry weight due to its dominance in utilizing the growth resources like sunlight, nutrients, moisture, CO₂ etc., Weed free check recorded significantly lower weed dry weight at all the growth stages of pigeonpea. Among the herbicidal treatments, Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 2000 ml ha⁻¹ (3.24, 3.50, 3.49, 3.57 and 3.23 g 0.25 m⁻², respectively at 30, 60, 90, 120 and at harvest) recorded significantly lower total dry weight of weeds and was on par with that of Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 1500 ml ha⁻¹, Imazamox 35 WG + Imazethapyr 35 WG @ 100 g ha⁻¹. This could be

due to effective control of weeds by post emergence application of herbicides during growing stage of crop which curb the biomass of the weed. These results were in agreement with Murali et al. (2013), Manu et al. [5] and Das [6].

3.4 Weed Control Efficiency (%) and Weed Index (%)

Among the weed control treatments, Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 2000 ml ha⁻¹ (92.60, 93.23, 91.08, 90.07 and 91.36 % respectively at 30, 60, and 90,120 and at harvest) significantly recorded higher weed control efficiency over the other treatments followed by Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 1500 ml ha⁻¹ Imazamox 35 WG + Imazethapyr 35 WG @ 100 g ha⁻¹ and HW at 20 DAS and IC at 40 and 60 DAS. However, significantly lower WCE was recorded with weedy check and highest WCE recorded in the weed free check. This may be due to total elimination of weeds at critical stages of crop growth and could be attributed to lower weed count as well as dry weight of weeds in these treatments when compared to the weedy check due to reduction in dry matter accumulation by weeds under combined application of the herbicides rather than alone application. Similar results are also obtained by Susmita et al. [7] who reported that post-emergence application of Propaquizafop alone recorded lower WCE, curbed only grassy weeds. But combined application of Propaquizafop + Imazethapyr mixture applied attained higher values of weed control efficiency Table 6.

With respect to weed index, significantly lower weed index was observed in POE application of Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 2000 ml ha⁻¹ at 20-25 DAS (8.78%) followed by Propaquizafop 2.5% + Imazethapyr 3.75% w/w ME at 1500 ml ha⁻¹ at 20-25 DAS, Imazamox 35 WG + Imazethapyr 35 WG @ 100 g ha⁻¹ at 20-25 DAS. However, weedy check recorded significantly higher weed index (43.42%). While, weed free plot recorded significantly lower weed index than other treatments under study. Weed index is an ideal parameter to describe yield loss caused by weed infestation in comparison with weed free plots [8].

3.5 Grain Yield (kg ha⁻¹)

During both the years of study Table 7, significantly higher grain yield of pigeonpea was recorded with weed free check (1179 and 1438 kg ha⁻¹, respectively) when compared to weedy

check (776 and 987 kg ha⁻¹, respectively). Among the weed management treatments viz., Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 2000 ml ha⁻¹ at 20-25 DAS (1101 and 1317 kg ha⁻¹, respectively) recorded significantly higher grain yield and was on par with that of Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 1500 ml ha⁻¹ at 20-25 DAS (986 and 1274 kg ha⁻¹, respectively), Imazamox 35 WG + Imazethapyr 35 WG @ 100 g ha⁻¹ at 20-25 DAS (983 and 1263 kg ha⁻¹, respectively) and HW at 20 DAS and IC at 40 and 60 DAS (995 and 1276 kg ha⁻¹, respectively) treatments. The higher yields in these treatments could be attributed due to higher weed control efficiency and higher nutrient uptake by crop and selective nature of herbicide leads to minimize crop-weed competition. Thus, crop plants have used available resources effectively throughout the crop growth resulting in higher seed yield. Results obtained in this study are in conformity with Vinuta [9] and Pradhan et al. [10] who reported post emergence application of lectofen 120 g ha⁻¹ + propaquizafop 60 g ha⁻¹ mixture gave higher weed control efficiency and seed yield due to reduction in dry matter accumulation by weeds under combined application of the herbicides rather than alone application.

3.6 Economics

The pooled data Table 7 indicated that significantly higher gross return was recorded with weed free check (₹81,148 ha⁻¹) as against weedy check control (₹54,636 ha⁻¹). Among the weed management treatments viz., Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 2000 ml ha⁻¹ at 20-25 DAS (₹74961 ha⁻¹) registered significantly higher gross returns when compared to other treatments. The lower gross returns were obtained in weedy check, which was mainly owing to less seed yield, obtained due to uncontrolled weeds throughout the crop growth. Similar results were found by Susmita [7].

Significantly higher net returns were recorded with POE application of Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME @ 2000 ml ha⁻¹ at 20-25 DAS (₹43,036 ha⁻¹). The higher net returns were due to higher gross returns and lower cost of cultivation incurred on the production in respective treatments compared to other treatments. Higher benefit cost 2.35 was recorded in POE application of propaquizafop 2.5% + imazethapyr 3.75%w/w ME @ 2000 ml ha⁻¹ at 20-25 DAS. The higher benefit cost ratio was due to reduced cost of cultivation and higher

Table 1. Monocot weed count (No. 0.25 m⁻²) at different crop growth stages of pigeonpea as influenced by chemical weed management approaches

Treatments	2018					2019					Pooled				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T ₁	1.46 (1.67)	1.77 (2.67)	1.46 (1.67)	1.34 (1.33)	1.34 (1.33)	1.58 (2.00)	1.86 (3.00)	1.68 (2.33)	1.58 (2.00)	1.68 (2.33)	1.53 (1.83)	1.82 (2.83)	1.58 (2.00)	1.47 (1.67)	1.53 (1.83)
T ₂	1.34 (1.33)	1.56 (2.00)	1.22 (1.00)	1.22 (1.00)	1.22 (1.00)	1.34 (1.33)	1.44 (1.67)	1.34 (1.33)	1.17 (1.00)	1.34 (1.33)	1.35 (1.33)	1.51 (1.83)	1.29 (1.17)	1.21 (1.00)	1.29 (1.17)
T ₃	1.58 (2.00)	1.95 (3.33)	1.77 (2.67)	1.58 (2.00)	1.68 (2.33)	1.68 (2.33)	2.11 (4.00)	1.86 (3.00)	1.86 (3.00)	1.77 (2.67)	1.63 (2.17)	2.04 (3.67)	1.82 (2.83)	1.73 (2.50)	1.73 (2.50)
T ₄	1.46 (1.67)	1.68 (2.33)	1.46 (1.00)	1.46 (1.67)	1.56 (2.00)	1.58 (2.00)	1.86 (3.00)	1.77 (2.67)	1.58 (2.00)	1.58 (2.00)	1.53 (1.83)	1.78 (2.67)	1.63 (2.17)	1.53 (1.83)	1.58 (2.00)
T ₅	1.22 (1.00)	1.67 (1.46)	1.22 (0.67)	1.17 (1.00)	1.05 (0.67)	1.22 (1.00)	1.46 (1.67)	1.22 (1.00)	1.22 (1.00)	1.34 (1.33)	1.22 (1.00)	1.47 (1.67)	1.22 (1.00)	1.21 (1.00)	1.21 (1.00)
T ₆	1.05 (0.67)	1.33 (1.34)	1.05 (0.33)	0.88 (0.33)	0.88 (0.33)	1.17 (1.00)	1.34 (1.33)	1.05 (0.67)	1.05 (0.67)	1.22 (1.00)	1.12 (0.83)	1.35 (1.33)	1.07 (0.67)	0.98 (0.50)	1.07 (0.67)
T ₇	1.58 (2.00)	1.68 (2.33)	1.46 (1.67)	1.34 (1.33)	1.44 (1.67)	1.68 (2.33)	1.95 (3.33)	1.77 (2.67)	1.77 (2.67)	1.68 (2.33)	1.63 (2.17)	1.82 (2.83)	1.63 (2.17)	1.58 (2.00)	1.58 (2.00)
T ₈	1.68 (2.33)	1.87 (3.00)	1.77 (2.67)	1.77 (2.67)	1.87 (3.00)	1.77 (2.67)	2.04 (3.67)	1.95 (3.33)	2.04 (3.67)	2.04 (3.67)	1.73 (2.50)	1.96 (3.33)	1.87 (3.00)	1.91 (3.17)	1.96 (3.33)
T ₉	1.34 (1.33)	1.46 (1.67)	1.17 (1.00)	1.05 (0.67)	1.17 (1.00)	1.34 (1.33)	1.56 (2.00)	1.29 (2.33)	1.44 (1.67)	1.46 (1.67)	1.35 (1.33)	1.53 (1.83)	1.27 (1.17)	1.27 (1.17)	1.33 (1.33)
T ₁₀	3.72 (13.33)	3.89 (14.67)	3.89 (14.67)	3.89 (14.33)	3.89 (14.67)	3.67 (13.00)	15.67 (4.02)	4.14 (16.67)	3.90 (15.33)	4.06 (16.00)	3.70 (13.17)	3.96 (15.17)	4.02 (15.67)	3.93 (15.00)	3.94 (15.33)
T ₁₁	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)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
S.Em±	0.28	0.31	0.35	0.36	0.44	0.32	0.38	0.38	0.42	0.26	0.23	0.19	0.24	0.30	0.27
C.D. at 5%	10.71	10.20	13.11	14.09	17.14	11.68	12.16	13.06	14.65	9.05	8.53	6.24	8.56	10.91	9.59

* Figures in parenthesis indicate original values, ** Values are square root transformed $\sqrt{x+0.5}$

T₁ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (70 g ha⁻¹)

T₂ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (100 g ha⁻¹)

T₃ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (2500 ml ha⁻¹)

T₄ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (3000 ml ha⁻¹)

T₅ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (1500 ml ha⁻¹)

T₆ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (2000 ml ha⁻¹)

T₇ : Imazethapyr 10 SL at 20-25 DAS (1000 ml ha⁻¹)

T₈ : Pendimethalin 30 EC at 2 DAS (3333 ml ha⁻¹)

T₉ : HW at 20 DAS and IC at 40 and 60 DAS

T₁₀ : Weedy check

T₁₁ : Weed free check

Table 2. Dicot weed count (No.0.25 m⁻²) at different crop growth stages of pigeonpea as influenced by chemical weed management approaches

Treatments	2018					2019					Pooled				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T ₁	4.30 (18.00)	4.00 (15.67)	3.91 (15.00)	3.80 (14.00)	3.72 (13.33)	4.33 (18.67)	4.20 (17.67)	4.02 (16.00)	3.78 (14.00)	3.77 (14.00)	4.33 (18.33)	4.11 (16.67)	3.94 (15.00)	3.79 (14.00)	3.75 (13.67)
T ₂	3.65 (13.00)	3.42 (11.33)	3.13 (9.33)	3.13 (9.33)	2.98 (8.67)	3.70 (13.33)	3.42 (11.33)	3.38 (11.00)	3.22 (10.00)	3.20 (10.00)	3.68 (13.17)	3.42 (11.33)	3.26 (10.17)	3.18 (9.67)	3.10 (9.33)
T ₃	4.47 (19.67)	4.09 (16.33)	4.22 (17.33)	4.05 (16.00)	4.02 (15.67)	4.59 (21.00)	4.09 (16.33)	4.05 (16.07)	4.05 (16.00)	4.02 (16.00)	4.53 (20.33)	4.10 (16.33)	4.12 (16.50)	4.05 (16.00)	4.04 (15.83)
T ₄	3.74 (14.00)	4.02 (15.67)	4.12 (16.67)	3.62 (12.33)	3.74 (13.67)	3.92 (15.00)	4.03 (16.00)	4.17 (17.00)	3.80 (14.33)	3.85 (14.67)	3.84 (14.50)	4.03 (15.83)	4.08 (16.17)	3.74 (3.50)	3.82 (14.17)
T ₅	3.62 (12.67)	3.11 (9.33)	3.05 (9.00)	3.03 (9.00)	2.86 (8.00)	3.57 (12.33)	3.49 (11.17)	3.48 (11.67)	3.23 (10.00)	3.18 (9.67)	3.60 (12.50)	3.31 (10.50)	3.28 (10.33)	3.16 (9.50)	3.04 (8.83)
T ₆	3.19 (9.67)	3.02 (8.67)	2.90 (8.00)	2.89 (8.00)	2.76 (7.33)	3.11 (9.33)	3.02 (7.33)	3.07 (9.00)	2.81 (7.67)	2.73 (7.00)	3.15 (9.50)	3.03 (8.67)	2.99 (8.50)	2.88 (7.83)	2.76 (7.17)
T ₇	5.17 (26.33)	4.96 (24.33)	4.89 (23.67)	4.81 (23.00)	4.78 (22.67)	5.27 (27.33)	5.20 (26.67)	5.14 (26.00)	5.07 (25.33)	5.03 (25.00)	5.22 (26.83)	5.09 (25.50)	5.02 (24.83)	4.95 (24.17)	4.91 (23.83)
T ₈	5.87 (34.00)	5.81 (33.33)	5.87 (34.00)	5.78 (33.00)	5.75 (32.67)	6.00 (35.67)	5.98 (35.33)	5.92 (34.67)	5.94 (35.00)	5.90 (34.67)	5.94 (34.83)	5.90 (34.33)	5.90 (34.33)	5.87 (34.00)	5.84 (33.67)
T ₉	3.72 (13.67)	3.42 (11.67)	3.24 (10.00)	3.19 (9.67)	3.08 (9.00)	3.19 (16.00)	3.28 (10.33)	3.29 (10.33)	3.18 (9.67)	3.24 (10.00)	3.86 (14.83)	3.38 (11.00)	3.27 (10.17)	3.19 (9.67)	3.16 (9.50)
T ₁₀	6.79 (46.67)	7.81 (61.33)	8.13 (66.00)	8.48 (72.00)	8.54 (72.67)	7.67 (58.67)	7.94 (63.00)	8.18 (67.33)	7.60 (57.67)	7.59 (57.33)	7.27 (52.67)	7.91 (62.17)	8.19 (66.67)	8.08 (64.83)	8.09 (65.00)
T ₁₁	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)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
S.Em±	0.35	0.30	0.27	0.29	0.30	0.34	0.30	0.31	0.31	0.32	0.28	0.20	0.17	0.18	0.20
C.D. at 5%	1.03	0.90	0.79	0.86	0.88	0.99	0.89	0.92	0.91	0.93	0.82	0.58	0.50	0.54	0.60

* Figures in parenthesis indicate original values, ** Values are square root transformed $\sqrt{x+0.5}$

T₁ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (70 g ha⁻¹)

T₂ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (100 g ha⁻¹)

T₃ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (2500 ml ha⁻¹)

T₄ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (3000 ml ha⁻¹)

T₅ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (1500 ml ha⁻¹)

T₆ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (2000 ml ha⁻¹)

T₇ : Imazethapyr 10 SL at 20-25 DAS (1000 ml ha⁻¹)

T₈ : Pendimethalin 30 EC at 2 DAS (3333 ml ha⁻¹)

T₉ : HW at 20 DAS and IC at 40 and 60 DAS

T₁₀ : Weedy check

T₁₁ : Weed free check

Table 3. Sedge weed count (No .0.25 m⁻²) at different crop growth stages of pigeonpea as influenced by chemical weed management approaches

Treatments	2018					2019					Pooled				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T ₁	1.68 (2.33)	1.86 (3.00)	1.68 (2.33)	1.58 (2.00)	1.46 (1.67)	1.86 (3.00)	1.94 (3.33)	1.87 (3.00)	1.78 (2.67)	1.566 (2.33)	1.78 (2.67)	1.91 (3.17)	1.78 (2.67)	1.68 (2.33)	1.52 (1.83)
T ₂	1.44 (2.00)	1.64 (2.33)	1.58 (2.00)	1.35 (1.33)	1.34 (1.33)	1.56 (2.00)	1.44 (2.67)	1.58 (2.00)	1.47 (1.67)	1.34 (1.33)	1.50 (1.83)	1.58 (2.00)	1.58 (2.00)	1.41 (1.50)	1.35 (1.33)
T ₃	1.86 (3.00)	1.94 (3.33)	1.87 (3.00)	1.78 (2.67)	1.68 (2.33)	1.94 (3.33)	2.04 (3.67)	1.96 (3.33)	1.87 (3.00)	1.77 (2.67)	1.91 (3.17)	2.00 (3.50)	1.91 (3.17)	1.82 (2.83)	1.73 (2.50)
T ₄	1.77 (2.67)	1.82 (3.00)	1.78 (2.67)	1.68 (2.33)	1.56 (2.00)	1.86 (3.00)	1.94 (3.33)	1.87 (3.00)	1.78 (2.67)	1.68 (2.33)	1.82 (2.83)	1.91 (3.17)	1.81 (2.83)	1.73 (2.50)	1.62 (2.17)
T ₅	1.34 (1.33)	1.56 (2.00)	1.47 (1.67)	1.35 (1.33)	1.17 (1.00)	1.44 (1.67)	1.46 (1.33)	1.47 (1.67)	1.35 (1.33)	1.34 (1.33)	1.39 (1.50)	1.51 (1.83)	1.46 (1.67)	1.35 (1.33)	1.29 (1.17)
T ₆	1.22 (1.00)	1.46 (1.67)	1.35 (1.33)	1.22 (1.00)	1.05 (0.67)	1.34 (1.33)	1.34 (1.33)	1.35 (1.33)	1.22 (1.00)	1.22 (1.00)	1.29 (1.17)	1.41 (1.50)	1.35 (1.33)	1.22 (1.00)	1.15 (0.83)
T ₇	1.77 (2.67)	1.86 (3.00)	1.78 (2.67)	1.68 (2.33)	1.56 (2.00)	1.86 (3.00)	1.94 (3.33)	1.96 (3.33)	1.87 (3.00)	1.77 (2.67)	1.82 (2.83)	1.91 (3.17)	1.87 (3.00)	1.77 (2.67)	1.68 (2.33)
T ₈	1.86 (3.00)	2.11 (4.00)	2.12 (4.00)	2.04 (3.67)	1.95 (3.33)	2.04 (3.67)	2.19 (4.33)	2.20 (4.33)	2.12 (4.00)	2.04 (3.67)	1.95 (3.33)	2.15 (4.17)	2.15 (4.17)	2.07 (3.83)	2.00 (3.50)
T ₉	1.46 (1.67)	1.66 (2.33)	1.68 (2.33)	1.47 (1.67)	1.34 (1.53)	1.58 (2.00)	1.56 (2.00)	1.58 (2.00)	1.47 (1.67)	1.27 (1.33)	1.53 (1.83)	1.62 (2.17)	1.61 (2.17)	1.46 (1.67)	1.33 (1.33)
T ₁₀	2.80 (7.33)	3.23 (10.00)	3.29 (10.33)	3.34 (10.67)	3.29 (10.33)	3.13 (7.33)	3.29 (10.33)	3.34 (10.67)	3.34 (10.67)	3.24 (10.00)	2.97 (8.33)	3.27 (10.17)	3.31 (10.50)	3.34 (10.67)	3.27 (10.17)
T ₁₁	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)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
S.Em±	0.14	0.13	0.14	0.14	0.14	0.15	0.15	0.16	0.13	0.1	0.10	0.07	0.08	0.10	0.09
C.D. at 5%	0.42	0.38	0.40	0.42	0.40	0.44	0.45	0.47	0.39	0.4	0.30	0.20	0.25	0.29	0.27

* Figures in parenthesis indicate original values

** Values are square root transformed $\sqrt{x+0.5}$

- T₁ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (70 g ha⁻¹)
- T₂ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (100 g ha⁻¹)
- T₃ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (2500 ml ha⁻¹)
- T₄ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (3000 ml ha⁻¹)
- T₅ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (1500 ml ha⁻¹)
- T₆ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (2000 ml ha⁻¹)

- T₇ : Imazethapyr 10 SL at 20-25 DAS (1000 ml ha⁻¹)
- T₈ : Pendimethalin 30 EC at 2 DAS (3333 ml ha⁻¹)
- T₉ : HW at 20 DAS and IC at 40 and 60 DAS
- T₁₀ : Weedy check
- T₁₁ : Weed free check

Table 4. Total weed density (No. 0.25 m⁻²) at different crop growth stages of pigeonpea as influenced by chemical weed management approaches

Treatments	2018					2019					Pooled				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T ₁	4.74 (22.00)	4.66 (21.33)	4.39 (19.00)	4.22 (17.33)	4.10 (16.33)	4.88 (23.67)	4.91 (24.00)	4.64 (21.33)	4.36 (18.67)	4.32 (18.67)	4.82 (22.83)	4.79 (22.67)	4.49 (19.67)	4.29 (18.00)	4.21 (17.33)
T ₂	4.04 (16.00)	4.02 (15.67)	3.58 (12.33)	3.48 (11.67)	3.36 (11.00)	4.12 (16.67)	3.85 (14.67)	3.84 (14.33)	3.62 (12.67)	3.94 (12.67)	4.08 (16.33)	3.94 (15.17)	3.72 (13.33)	3.56 (12.17)	3.49 (11.83)
T ₃	4.99 (24.67)	4.84 (23.00)	4.85 (23.00)	4.59 (20.67)	4.56 (20.33)	5.18 (26.67)	4.95 (24.00)	4.77 (22.33)	4.74 (22.00)	4.65 (21.33)	5.09 (25.67)	4.90 (23.50)	4.79 (22.50)	4.67 (21.33)	4.62 (20.83)
T ₄	4.30 (18.33)	4.63 (21.00)	4.60 (21.00)	4.14 (16.67)	4.24 (17.67)	4.51 (20.00)	4.74 (22.33)	4.80 (22.67)	4.39 (19.00)	4.39 (19.00)	4.41 (19.17)	4.70 (21.67)	4.65 (21.17)	4.28 (17.33)	4.33 (18.33)
T ₅	3.93 (15.00)	3.64 (13.00)	3.46 (11.67)	3.42 (11.33)	3.13 (9.67)	3.93 (15.00)	3.94 (15.00)	3.85 (14.33)	3.58 (12.33)	3.57 (12.33)	3.93 (15.00)	3.80 (14.00)	3.69 (13.17)	3.51 (11.83)	3.38 (11.00)
T ₆	3.44 (11.33)	3.48 (11.67)	3.23 (10.00)	3.12 (9.33)	2.95 (8.33)	3.47 (11.67)	3.43 (11.33)	3.38 (11.00)	3.11 (9.33)	3.08 (9.00)	3.46 (11.50)	3.46 (11.50)	3.31 (10.50)	3.13 (9.33)	3.02 (8.67)
T ₇	5.61 (31.00)	5.48 (29.67)	5.32 (28.00)	5.18 (26.67)	5.14 (26.33)	5.75 (32.67)	5.81 (33.33)	5.69 (32.00)	5.60 (31.00)	5.51 (30.00)	5.68 (31.83)	5.65 (31.50)	5.51 (30.00)	5.40 (28.83)	5.33 (28.17)
T ₈	6.30 (39.33)	6.38 (40.33)	6.41 (40.67)	6.30 (39.33)	6.27 (39.00)	6.51 (42.00)	6.61 (43.33)	6.54 (42.33)	6.56 (42.67)	6.50 (42.00)	6.41 (40.67)	6.50 (41.83)	6.48 (41.50)	6.44 (41.00)	6.40 (40.50)
T ₉	4.10 (16.67)	4.02 (15.67)	3.72 (13.33)	3.53 (12.00)	3.44 (11.33)	4.40 (19.33)	3.83 (14.33)	3.76 (13.67)	3.65 (13.00)	3.66 (13.00)	4.25 (18.00)	3.93 (15.00)	3.74 (13.50)	3.59 (12.50)	3.55 (12.17)
T ₁₀	8.19 (67.33)	9.27 (86.00)	9.56 (91.00)	9.87 (97.33)	9.87 (97.00)	9.01 (81.00)	9.45 (89.00)	9.72 (94.67)	9.17 (83.67)	9.15 (83.33)	8.63 (74.17)	9.38 (87.50)	9.66 (92.83)	9.54 (90.50)	9.52 (90.17)
T ₁₁	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)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
S.Em±	0.32	0.25	0.25	0.26	0.28	0.31	0.30	0.27	0.25	0.28	0.27	0.19	0.15	0.16	0.19
C.D. at 5%	0.95	0.74	0.74	0.76	0.82	0.91	0.88	0.81	0.73	0.82	0.79	0.55	0.44	0.48	0.56

* Figures in parenthesis indicate original values, ** Values are square root transformed $\sqrt{x+0.5}$

T₁ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (70 g ha⁻¹)
 T₂ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (100 g ha⁻¹)
 T₃ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (2500 ml ha⁻¹)
 T₄ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (3000 ml ha⁻¹)
 T₅ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (1500 ml ha⁻¹)
 T₆ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (2000 ml ha⁻¹)

T₇ : Imazethapyr 10 SL at 20-25 DAS (1000 ml ha⁻¹)
 T₈ : Pendimethalin 30 EC at 2 DAS (3333 ml ha⁻¹)
 T₉ : HW at 20 DAS and IC at 40 and 60 DAS
 T₁₀ : Weedy check
 T₁₁ : Weed free check

Table 5. Total weed dry weight (g 0.25 m⁻²) at different crop growth stages of pigeonpea as influenced by chemical weed management approaches

Treatment s	2018					2019					Pooled				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T ₁	3.79 (14.97)	4.88 (23.33)	4.44 (19.27)	4.62 (20.95)	4.59 (20.77)	4.59 (20.63)	5.29 (27.76)	5.13 (26.46)	4.86 (23.22)	4.58 (20.56)	4.24 (17.80)	5.09 (25.33)	4.82 (22.87)	4.74 (22.00)	4.59 (20.67)
T ₂	3.62 (13.53)	4.60 (20.75)	3.99 (15.44)	4.16 (16.89)	4.10 (16.40)	4.16 (16.98)	4.41 (19.05)	3.96 (15.40)	4.10 (16.34)	3.99 (15.48)	3.92 (15.25)	4.51 (19.90)	3.98 (15.42)	4.13 (16.62)	4.05 (15.94)
T ₃	5.19 (26.60)	5.18 (26.39)	4.71 (21.76)	4.79 (22.55)	4.76 (22.36)	5.04 (24.94)	5.81 (34.01)	5.29 (27.61)	5.00 (24.59)	4.90 (23.62)	5.12 (25.77)	5.52 (30.20)	5.02 (24.69)	4.95 (24.62)	4.84 (22.99)
T ₄	4.78 (22.33)	4.93 (23.15)	4.47 (19.71)	4.91 (23.71)	4.38 (19.22)	4.70 (21.68)	5.30 (27.61)	5.16 (26.34)	4.90 (23.80)	4.75 (22.16)	4.74 (22.01)	5.13 (25.88)	4.84 (23.03)	4.91 (23.76)	4.59 (20.69)
T ₅	3.49 (12.04)	3.77 (13.76)	3.75 (13.71)	3.91 (15.10)	3.08 (9.23)	4.19 (17.06)	4.45 (19.33)	4.23 (17.40)	4.11 (16.47)	3.96 (15.24)	3.87 (14.55)	4.13 (16.54)	4.00 (15.55)	4.02 (15.78)	3.56 (12.24)
T ₆	2.79 (7.31)	3.61 (12.74)	3.37 (10.85)	3.52 (11.97)	3.23 (8.04)	3.62 (12.79)	3.36 (10.90)	3.60 (12.59)	3.60 (12.54)	3.21 (10.02)	3.24 (10.05)	3.50 (11.82)	3.49 (11.72)	3.57 (12.26)	3.23 (10.03)
T ₇	5.93 (34.67)	6.08 (37.02)	5.53 (30.30)	5.94 (36.05)	5.70 (32.38)	6.94 (48.37)	8.85 (82.60)	6.19 (37.84)	7.46 (55.32)	5.93 (34.82)	6.46 (41.52)	7.62 (59.81)	5.87 (34.07)	6.76 (45.69)	5.82 (33.60)
T ₈	6.97 (48.24)	9.66 (92.81)	6.84 (46.34)	7.22 (51.73)	6.79 (45.85)	9.88 (97.10)	11.27 (127.26)	7.49 (55.62)	7.69 (58.73)	7.70 (59.95)	8.55 (72.67)	10.51 (110.04)	7.17 (50.98)	7.46 (55.23)	7.26 (52.90)
T ₉	3.83 (14.28)	4.77 (22.33)	3.82 (14.19)	4.10 (16.32)	4.14 (55.96)	4.04 (15.90)	4.05 (15.94)	4.06 (15.95)	4.05 (15.98)	3.97 (15.30)	3.93 (58.09)	4.43 (19.14)	3.94 (15.07)	4.08 (16.15)	4.06 (15.97)
T ₁₀	11.96 (134.18)	12.70 (163.02)	11.60 (135.53)	12.69 (160.69)	11.15 (125.33)	11.55 (140.18)	14.67 (214.70)	11.61 (134.40)	10.17 (103.22)	10.68 (112.37)	11.73 (137.18)	13.74 (188.86)	11.63 (134.96)	11.51 (131.95)	10.93 (119.52)
T ₁₁	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)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)	0.71 (0.00)
S.Em±	0.40	0.42	0.34	0.32	0.40	0.28	0.59	0.27	0.22	0.32	0.25	0.41	0.20	0.21	0.30
C.D. at 5%	1.19	1.24	1.00	0.95	1.17	0.84	1.74	0.80	0.65	0.94	0.75	1.22	0.59	0.61	0.87

* Figures in parenthesis indicate original values

** Values are square root transformed $\sqrt{x+0.5}$

T₁ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (70 g ha⁻¹)
 T₂ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (100 g ha⁻¹)
 T₃ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (2500 ml ha⁻¹)
 T₄ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (3000 ml ha⁻¹)
 T₅ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (1500 ml ha⁻¹)
 T₆ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (2000 ml ha⁻¹)

T₇ : Imazethapyr 10 SL at 20-25 DAS (1000 ml ha⁻¹)
 T₈ : Pendimethalin 30 EC at 2 DAS (3333 ml ha⁻¹)
 T₉ : HW at 20 DAS and IC at 40 and 60 DAS
 T₁₀ : Weedy check
 T₁₁ : Weed free check

Table 6. Weed control efficiency (%) and WI (%) at different crop growth stages of pigeonpea as influenced by chemical weed management approaches

Treatments	2018					2019					Pooled					WI (%)		
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	30 DAS	60 DAS	90 DAS	120 DAS	At harvest	2018	2019	Pooled
T ₁	91.06	84.80	85.51	86.93	82.68	85.27	87.11	80.30	77.61	81.79	88.16	85.95	82.90	82.27	82.23	23.76	25.58	24.75
T ₂	90.28	86.54	88.07	89.50	86.71	87.80	91.11	88.62	83.98	86.13	89.04	88.83	88.35	86.74	86.42	17.48	14.02	15.54
T ₃	80.06	83.05	83.63	85.99	81.46	82.08	84.09	79.37	75.16	78.96	81.07	83.57	81.50	80.58	80.21	31.44	34.43	32.72
T ₄	82.55	84.35	84.69	85.17	83.29	84.38	87.14	80.16	76.45	80.62	83.47	85.75	82.43	80.81	81.95	18.15	16.63	17.21
T ₅	91.16	90.90	89.10	90.59	92.21	87.76	91.00	87.06	83.92	86.48	89.46	90.95	88.08	87.26	89.34	17.57	14.21	15.54
T ₆	94.33	91.56	91.63	92.52	91.50	90.86	94.91	90.52	87.62	91.21	92.60	93.23	91.08	90.07	91.36	6.72	10.86	8.78
T ₇	73.47	75.12	76.11	77.71	72.94	65.23	61.69	71.89	46.18	68.83	69.35	68.41	74.00	61.95	70.88	24.03	32.98	28.49
T ₈	62.46	39.46	64.54	67.76	62.78	30.13	40.59	58.37	42.52	47.81	46.30	40.02	61.45	55.14	55.29	40.29	37.22	38.44
T ₉	89.03	85.54	88.83	89.85	86.25	88.56	92.56	88.10	84.29	86.41	88.80	89.05	88.46	87.07	86.33	17.24	19.41	18.43
T ₁₀	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	44.28	42.89	43.42	
T ₁₁	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	0.00	0.00	0.00
S.Em±	3.07	3.46	2.07	2.18	2.71	2.67	4.75	2.15	2.31	3.28	1.82	3.02	1.36	1.90	2.39			
C.D. at 5%	9.05	10.19	6.10	6.42	7.98	7.88	14.01	6.35	6.81	9.69	5.38	8.91	4.01	5.60	7.05			

T₁ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (70 g ha⁻¹)
 T₂ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (100 g ha⁻¹)
 T₃ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (2500 ml ha⁻¹)
 T₄ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (3000 ml ha⁻¹)
 T₅ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (1500 ml ha⁻¹)
 T₆ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (2000 ml ha⁻¹)

T₇ : Imazethapyr 10 SL at 20-25 DAS (1000 ml ha⁻¹)
 T₈ : Pendimethalin 30 EC at 2 DAS (3333 ml ha⁻¹)
 T₉ : HW at 20 DAS and IC at 40 and 60 DAS
 T₁₀ : Weedy check
 T₁₁ : Weed free check

Table 7. Grain yield and economics of pigeonpea as influenced by chemical weed management approaches

Treatments	Grain Yield (Kg ha ⁻¹)			Cost of cultivation (₹ ha ⁻¹)			Gross returns (₹ ha ⁻¹)			Net Returns (₹ ha ⁻¹)			B:C		
	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled	2018	2019	Pooled
T ₁	931	1128	1029	31925	31925	31925	57710	69915	63812	25785	37990	31887	1.81	2.19	2.00
T ₂	983	1263	1123	32375	32375	32375	60946	78285	69616	28571	45910	37241	1.91	2.43	2.17
T ₃	895	1058	976	32550	32550	32550	55488	65575	60532	22938	33025	27982	1.70	2.01	1.86
T ₄	970	1153	1062	32885	32885	32885	60140	71486	65813	27255	38601	32928	1.88	2.17	2.03
T ₅	986	1274	1130	31625	31625	31625	61153	78967	70060	29528	47342	38435	1.92	2.50	2.21
T ₆	1101	1317	1209	31925	31925	31925	68288	81633	74961	36363	49708	43036	2.14	2.56	2.35
T ₇	925	1105	1015	32075	32075	32075	57371	68536	62953	25296	36461	30878	1.79	2.14	1.96
T ₈	788	1025	906	32125	32125	32125	48835	63529	56182	16710	31404	24057	1.52	1.98	1.75
T ₉	995	1276	1136	35000	35000	35000	61711	79091	70401	26711	44091	35401	1.72	2.26	1.99
T ₁₀	776	987	881	29750	29750	29750	48099	61173	54636	18349	31423	24886	1.62	2.06	1.84
T ₁₁	1179	1438	1309	38750	38750	38750	73119	89177	81148	34369	50427	42398	1.89	2.30	2.09
S.Em±	43	50	35	-	-	-	2656	3119	2184	2656	3119	2184	0.08	0.10	0.06
C.D. at 5%	126	148	104	-	-	-	7836	9201	6443	7836	9201	6443	0.25	0.29	0.18

T₁ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (70 g ha⁻¹)
 T₂ : Imazamox 35 WG + Imazethapyr 35 WG at 20-25 DAS (100 g ha⁻¹)
 T₃ : Pendimethalin 30 EC + Imazethapyr 2 EC at 2 DAS (2500 ml ha⁻¹)
 T₄ : Pendimethalin 30 EC + Imazethapyr 2EC at 2 DAS (3000 ml ha⁻¹)
 T₅ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (1500 ml ha⁻¹)
 T₆ : Propaquizafop 2.5% + Imazethapyr 3.75%w/w ME at 20-25 DAS (2000 ml ha⁻¹)

T₇ : Imazethapyr 10 SL at 20-25 DAS (1000 ml ha⁻¹)
 T₈ : Pendimethalin 30 EC at 2 DAS (3333 ml ha⁻¹)
 T₉ : HW at 20 DAS and IC at 40 and 60 DAS
 T₁₀ : Weedy check
 T₁₁ : Weed free check

yield which in turn increase the benefit cost ratio. The less B:C ratio in weed free check was due to high cost of cultivation as a result of more cost incurred for labour to remove weeds as and when it appeared. While in weedy check less B:C ratio may be attributed to low gross returns due to low seed yield due to sever weed competition. Similar results reported by Susmita [7] and Amitesh et al. [11].

4. CONCLUSION

It was concluded from the two years study that post emergence application of propaquizafop 2.5% + imazethapyr 3.75% w/w ME @ 2000 ml ha⁻¹ at 20-25 DAS was the best option for controlling diverse weed flora in pigeonpea and resulted in lower weed density, higher weed control efficiency, lower weed index, higher grain yields, net returns and benefit cost ratio.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Tewari AN. Weed management in arhar. Indian Farming. 1989;38(11):13-14.
2. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers, ICAR publications, New Delhi. 1967;32.
3. Channabasavanna AS, Talawar AM, Kitturmath MS, Rajkumar H. Evaluation of post emergence herbicides on grass weeds in pigeon pea and its bioassay on following crop. Indian J. Agric. Res. 2017;51(2):188-190.
4. Asma AA, Anay KR, Nisha M. To find out the suitable post emergence herbicides for controlling weeds in pigeonpea. Int. J. Curr. Microbiol. App. Sci. 2018;7(12):662-664
5. Manu P. Chemical weed management in pigeonpea in northern dry zone of Karnataka.M. Sc. (Agri.) Thesis, Univ. Agric. Sci., Dharwad. 2013;149.
6. Das SK, Biswas B, Moinuddin G, Hansda A. Effect of integrated and purely chemical management practices on yield attributing characters, yield, weed density, weed dry weight and total microbial population in soil of pigeonpea (*Cajanuscajan* (L.) Millsp). Eco.Env and Cons. 2016;22(April Suppl.).
7. Susmita Panda ML, Kewat, Mukesh Kumar Saini. Efficacy of propaquizafop and imazethapyr mixture against weeds in soybean. Int. J. Curr. Microbiol. App. Sci. 2017;6(10):3251-3256
8. Suria ASMJ, Juraimi AS, Rahman MM, Man AB, Selamat A. Efficacy and economics of different herbicides in aerobic rice system. Afr. J. Biotechnol. 2011;10:8007–8022
9. Vinuta BS. Weed management in Pigeonpea [*Cajanus cajan*(L.) Millsp.].M. Sc. (Agri.) Thesis, College of agriculture, Vijayapur, Karnataka; 2015.
10. Pradhan A, Kolhe SS, Singh V. Studies of weed control efficiency by application of post-emergence herbicides in soybean grown under Chhattisgarh plain. Indian J. Weed Sci. 2010;42(1&2):101-103.
11. Amitesh KS, Singh RS, Amit KS, Rakesh K, Narendra Kumawat K, Nikhil KS, Singhs P, Ravi S. Effect of Weed Management on Weed Interference, Nutrient Depletion by Weeds and Production Potential of Long Duration Pigeonpea (*Cajanus cajan* L.) under Irrigated Ecosystem. Int. J. Curr. Microbiol. App. Sci., 2020;9(1): 676-689.

© 2021 Nimbargi et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle4.com/review-history/67204>