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# Intercropping and weed management effects on weed dynamics, productivity and economics of pigeonpea

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## ABSTRACT

A field experiment was conducted to study the weed dynamics, productivity and economics of pigeonpea [*Cajanus cajan* (L.) Millsp.] under intercropping and weed management practices under rainfed. Among intercropping systems, greengram and blackgram were planted in paired row (2:2) system at 30/90 cm row spacing in main plots and six weed management treatments include pre-emergence herbicides (pendimethalin and oxiflourfen), post-emergence herbicide (imazethapyr) and their combinations in sub plots. Both the intercropping systems (pigeonpea + greengram or pigeonpea + blackgram) recorded higher Crop Equivalent Yield (CEY) (1.23 to 1.36 t/ha), Land Equivalent Ratio (LER) (1.6) and B: C ratio (2.5 - 2.7) than sole pigeonpea. Among herbicide treatments significantly higher weed controlling efficiency was recorded in pendimethalin + imazethapyr and oxyflourfen + imazethapyr (90.6 - 91.5%) as compared to pendimethalin or oxiflourfen or imazethapyr (72.1 - 84.6%).

**Key words:** Blackgram, Greengram, Intercropping, Pigeonpea, Weed management

The present production of pulses in the country hovers around 13-15 million tonnes from an area of 22-23 million hectares during the last decade (1999-2009). Consequently, per capta availability of pulses in India has declined from 64 g/day (1951/52) to 34 g/day (2010) as against recommendation of 80 g/day. Assuming a moderate requirement of 50 g pulses per capta per day with 10% additional need for seeds and feed wastages *etc*, the projected pulse requirement for the year 2030 is 32 million tonnes, which necessitates annual growth rate of 4.2% in pulse production. To meet the projected requirement the productivity needs to uplift at 1361 kg/ha and about 3.00 million ha has to be bought under pulses besides reducing the post harvest losses (IIPR, Vision 2030).

Pigeonpea because of its slow initial growth rate is very sensitive to weed competition in the first 45 to 60 days after sowing. In many rainfed pigeonpea growing area, optimum land preparation is seldom done and weeds cause severs yield losses ranged from 70 to 90% as reported by Padmaja *et al.* (2013). To achieve the target of additional production of pulses the intercropping is the ultimate solution. It overcomes the drawbacks of mono cropping systems and suppresses weed growth as reported by Kiroriwal and Yadav (2013). Hence keeping all the above aspects in consideration, the present study was undertaken to find out most suitable weed control method and intercropping system for increasing the yield of rainy season pulses per unit area per unit time to achieve the mentioned target.

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## MATERIALS AND METHODS

Field experiment was conducted at the Research Farm of Mahatma Gandhi Chitrakoot Gramodaya Vishwa Vidhyalaya Chitrakoot, Satna (M.P.) during rainy (*Kharif*) season of 2012-13 and 2013-14. Geographically Chitrakoot is situated between the $25^{0}10'$ N latitude and $80^{0}52'$ E longitude and about 190-210 meter above mean sea level. The soil of the experimental field was sandy clay loam with pH value 7.44 to 7.46, electrical conductivity 0.32 to 30 dS/m, organic carbon 2.4 to 2.9 g/kg, available N, 193 to 201 kg/ha, available P 16.7 to 20.1 kg/ha and available K 201 to 207 kg/ha. The treatments comprised three intercropping systems sole pigeonpea planted at 60 cm row spacing, pigeonpea + greengram (2:2) planted at 90/30 cm row spacing and pigeonpea + blackgram (2:2) planted at 90/30 cm row spacing in main plots and six weed control treatments weedy check (control), pendimethalin 1.0 kg/ha pre-emergence (PE), oxiflourfen 0.2 kg/ha pre-emergence (PE), imazethapyr 0.1 kg/ha post-emergence (POE), pendimethalin 1.0 kg/ha PE followed by imazethapyr 0.1 kg/ha POE and

oxiflourfen 0.2 kg/ha PE followed by imazethapyr 0.1 kg/ha POE] as the sub-plot treatments. The experiment was laid out in split plot design with three replications. Pigeonpea variety '*ICPL 88039*', greengram variety '*Samrat*' and blackgram varity '*Azad-1*' were sown at 15, 12 and 15 kg seed per hectare respectively. Pre-emergence herbicides (pendimethalin and oxyflourfen) were applied in the next day after sowing of the crop while post-emergence herbicide (imazethapyr) was applied 25 days after sowing the crop with the help of knapsack sprayer fitted with flat-fan nozzle using 500 liters of water per hectare. Weeds were allowed to grow freely in the control plots throughout the cropping season. Other crop management practices followed as per recommendations for the region.

Weed species associated with the crops in the experimental area were counted periodically and grouped according to the nature of cotyledons and botanical names. The percentage composition of weed flora was estimated from weedy check and relative density of weeds was worked out as per the standard formula at 25 DAS stage. The total weed biomass obtained before harvest was utilized to determine the weed control efficiency of various treatments. Crop equivalent yield was calculated as the pigeonpea equivalent yield by taking into account the seed yield of component crops and their prevailing market rates. Various observations recorded periodically during the course of experiment, analyzed statistically by using analysis of variance technique appropriate to split plot design. The treatment differences were tested for significance by 'F' test and the data in which the treatment effects were found significant the appropriate standard error of mean and the critical different were worked out at 5% level of significance.

## RESULTS AND DISCUSSION

### Weed dynamics

Pigeonpea sole as well as intercropped faced acute problem of weeds pertaining to both monocot and dicot in nature. *Echinochloa* spp., *Cynodon dactylon, Cyperus rotundus* and *Sorghum helpense* among the monocots, whereas, *Convolvulus arvensis, Commelina benghalensis, Launea splenifolia, Amaranthus virdis* and *Digara arvensis* among the dicots were dominant. Relative weed density of monocot weeds found conspicuously higher as compared to dicot weeds in weedy check (control) plots grown with pigeonpea alone or intercropped with greengram or blackgram. Similar weed flora were also found by Punia *et al.* (2013) in *Kharif* legumes under rainfed conditions.Weed density/$m^2$ of pigeonpea sole found significantly higher as compared to intercropping systems at every stage of observations. This might be due more plant spaces provided by sole pigeonpea caused more emergence of weeds, while under intercropping systems greengram and blackgram suppressed weed growth. Application of all the herbicidal treatments significantly reduced weed density/$m^2$ compared with weedy check. The weedy check treatment recorded the maximum weed density at every stage of observations in the studies of Nirala and Dewangan (2012) also.

### Weed control efficiency

Weed control efficiency (WCE) of both the intercropping systems (pigeonpea + greengram or pigeonpea + blackgram) was found significantly higher to that of sole pigeonpea at every stage of observations whereas among weed control treatments, it recorded significantly higher (90.58 to 91.51%) under combined influenced of herbicides (pendimethalin PE followed by imazethapyr POE and oxyflourfen PE followed by imazethapyr POE) as compared to the single applied herbicides (pendimethalin or oxiflourfen or imazethpyr alone). Out of single herbicides, pendimethalin proved significantly superior to oxyflourfen and imazethapyr, and oxyflourfen was significantly superior to imazethapyr. The field experiments of Gupta *et al.* (2013) and Padmaja *et al.* (2013) also confirmed that all the weed control treatments recorded significantly higher weed control efficiencies over weedy check.

### Yield

Yield attributes of pigeonpea namely: pods/plant, pod length, seeds/pod, seed weight/plant and 1000 seed weight were found significantly higher under sole pigeonpea cropping systems over pigeonpea + greengram and pigeonpea + blackgram. This increase in yield attributes may be due to greater growth parameters and more root nodules formation that might have promoted for greater formation of yield attributes parameters. In case of weed management practices, all the yield attributes were found significantly higher under the use of pendimethalin at 1.0 kg/ha PE followed by imazethapyr at 0.1 kg/ha as compared to other weed control measures. The significantly lowest yield attributes were recorded under weedy check plots.

Seed yield was significantly higher (718 kg/ha) under pigeonpea sole, followed by PP + GG 2:2 and lowest by PP + BG 2:2 intercropping systems. This could be ascribed due to greater value of growth

**Table 1. Composition of weed flora in weedy check plots at 25 DAS (pooled for 2 years)**

| Weed species | Population /m² | Relative density (%) |
|---|---|---|
| *Monocot* | | |
| *Echinochloa* spp. | 52.6 | 29.7 |
| *Cyperus* spp. | 27.0 | 15.1 |
| *Cynodon dectylon* | 9.4 | 5.4 |
| *Sorghum halepense* | 6.6 | 3.8 |
| Other monocots | 5.1 | 2.9 |
| Total monocot weeds | 95.6 | 54.4 |
| *Dicot* | | |
| *Digera arvensis* | 39.3 | 22.4 |
| *Commelina benghalensis* | 17.4 | 10.0 |
| *Convolvulus arvensis* | 14.2 | 8.0 |
| Other dicots | 8.8 | 5.1 |
| Total dicot weeds | 74.7 | 45.6 |
| Total weeds | 175.3 | 100 |

parameters and yield attributes under sole pigeonpea. Such trend might be due to better spatial arrangement of pigeonpea under sole. Kumawat *et al.* (2013) also observed that pigeonpea sole gave higher grain yield over pigeonpea + blackgram intercropping. In case of weed management practices, the seed yield of pigeonpea was obtained significantly greater (868 kg/ ha) under the pendimethalin at 1.0 kg/ha PE followed by imazethapyr at 0.1 kg/ha POE. Such enhancement might be due to least competition between crop plants and weeds which resulted in better interception and utilization of radiant energy leading to higher photosynthesis and finally more formation of yield attributes and ultimately greater seed yield of pigeonpea.

**Land equivalent ratio (LER)**

Yield advantage in term of LER of pigeonpea + blackgram and pigeonpea + greengram systems recorded higher than sole cropping of pigeonpea. The higher LER under these intercropping systems may be due to better planting geometry and spatial arrangements that might have avoided the coincidence of the peak period of growth of comment crops. This might have helped for efficient use of natural resources by the component crops under intercropping system. Weed control treatments also influenced LER significantly.

**Crop equivalent yield (CEY)**

Significantly enhanced CEY recorded under intercropping systems (1226 to 1363 kg/ha) than sole pigeonpea (718 kg/ha). This might be due to additional yield advantages from intercrops as compared to the sole crop only. The total increased yield fetched increased market price thereby increased the equivalent yield of main crop. The weed control methods also significantly influenced CEY because of increased total yield due to weed control methods. The result of Sharma *et al.* (2010) and Pandey *et al.* (2013) also indicates that higher LER and CEY was recorded by pigeonpea based intercropping systems over pigeonpea sole.

**Economics**

The economical parameters like net returns (₹/ ha) and return per rupee invested (B: C ratio) significantly influenced due to intercropping systems and weed management treatments. Higher net returns obtained under intercropping systems over sole

**Table 2. Weed dynamics as influenced by intercropping and weed management (pooled for 2 years)**

| Treatment | Weed density/m² | | | Dry matter of weeds (g/m²) | | | Weed control efficiency (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| | 25 | 50 | 75 DAS | 25 | 50 | 75 DAS | 25 | 50 | 75 DAS |
| *Intercropping* | | | | | | | | | |
| Sole pigeonpea | 43.5 | 46.9 | 43.4 | 25.3 | 30.0 | 28.9 | 67.4 | 69.5 | 69.7 |
| Pigeonpea + blackgram (2:2) | 37.8 | 41.2 | 38.4 | 22.9 | 26.9 | 26.0 | 67.5 | 69.8 | 69.6 |
| Pigeonpea + greengram (2:2) | 40.1 | 43.4 | 40.3 | 23.9 | 28.2 | 26.9 | 67.5 | 69.9 | 69.4 |
| LSD (P=0.05) | 0.36 | 0.36 | 0.31 | 0.15 | 0.20 | 0.19 | 0.01 | 0.02 | 0.02 |
| *Weed control* | | | | | | | | | |
| Weedy check (control) | 162.0 | 175.3 | 161.2 | 74.4 | 94.2 | 89.6 | 0.0 | 0.0 | 0.00 |
| Pendimethalin (1 kg/ha) | 15.8 | 19.5 | 18.8 | 13.1 | 13.9 | 13.5 | 82.2 | 85.0 | 84.6 |
| Oxyfluorfen ( 0.2 kg/ha) | 18.2 | 26.4 | 23.5 | 19.9 | 20.3 | 19.7 | 74.2 | 78.3 | 78.5 |
| Imazethapyr ( 0.1 kg/ha) | 24.0 | 17.6 | 19.4 | 23.2 | 25.3 | 24.8 | 68.6 | 73.0 | 72.1 |
| Pendimethalin + imazethapyr | 10.5 | 11.9 | 9.4 | 7.0 | 7.9 | 7.5 | 90.5 | 91.6 | 91.5 |
| Oxyflourfen + imazethapyr | 12.2 | 12.3 | 12.1 | 7.9 | 8.7 | 8.4 | 89.3 | 90.7 | 90.6 |
| LSD (P=0.05) | 3.17 | 3.43 | 3.14 | 1.35 | 1.75 | 1.66 | 1.81 | 1.85 | 1.85 |

**Table 3. Yield attributes and yield of pigeonpea as influenced by intercropping and weed management (pooled for 2 years)**

| Treatment | Pods/ plant | Pod length (cm) | Seeds/ pod | Weed weight/ plant(g) | Test weight (g) | Seed yield kg/ha |
|---|---|---|---|---|---|---|
| *Intercropping* | | | | | | |
| Sole pigeonpea | 107.2 | 5.74 | 4.66 | 37.8 | 94.5 | 718 |
| Pigeonpea + blackgram (2:2) | 100.0 | 5.52 | 4.40 | 35.5 | 92.7 | 649 |
| Pigeonpea + greengram (2:2) | 99.3 | 5.48 | 4.38 | 35.1 | 92.3 | 624 |
| LSD (P=0.05) | 3.43 | 0.13 | 0.13 | 1.55 | 0.41 | 72 |
| *Weed control* | | | | | | |
| Weedy check (control) | 66.6 | 4.31 | 4.11 | 22.6 | 88.4 | 369 |
| Pendimethalin (1 kg/ha) | 106.3 | 5.75 | 4.51 | 37.8 | 94.2 | 704 |
| Oxyfluorfen (0.2 kg/ha) | 103.9 | 5.51 | 4.37 | 37.3 | 93.4 | 618 |
| Imazethapyr (0.1 kg/ha) | 103.3 | 5.42 | 4.21 | 36.1 | 92.4 | 637 |
| Pendimethalin + imazethapyr | 120.5 | 6.41 | 5.04 | 42.6 | 96.1 | 868 |
| Oxyflourfen + imazethapyr | 112.3 | 6.07 | 4.62 | 40.5 | 94.6 | 785 |
| LSD (P=0.05) | 3.13 | 0.09 | 0.15 | 1.46 | 1.23 | 11 |

**Table 4. Productivity and economics of pigeonpea as influenced by intercropping and weed management (pooled for 2 years)**

| Treatment | LER | CEY (kg/ha) | Net income ($x10^3$ `/ha) | B:C ratio |
|---|---|---|---|---|
| *Intercropping* | | | | |
| Sole pigeonpea | 1.00 | 718 | 12.5 | 1.54 |
| Pigeonpea + blackgram (2:2) | 1.60 | 1226 | 35.2 | 2.45 |
| Pigeonpea + greengram (2:2) | 1.62 | 1363 | 39.9 | 2.64 |
| LSD (P = 0.05) | 0.12 | 68 | - | 0.20 |
| *Weed control* | | | | |
| Weedy check (control) | 1.20 | 650 | 10.3 | 1.47 |
| Pendimethalin (1 kg/ha) | 1.43 | 1159 | 32.4 | 2.40 |
| Oxyfluorfen (0.2 kg/ha) | 1.36 | 1015 | 25.6 | 2.09 |
| Imazethapyr (0.1 kg/ha) | 1.41 | 1064 | 27.5 | 2.16 |
| Pendimethalin + imazethapyr | 1.55 | 1427 | 42.7 | 2.69 |
| Oxyflourfen + imazethapyr | 1.50 | 1300 | 36.6 | 2.44 |
| LSD (P=0.05) | 0.01 | 155 | - | 0.31 |

cropping owing to more increase in gross return as compared to lesser increase in the cost of cultivation. Benefit: cost ratio was also estimated higher under intercropping system as compared to sole pigeonpea. In case of weed management treatments higher benefit cost ratio was obtained under pendimethalin at 1.0 kg/ha PE followed by imazethapyr at 0.1 kg/ha POE than other treatments.

It was concluded that growth and productivity of pigeonpea proved superior with sole cropping over intercropping systems. In spite of it intercropping of pigeonpea with blackgram or greengram was more remunerative because of better system productivity and more economical returns besides better suppression of weeds.

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