International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(3): 885-888

Received: 20-03-2020
Accepted: 21-04-2020

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Effect of different agro techniques for weed management in Pigeonpea (*Cajanus cajan* L. Millsp.)

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DOI: https://doi.org/10.22271/chemi.2020.v8.i3k.9314

Abstract
A field experiment was conducted during the rainy season of 2014-2015 on ""Evaluation of agro-techniques for yield maximization in pigeonpea [*Cajanus cajan* (L.) Millsp.]" at Experimental Farm of Agricultural research station Badnapur, Marathwada Agril. University, Parbhani. The experiment was laid out in a split plot design and replicated thrice and application of Pendimethalin @ 0.75 Kg ha^{-1} on 3 DAE + Imazethapyr @100 g a.i ha^{-1} on 10-15 DAE of weeds + 1 HW on 50 DAS. To find out the crop weed association in pigeonpea, to study the weed growth, dry matter and weed control efficiency in pigeonpea to assess the extent of losses due to weeds in pigeonpea, to find out the most economic method of weed control in pigeonpea. The study found, the maximum weed control efficiency observed by INM +IWM + IPM treatments (95.61%) followed by IWM (94.61 %) and INM +IWM +IPM (88.23%). These treatments produced maximum seed yield (1565 kg ha^{-1}) than those observed in rest of the treatment under study that might be due to weed free condition.

Keywords: Pigeon pea, pendimethalin, weed management, weed index, WCE

Introduction
Pulses constitute an important ingredient in predominantly vegetarian diet and are important source of protein that nutritionally balances the protein requirement of vegetarian population. They supply minerals and vitamins and provide an abundance of food energy. Pulses provide a cheaper source of nutrients/ proteins as they generally contain nearly twice as much as protein as that of cereals and hence correctly called poor man's meat. Pulses are also important for sustainable agriculture enriching the soil through biological fixation. (Hariprasanna and Bhatt, 2002) [6].

Pigeonpea is most important *kharif* pulse crop.Pigeon pea is a main source of protein (22.3 per cent), minerals (3.5 per cent), carbohydrates (57.6 per cent) and provides 335 k cal energy per 100g. Recent findings of "National Institute of Nutrition" concluded that pulses not only supply 15 to 23 per cent of proteins but also supply 20 per cent calories of dietary requirements. The crop is extensively grown in Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, Andhra Pradesh and Gujarat etc. After gram, pigeonpea is the second most important pulse crop in the country. It accounts for about 11.8% of the total pulse area and 17% of the total pulse production of the country. Maharashtra, Uttar Pradesh, Madhya Pradesh, Karnataka, Gujarat and Andhra Pradesh accounts for 87% area of the country and 83.8% of total production. Bihar and Haryana have the highest productivity 1115 kg ha^{-1} and 1036 kg ha^{-1} respectively.

In India, the area under pigeonpea was 3.88 million. Hectares. Production and productivity were 3.29 million tones and 849 kg ha^{-1} respectively and in Maharashtra, the area under pigeonpea was 11.41 lakh hectares and production was 10.34 lakh tones during the year 2013-14. (Anonymous, 2015).

In *kharif* season, because of favorable climatic conditions, weeds have become a major problem. Weeds cause great losses than either insects or plant diseases (Crafts and Robins (1973) [2]. Tiwari (1989) [11] reported that 68 per cent yield losses caused in *Cajanus cajan* L. Millsp. in peninsular zone were due to weeds.

It is, therefore, necessary to control weeds so as to reduce the competition for nutrients, moisture and radiant energy and to obtain maximum fertilizer and water use efficiency. Unavailability of timely and cheap labour has caused the problem of weed competition in crops and further it is aggravated making it imperative to develop cheaper methods of weed control with herbicides alone or in combination with other mechanical methods. Integrated weed management helps in reducing the weed population without much adverse effect on the crop.

Materials and methods

The experiment was laid out in randomized block design (RBD) with nine treatments replicated three times during *kharif*, 2014 at Experimental Farm of Agricultural research station Badnapur, Marathwada Agril. University, Parbhani. The soil of the experimental field was clay loam, low in available N, medium in available P and very high in K content and slightly alkaline in reaction. The total rainfall received during crop growth period was 639.2 mm in 33 rainy days. Well decomposed FYM (5 t/ha) was applied as per treatment and incorporated in to soil. Seeds of pigeonpea variety BSMR-853 sown on 19 July, 2014 as per treatment by dibbling method. Recommended dose of fertilizer 25 kg N and 50 kg P O and 15 kg Z,20 kg S were applied through urea and single super phosphate before dibbling. The gross and net plot sizes were24.3 and 14.04 m^2 respectively. The seeds were treated with rhizobium and PSB culture @ 200 g/kg seed just before sowing. Cost of cultivation, net returns as well as BC ratio were also worked out.

Treatment details

1. INM (FYM @ 5t ha^{-1} + RDF i.e. NPKSZn) + *Rhizobium* + PSB
2. IWM (Pendimethalin @ 0.75 Kg ha^{-1} on 3 DAE + Imazethapyr @100 g a.i ha^{-1} on 10-15 DAE of weeds + 1 HW on 50 DAS.
3. IPM (Indoxacarb 15.8 % EC at the time of Flowering @ 375 ml ha^{-1} + one Systemic insecticide spray 15 days after first spray.
4. INM + IWM.
5. INM+IPM.
6. IWM + IPM.
7. INM +IWM + IPM.
8. Control (Farmer's practices)

Weeds Associated with the Pigeonpea

Weeds, which are observed in experimental field during entire life cycle, are as follows and grouped into broad leaved, grassy and sedges. *Amiscophacelus cuculata, Commelina benghalensis, Cynodon dactylon, Allotropsis cimicina, Direbra retraflexa, Brachiaria eruciformis Digera Arvensis, Parthenium Hysterophorus, Sida ovata, Tridex procumbense, Sonchus asper, Acalpa indica, Euphorbia hirta, Euphorbia geniculate, Euphorbia microphora, Phaseolus filibulus, Acacia Arabica, Cardiospernum helicacabum, Pseuthia viscid.* (Goud and Patil 2014) [5].

Population of monocot and dicot weeds m^{-2} in Pigeonpea Field

The data pertaining to number of weeds per m^2 presented table indicated that significant differences among the treatments were observed.

Treatments	30 DAS monocot	30 DAS dicot	60 DAS monocot	60 DAS Dicot	90 DAS monocot	90 DAS dicot
T1= INM	12.66	40.33	48.00	46.00	14.00	23.00
T2=IWM	5.33	12.33	00	00	00	00
T3 =IPM	11.0	45.33	18.33	44.00	9.66	21.60
T4= INM + IWM	1.66	17.33	00	00	00	00
T5= INM+IPM	2.6	63.00	30.66	50.33	15	26.33
T6=IWM + IPM.	2.6	20	00	00	00	00
T7= INM +IWM + IPM.	1.33	26.33	00	00	00	00
T8=Control(Farmer'spractices)	0.66	54.00	18.33	45.00	7.00	25.00
SE +m	1.82	8.48	6.86	5.80	3.28	3.10
C.D.at 5%	5.52	25.61	20.71	17.54	5.70	12.00
General Mean	4.83	33.16	14.41	23.16	5.7	12

The treatment receiving only INM recorded significantly maximum number of monocot weeds m^2 at all the growth stages, however it was on par with IPM at 30 DAS and with INM + IPM at 60 and 90 DAS. Minimum number of monocot weeds per m^2 was recorded by treatments receiving only IWM; INM + IWM; IWM + IPM and INM + IWM + IPM during 60 to 90 DAS.

Significantly maximum number of dicot weeds per meter ^{2} was recorded by treatment receiving INM + IPM however; it was on par with INM; INM + IPM and control during all growth stages of crop. Significantly minimum number of dicot weeds per meter^2 was observed in treatments *viz*., IWM; INM +IWM; IWM + IPM and INM +IWM + IPM during 60 to 90 DAS.

Mean total dry matter of weeds per m^2 (g)

The data pertaining to mean total dry matter of weeds per (m^2) as influenced by various treatments at different crop growth stages are presented in table 1 and depicted in fig.7 indicated significant differences among the treatments at all the stages.

Table 1: Mean total dry matter of weeds per m^2 (g) as influenced by various treatments at different crop growth stages.

Treatments	30 DAS	60 DAS	90DAS
T1= INM	334 (18.07)	462 (21.24)	374 (19.09)
T2= IWM	18 (3.94)	0 (0.71)	0 (0.71)
T3 =IPM	197 (13.69)	0 (14.25)	204 (14.25)
T4= INM + IWM.	15 (3.89)	0 (0.71)	0 (0.71)
T5= INM+IPM.	295 (17.12)	284 (16.69)	276 (15.93)
T6=IWM + IPM.	15 (3.89)	0 (0.71)	0 (0.71)

T7= INM +IWM + IPM.	39 (5.76)	0 (0.71)	0 (0.71)
T8=Control(Farmer's practices)	197 (13.81)	236 (15.08)	284 (16.81)
SE +m	1.47	1.45	1.58
C.D. at 5%	4.43	4.37	4.78
General Mean	10.02	8.76	8.61

Figures in parentheses are $\sqrt{x + 0.50}$ transformed values.

Significantly higher mean total dry matter of weeds per m^2 was observed in INM treatment which was on par with IPM; INM+IPM and control during 30 and 90 DAS except at 90 DAS, where it was significantly superior over IPM also At 60 DAS, treatment receiving only INM recorded significantly highest mean total dry matter of weeds per m^2.

Weed control efficiency and Weed index

The data pertaining to weed control efficiency indicated significant differences among the treatments at all the growth stages (Table 2 and depicted in fig. 8.).

Table 2: Weed control efficiency (%) and weed index (%) as influenced by various treatments during different crop growth stages.

Treatments	Weed control efficiency (%)			Weed index
	30 DAS	60 DAS	90 DAS	
T1= INM	0	0	0	40.92
T2= IWM	94.61	100	100	27.00
T3 =IPM	41.17	55.01	45.50	48.48
T4= INM + IWM.	95.61	100	100	22.30
T5= INM+IPM.	39.33	38.41	26.35	29.52
T6=IWM + IPM.	95.61	100	100	22.68
T7= INM +IWM + IPM.	88.23	100	100	00
T8=Control(Farmer's practices)	41.37	48.80	24.39	28.17
General Mean	61.99	67.77	62.03	27.38

At 30 DAS, maximum weed control efficiency was achieved by the INM + IWM and IWM + IPM treatments (95.61%) followed by IWM (94.61 %) and INM + IWM +IPM (88.23%). During 60 to 90 DAS cent percent weed control efficiency was recorded in treatments *viz*., IWM, INM + IWM, IWM + IPM, INM +IWM + IPM.

Highest weed index values were observed in IPM treatment (48.48%) followed by INM (40.92 %); INM+ IPM (29.52 %); Control (28.17 %) and IWM (27.00 %). Lowest weed index values were recorded in treatment INM+IPM (22.30 %) followed by IWM +IPM (22.68 %).

Result and Discussion

Effect of weeds

Effect of treatments on monocot weeds

The treatment receiving only INM recorded significantly max imum number of monocot weeds per m^2 at all the growth stages, however it was on par with IPM at 30 DAS and with INM + IPM at 60 and 90 DAS. Minimum number of monocot weeds per m^2 was recorded by treatments receiving only IWM; INM + IWM; IWM + IPM and INM + IWM + IPM during 60 to 90 DAS. These results were in confirmation with results of Patel *et al.* (1993) [10], Virkar *et al.* (2007) [13] and Padmaja *et al.* (2013) [9] in case of IWM.

Effect of treatments on dicot weeds

Significantly maximum number of dicot weeds per meter ^{2} was recorded by treatment receiving INM + IPM however; it was on par with INM; INM + IPM and control during all growth stages of crop. Significantly, minimum number of dicot weeds per meter^2 was observed in treatments *viz*., IWM; INM +IWM; IWM + IPM and INM +IWM + IPM during 60 to 90 DAS.

Among all INM + IPM treatment showed highest dicot weed followed by INM; Control, IPM.

Due to the integration of different agro techniques results in suppression of weed population.These results are in close conformity with those reported by Dhonde *et al.* (2009) [4], Virkar *et al.* (2007) [13] and Padmaja *et al.* (2013) [9].

Effect of treatments on dry matter production by weeds

All the weed free treatment brought significant reduction in weed dry matter as compared to unweeded plot. The highest reduction of weed dry matter was found in IWM; INM + IWM; IWM + IPM and INM + IWM + IPM. The dry matter of weeds in unweeded INM plot was maximum because of higher weed intensity and its dominance in utilizing the sunlight, nutrient, moisture, CO_2 etc. These results are in conformity with those reported by Virkar *et al.* 2007 [13], Dhonde *et al.* (2009) [4], Padmaja *et al.* (2013) [9].

Weed control efficiency

At 30 DAS, maximum weed control efficiency was achieved due to the combination of components (tratments) like INM + IWM and IWM + IPM treatments (95.61%) followed by IWM (94.61 %) and INM +IWM +IPM (88.23%). During 60 to 90 DAS cent percent weed control efficiency was recorded in treatments *viz*., IWM, INM + IWM, IWM + IPM, INM +IWM + IPM. This might be due to efficient suppression of weed growth at early stage by pre emergence herbicide (Pendimethalin) followed by its integration with post emergence herbicide (Imazethapyr) at later stage of crop growth. These results are in agreement to the findings of Virkar *et al.* 2007 [13], Dhonde *et al.* (2009) [4], Padmaja *et al.* (2013) [9].

Weed index

Lower weed index was observed in treatment receiving INM+IWM+IPM. The treatment INM+IWM+IPM produced maximum seed yield (1565 kg ha^{-1}) than those observed in rest of the treatment under study which might be due to weed free condition, crop grow without competition of moisture, nutrient, sunlight etc. These results are in agreement with results of Dhonde (2009) [4], Padmaja (2013) [9].

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