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Priyanka Kumawat
Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

MK Kaushik
Professor, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Dinesh Panwar
Ph.D. Scholar, Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Versha Gupta
Ph.D. Scholar, Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Naresh Sharma
Ph.D. Scholar, Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Sumitra Bamboriya
Ph.D. Scholar, Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Correspondence
Priyanka Kumawat
Department of Agronomy, Rajasthan College of Agriculture, Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan, India

Yield, nutrient uptake and economics of Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub] as influenced by weed management and fertility levels

Priyanka Kumawat, MK Kaushik, Dinesh Panwar, Versha Gupta, Naresh Sharma and Sumitra Bamboriya

Abstract
A field experiment was conducted during *Kharif* seasons of 2014 and 2015 at Udaipur (Rajasthan) to evaluate the effect of weed management and fertility levels on yield, nutrient uptake and economics of clusterbean. Among various weed management practices, two hand weeding 20 and 40 DAS recorded highest weed control efficiency (85.02%), seed yield (1304 kg ha^{-1}), nitrogen and phosphorus content and their uptake closely followed by sequential application of pendimethalin with imazethapyr which was statistically at par. However, in monetary terms, sequential application of pendimethalin with imazethapyr gave maximum net return of Rs. 48849 ha^{-1} and B:C (2.45) which was superior over rest of the weed management treatments. Among the fertility levels application 20 Kg N + 40 Kg P_2O_5 ha^{-1} significantly increased seed yield (1035 kg ha^{-1}), nitrogen and phosphorus content and their uptake over 10 Kg N + 20 Kg P_2O_5 ha^{-1} however, it was found statistically at par with fertility level 30 Kg N + 60 Kg P_2O_5 ha^{-1}. Application of 20 Kg N + 40 Kg P_2O_5 ha^{-1} also recorded higher net return (Rs. 36495 ha^{-1}) and maximum B:C (1.77). Highest available nitrogen (284.39 kg ha^{-1}) and phosphorus (20.06 kg ha^{-1}) was registered under application of 30 Kg N + 60 Kg P_2O_5 ha^{-1}.

Keywords: Clusterbean, fertility, hand weeding, imazethapyr, pendimethalin, nitrogen and phosphorus

Introduction
Clusterbean [*Cyamopsis tetragonoloba* (L.) Taub]. Locally known as guar, is an important drought hardy leguminous crop. Cluster bean is grown for different purposes from very ancient time. A seed of cluster bean contains 28-33% gum which is used in almost all types of industries, *viz*. textiles, paper, petroleum, pharmaceuticals, food processing, cosmetics, mining explosives, oil drilling *etc*. India ranks at top position in the world trade for guar gum and earns lot of foreign exchange by its export. Rajasthan has emerged as a major clusterbean growing state of India and it ranks first with respect to both area (47.87 lac ha) and production (22.23 lac tones) of clusterbean (Govt. of Rajasthan, 2015-16) [5]. As guar is a rainy season crop and due to frequent rains, weed population increase tremendously and compete for nutrients, moisture and space with crop causing considerable yield reduction. Hand weeding is a traditional and effective method of weed control, but untimely rains, unavailability of labour at peak time and increasing labour cost are the main limitations of manual weeding. Under such situations, the only alternative that needs to be explored is the use of suitable herbicide, which may be effective and economically viable. So it was felt necessary to evaluate pre- and post-emergence herbicides which can be the best alternative to traditional practices.

Poor soil fertility and lack of nutrients are considered the major reasons of low productivity. Therefore, augmenting of nutrient supply assumes prime significance to improve crop productivity Among different plant nutrients, nitrogen is the utmost important for plant growth and development. Nitrogen plays an important role in synthesis of chlorophyll, amino acids and other organic compounds of physiological significance in plant system. Phosphorus is the second important plant nutrient after nitrogen. Phosphorus is known to activate microbes, influencing plant growth and involved in energy transformation in plants. Application of phosphorus, influences symbiotic nitrogen fixation and increase yield and quality of pods of clusterbean. Therefore, proper nutrient management is of prime importance.

So it was felt necessary to investigate the response of clusterbean to weed management practices in conjunction with different fertility levels on yield, uptake of nutrients and economics.

Materials and Methods

A field experiments was carried out at Rajasthan College of Agriculture, Udaipur for two consecutive years during *Kharif* seasons of 2014 and 2015 with twenty four treatment combinations viz. 8 weed management practices (Weedy check, Pendimethalin 1.0 kg ha^{-1} (PE), One hand weeding 20 DAS (Farmers' practice), Two hand weeding 20 and 40 DAS, Imazethapyr 0.1 kg ha^{-1} 20 DAS (PoE), Imazethapyr 0.1 kg ha^{-1} 20 DAS *fb* hand weeding 40 DAS, Pendimethalin 0.75 kg ha^{-1} (PE) *fb* hand weeding 40 DAS and Pendimethalin 0.75 kg ha^{-1} (PE) *fb* Imazethapyr 0.1 kg ha^{-1} 20 DAS) as main plot treatment and three fertility levels (10 Kg N + 20 Kg P_2O_5 ha^{-1}, 20 Kg N + 40 Kg P_2O_5 ha^{-1} and 30 Kg N + 60 Kg P_2O_5 ha^{-1}) as sub plot treatments, was laid out in split-plot design with three replications. Clusterbean variety "RGC-1031" was sown with the onset of monsoon during both the years at a row-to-row and plant-to-plant spacing of 30 cm x 10 cm with a seed rate of 20 kg ha^{-1}.

Weed control efficiency (WCE) was computed on the basis of dry matter of weeds using the following formula (Mani *et al*., 1968).

$$WCE = \frac{X-Y}{X}$$

Where,
WCE = Weed control efficiency
X = Weed dry matter in weedy check
Y = Weed dry mater in treated plot

The nutrient uptake by crop was computed by using the following formula:

$$\text{Nutrient uptake} = \frac{\text{Nutrient content in seed / haulm (\%) x Seed/haulm yield (kg ha}^{-1}\text{)}}{\text{by seed/ haulm (kg ha}^{-1}\text{)}} 100$$

Total uptake of nutrients were computed by summing up the uptake by seed and haulm. In order to evaluate the economic viability of different treatments and to ascertain the most remunerative treatment, economics of different treatment combinations were worked out in terms of net return (₹ ha^{-1}) and B: C. B: C for each treatment was calculated using the following formula:

$$\text{Benefit Cost ratio} = \frac{\text{Net returns (₹ ha}^{-1}\text{)}}{\text{Cost of cultivation (₹ ha}^{-1}\text{)}}$$

All the data were subjected to statistical analysis by adopting appropriate method of analysis of variance assuming homogeneity, pooled analysis of the data was also carried out to establish the trend of treatments applied as per Gomez and Gomez (1984) [4]. Wherever, the F values were found significant at 5 % level of probability, the critical difference (CD) values were computed for making comparison among the treatment means.

Results and Discussion

The weed flora emerged during the period of experimentation comprised of narrow-leaved weeds mainly *Cyanadon dactylon, Echinochloa colona, Brachiaria reptans* broad-leaved weeds like *Amarathus viridis, Digera arvensis, Commelina benghalensis and Trianthema portulacustrum* etc.

Various weed management practices differed in their ability to control weeds. The highest weed control efficiency (85.02 %) for total weeds was achieved under hand weeding twice during both the years of investigation and on pooled basis. The pooled data resulted in weed control efficiency of 81.89, 81.14 and 80.91 % under pendimethalin *fb* imazethapyr, imazethapyr *fb* hand weeding and pendimethalin *fb* hand weeding, respectively. Further, imazethapyr (63.63 %) proved better than one hand weeding (61.84 %) and pendimethalin (53.86 %) in this regard. Higher weed control efficiency in two hand weeding and pendimethalin *fb* imazethapyr might be due to the fact removal of weeds manually twice in the field controlled weeds which emerged during early as well as later stages of crop growth resulted in excellent performance compared to herbicides specially applied alone. Aggarwal *et al*. (2014) [1] reported maximum weed control efficiency (85.1%) under two hand weeding 20 and 40 DAS in blackgram. Further, sequential application of pendimethalin controlled early flush of weeds while post emergence imazethapyr destroyed late flush of weeds most efficiently during entire crop season compared to weedy check and herbicide applied alone. Jha and Soni (2013) [7] also reported maximum weed control efficiency in soybean through application of pendimethalin (1 kg ha^{-1}) *fb* imazethapyr (100g ha^{-1}).

No significant change was observed in nitrogen and phosphorus content in seed and haulm due to weed management practices during both the years of investigation and as well as on pooled basis. Amongst all weed management practices, hand weeding twice resulted in significantly higher nitrogen and phosphorus uptake by seed and haulm over other treatments but statistically at par with application of pendimethalin *fb* imazethapyr in both the experimental years. At the same time application of pendimethalin *fb* imazethapyr differed non-significantly with imazethapyr *fb* hand weeding and pendimethalin *fb* hand weeding in this regard. On pooled basis, two hand weeding and application of pendimethalin *fb* imazethapyr increased total nitrogen and phosphorus uptake by clusterbean to the extent of 157.8, 148.1, 159.4 and 150.4 per cent over weedy check, respectively. Higher nitrogen and phosphorus uptake by the crop under two hand weeding and pendimethalin *fb* imazethapyr might be ascribed to higher yield with these treatment as uptake of nutrient is mainly the function of crop yield and nutrient concentration. Thus, higher nutrient uptake by crop might be due to decreased crop weed competition concurrently increased nutrient availability, better crop growth and higher crop biomass production coupled with more nutrient content. Similar results were also reported by Jat *et al*. (2005) [6], Yadav *et al.* (2013) [12] and Singh *et al.* (2014) [1].

Two hand weedings achieved maximum seed yield followed by sequential application of pendimethalin with imazethapyr. Application of imazethapyr and pendimethalin in combination with hand weeding significantly increased seed yield compared to their single application and both these treatments differed non-significantly with pendimethalin *fb* imazethapyr in this regard. The improvement in yield with hand weeding has also been reported by Singh *et al.* (2015) [11]. However, in the present investigation application of pendimethalin *fb* imazethapyr also proved their superiority. Rao *et al.* (2015) [9] and Shruthi and Salakinkop (2015) [10] also observed increased seed yield against weedy check with pendimethalin as pre-emergence followed by imazethapyr as post-

emergence.

Sequential application of pendimethalin with imazethapyr gave maximum net return of ₹ 48849 ha^{-1} and B:C (2.45) on pooled basis which was superior over rest of the weed management treatments. The next best treatment in this aspect was pendimethalin *fb* hand weeding (2.07). The low investment under sequential application coupled with good economic yield might be the reason for higher net monetary return and B:C, even two hand weeding gave maximum gross monetary return but was nullified due to higher variable cost for weed management. Various weed management practices failed to exhibit any significant change in available nitrogen and phosphorus status of soil after harvest of crop during both the years and on pooled basis.

Increasing the fertility levels from 10 Kg N + 20 Kg P_2O_5 ha^{-1} to 20 Kg N + 40 Kg P_2O_5 ha^{-1} resulted in significantly increased seed yield of clusterbean. On pooled basis, application of 20 Kg N + 40 Kg P_2O_5 ha^{-1} and 30 Kg N + 60 Kg P_2O_5 ha^{-1} significantly increased seed yield by 13.23 and 15.75 per cent over the fertility level of 10 Kg N + 20 Kg P_2O_5 ha^{-1}, respectively. However, application of 30 Kg N + 60 Kg P_2O_5 ha^{-1} was found statistically at par with 20 Kg N + 40 Kg P_2O_5 ha^{-1} in this respect. Bhathal and Kumar (2016) [2] also reported increased seed yield of clusterbean through inorganic fertilizers. Application of various fertility levels improved concentration of nutrients (nitrogen and phosphorus) in seed as well as haulm. On pooled basis, application of 20 Kg N + 40 Kg P_2O_5 ha^{-1} and 30 Kg N + 60 Kg P_2O_5 ha^{-1} significantly increased nitrogen and phosphorus content in seed and haulm over application of 10 Kg N + 20 Kg P_2O_5 ha^{-1}. However, 20 Kg N + 40 Kg P_2O_5 ha^{-1} and 30 Kg N + 60 Kg P_2O_5 ha^{-1} were found at par with each other in this respect. Further, significantly higher total nitrogen and phosphorus uptake was registered with the application of 20 Kg N + 40 Kg P_2O_5 ha^{-1} by 16.44 and 13.97 per cent over 10 Kg N + 20 Kg P_2O_5 ha^{-1}. However, further increase in fertility level failed to exhibit significance over 20 Kg N + 40 Kg P_2O_5 ha^{-1}. It is an established fact that nutrient accumulation depends upon dry matter accumulation and concentration of nutrient at cellular level. The concomitant improvement in both of these components reflected higher accumulation of nutrients with nitrogen and phosphorus application.

Increasing fertility levels increased net return during the course of two years of study. On pooled basis, application of 30 Kg N + 60 Kg P_2O_5 ha^{-1} recorded maximum net return (₹ 36716 ha^{-1}) closely followed by application of 20 Kg N + 40 Kg P_2O_5 ha^{-1} (₹ 36495 ha^{-1}). Highest B:C (1.77) was obtained with the application of 20 Kg N + 40 Kg P_2O_5 ha^{-1} which was superior over 30 Kg N + 60 Kg P_2O_5 ha^{-1} (1.70) and 10 Kg N + 20 Kg P_2O_5 ha^{-1} (1.60). Increase in net realization might be due to increase in seed yield under 20 kg N + 40 kg P_2O_5 ha^{-1}. This is in accordance with the findings of Bhathal and Kumar (2016) [2], who also reported higher net return and B:C with the application of 20 kg N + 40 kg P_2O_5 ha^{-1} in clusterbean. Available nitrogen and phosphorus status of soil was significantly influenced by different fertility levels during both the years. On pooled basis, application of 30 kg N + 60 Kg P_2O_5 ha^{-1} registered maximum available nitrogen and phosphorus in soil which was significantly higher over 10 Kg N + 20 Kg P_2O_5 ha^{-1}. These results are in close conformity with the findings of Dhakal *et al*. (2016) [3].

Table 1: Effect of weed management on weed control efficiency (%) at harvest

Treatments	Narrow-leaved weeds			Broad- leaved weeds			Total weeds		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
Weed management									
Weedy check	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pendimethalin	54.34	56.58	55.46	51.99	52.81	52.40	53.07	54.65	53.86
One hand weeding	62.81	63.36	63.08	59.26	62.20	60.73	60.91	62.76	61.84
Two hand weeding	85.77	87.05	86.41	82.56	85.01	83.79	84.07	85.98	85.02
Imazethapyr	64.80	64.42	64.61	61.31	64.16	62.74	62.95	64.32	63.63
Imazethapyr *fb* hand weeding	80.96	83.01	81.99	79.53	81.20	80.36	80.20	82.07	81.14
Pendimethalin *fb* hand weeding	80.67	82.78	81.72	79.31	80.97	80.14	79.97	81.84	80.91
Pendimethalin *fb* Imazethapyr	81.85	83.64	82.74	80.12	82.10	81.11	80.95	82.84	81.89

Table 2: Effect of weed management and fertility levels on nitrogen and phosphorus content in clusterbean

	Nitrogen (%)						Phosphorus (%)					
	Seed			Haulm			Seed			Haulm		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
Weed management												
Weedy check	3.923	3.948	3.936	1.411	1.388	1.399	1.098	1.117	1.107	0.334	0.339	0.336
Pendimethalin	3.953	3.950	3.951	1.408	1.400	1.404	1.110	1.120	1.115	0.337	0.341	0.339
One hand weeding	4.000	3.989	3.995	1.412	1.410	1.411	1.122	1.111	1.116	0.343	0.338	0.341
Two hand weeding	4.033	4.035	4.034	1.429	1.434	1.431	1.129	1.118	1.124	0.346	0.340	0.343
Imazethapyr	4.005	3.996	4.001	1.407	1.416	1.412	1.123	1.113	1.118	0.342	0.337	0.339
Imazethapyr *fb* hand weeding	4.015	4.009	4.012	1.420	1.419	1.418	1.126	1.116	1.121	0.344	0.338	0.341
Pendimethalin *fb* hand weeding	4.008	4.014	4.011	1.414	1.425	1.419	1.127	1.126	1.127	0.338	0.343	0.341
Pendimethalin *fb* Imazethapyr	4.013	4.021	4.017	1.428	1.426	1.427	1.119	1.128	1.123	0.339	0.344	0.342
S.Em. ±	0.048	0.034	0.029	0.017	0.018	0.012	0.009	0.007	0.006	0.003	0.004	0.002
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Fertility levels												
10 kg N + 20 kg P_2O_5 ha^{-1}	3.847	3.853	3.850	1.382	1.374	1.378	1.107	1.107	1.107	0.332	0.331	0.331
20 kg N + 40 kg P_2O_5 ha^{-1}	4.065	4.064	4.064	1.430	1.433	1.432	1.121	1.124	1.123	0.344	0.344	0.344
30 kg N + 60 kg P_2O_5 ha^{-1}	4.069	4.069	4.069	1.436	1.436	1.436	1.129	1.124	1.127	0.345	0.345	0.345
S.Em. ±	0.024	0.011	0.013	0.009	0.009	0.006	0.005	0.004	0.003	0.001	0.001	0.001
C.D. (P=0.05)	0.070	0.033	0.038	0.025	0.025	0.017	0.014	0.012	0.009	0.002	0.002	0.002

Table 3: Effect of weed management and fertility levels on nitrogen uptake by clusterbean

Treatments	Nitrogen uptake (kg ha^{-1})								
	Seed			Haulm			Total		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
Weed management									
Weedy check	17.58	18.34	17.96	16.88	16.70	16.79	34.46	35.03	34.75
Pendimethalin	32.50	32.91	32.70	26.97	26.71	26.84	59.48	59.62	59.55
One hand weeding	34.37	34.73	34.55	28.04	28.15	28.09	62.41	62.88	62.64
Two hand weeding	52.20	53.17	52.68	36.46	37.34	36.90	88.66	90.51	89.59
Imazethapyr	34.51	34.73	34.62	28.05	28.32	28.19	62.56	63.06	62.81
Imazethapyr *fb* hand weeding	48.83	49.29	49.06	33.21	33.84	33.53	82.05	83.13	82.59
Pendimethalin *fb* hand weeding	48.97	49.07	48.99	33.04	33.96	33.50	81.94	83.03	82.49
Pendimethalin *fb* imazethapyr	50.70	51.04	50.87	35.35	35.38	35.37	86.05	86.42	86.23
S.Em.±	1.15	1.24	0.85	1.13	1.12	0.80	1.94	1.73	1.30
C.D. (P=0.05)	3.48	3.77	2.45	3.43	3.42	2.31	5.89	5.24	3.77
Fertility levels									
10 kg N + 20 kg P_2O_5 ha^{-1}	35.15	35.44	35.30	27.42	27.61	27.51	62.57	63.04	62.81
20 kg N + 40 kg P_2O_5 ha^{-1}	41.76	42.52	42.14	30.78	31.22	31.00	72.54	73.74	73.14
30 kg N + 60 kg P_2O_5 ha^{-1}	42.93	43.28	43.10	31.06	31.32	31.19	73.99	74.60	74.29
S.Em. ±	0.53	0.66	0.42	0.31	0.34	0.23	0.63	0.79	0.50
C.D. (P=0.05)	1.54	1.89	1.19	0.89	0.98	0.65	1.81	2.27	1.42

Table 4: Effect of weed management and fertility levels on phosphorus uptake by clusterbean

Treatments	Phosphorus uptake (kg ha^{-1})								
	Seed			Haulm			Total		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
Weed management									
Weedy check	4.88	5.17	5.03	4.00	4.08	4.04	8.89	9.24	9.06
Pendimethalin	9.12	9.31	9.22	6.45	6.51	6.48	15.57	15.83	15.70
One hand weeding	9.62	9.65	9.64	6.81	6.74	6.78	16.43	16.39	16.41
Two hand weeding	14.60	14.72	14.66	8.84	8.87	8.85	23.43	23.58	23.51
Imazethapyr	9.66	9.65	9.66	6.82	6.73	6.77	16.48	16.39	16.43
Imazethapyr *fb* hand weeding	13.68	13.70	13.69	8.05	8.07	8.06	21.73	21.77	21.75
Pendimethalin *fb* hand weeding	13.76	13.75	13.75	7.89	8.18	8.04	21.65	21.93	21.79
Pendimethalin *fb* imazethapyr	14.14	14.31	14.22	8.40	8.54	8.47	22.53	22.85	22.69
S. Em.±	0.24	0.31	0.19	0.25	0.27	0.18	0.39	0.44	0.29
C.D. (P=0.05)	0.73	0.95	0.57	0.76	0.80	0.53	1.19	1.34	0.85
Fertility levels									
10 kg N + 20 kg P_2O_5 ha^{-1}	10.09	10.15	10.12	6.60	6.64	6.62	16.69	16.79	16.74
20 kg N + 40 kg P_2O_5 ha^{-1}	11.53	11.74	11.64	7.41	7.49	7.45	18.94	19.23	19.08
30 kg N + 60 kg P_2O_5 ha^{-1}	11.92	11.95	11.94	7.47	7.52	7.49	19.39	19.47	19.43
S.Em. ±	0.15	0.17	0.11	0.06	0.06	0.04	0.15	0.18	0.11
C.D. (P=0.05)	0.43	0.49	0.32	0.18	0.19	0.13	0.43	0.52	0.33

Table 5: Effect of weed management and fertility levels on seed yield, net return and B: C of clusterbean

	Seed yield (kg ha^{-1})			Net return (₹ha^{-1})			B:C		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
Weed management									
Weedy check	447	463	455	8570	10236	9403	0.52	0.62	0.57
Pendimethalin	821	831.	826	26400	28604	27502	1.45	1.56	1.50
One hand weeding	857	869	863	26599	28969	27784	1.33	1.44	1.39
Two hand weeding	1292	1315	1304	45256	49228	47242	1.91	2.07	1.99
Imazethapyr	860	867	863.	28345	30505	29425	1.55	1.65	1.60
Imazethapyr *fb* hand weeding	1214	1227	1221	41800	45817	43808	1.83	2.06	1.95
Pendimethalin *fb* hand weeding	1219	1221	1220	43308	46024	44666	2.01	2.12	2.07
Pendimethalin *fb* imazethapyr	1263	1269	1266	47385	50314	48849	2.38	2.51	2.45
S.Em.±	23.75	28.76	18.65	-	-	-	-	-	-
C.D. (P=0.05)	72.04	87.24	54.03	-	-	-	-	-	-
Fertility levels									
10 kg N + 20 kg P_2O_5 ha^{-1}	911	917	914	30175	32413	31294	1.54	1.65	1.60
20 kg N + 40 kg P_2O_5 ha^{-1}	1026	1044	1035	34797	38194	36495	1.68	1.85	1.77
30 kg N + 60 kg P_2O_5 ha^{-1}	1054	1062	1058	35402	38030	36716	1.65	1.76	1.70
S.Em. ±	12.91	15.26	9.99	-	-	-	-	-	-
C.D. (P=0.05)	37.19	43.95	28.23	-	-	-	-	-	-

Table 6: Effect of weed management and fertility levels on available nitrogen and phosphorus in soil after harvest

Treatment	Available N (kg ha^{-1})			Available P (kg ha^{-1})		
	2014	2015	Pooled	2014	2015	Pooled
Weed Management						
Weedy check	278.69	281.69	280.19	19.28	19.86	19.57
Pendimethalin	278.67	280.89	279.78	19.11	19.93	19.52
One hand weeding	279.44	281.67	280.56	19.27	20.02	19.64
Two hand weeding	278.22	282.00	280.11	19.33	19.96	19.64
Imazethapyr	279.56	281.67	280.61	19.16	20.03	19.59
Imazethapyr *fb* hand weeding	280.00	280.94	280.47	19.30	20.01	19.66
Pendimethalin *fb* hand weeding	278.22	280.67	279.44	19.43	20.06	19.74
Pendimethalin *fb* imazethapyr	278.47	280.69	279.58	19.29	20.08	19.68
S.Em. ±	6.37	7.46	4.90	0.27	0.38	0.23
C.d. (P = 0.05)	NS	NS	NS	NS	NS	NS
Fertility levels						
10 kg N + 20 kg P_2O_5 ha^{-1}	274.70	277.28	275.99	18.88	19.54	19.21
20 kg N + 40 kg P_2O_5 ha^{-1}	278.74	281.07	279.90	19.28	19.98	19.63
30 kg N + 60 kg P_2O_5 ha^{-1}	283.29	285.48	284.39	19.66	20.46	20.06
S.Em.±	2.31	2.19	1.59	0.13	0.119	0.09
CD (P=0.05)	6.67	6.29	4.50	0.36	0.34	0.24

Conclusion

The results of two years investigation revealed that weed management by two hand weeding 20 and 40 DAS gave the highest weed control efficiency and clusterbean seed yield followed by sequential application of pendimethalin 0.75 kg ha^{-1} as pre-emergence and imazethapyr 0.1 kg ha^{-1} 20 DAS on pooled basis. However, in monetary terms both net return and B:C were observed maximum under pre-emergence application of pendimethalin 0.75 kg ha^{-1} *fb* imazethapyr 0.1 kg ha^{-1} 20 DAS. Therefore, it was concluded that in southern zone of Rajasthan, clusterbean should be fertilized with 20 kg N + 40 kg P_2O_5 ha^{-1}. Further, weeds should be controlled effectively with the application of pendimethalin 0.75 kg ha^{-1} as pre-emergence followed by imazethapyr 0.1 kg ha^{-1} at 20 days after sowing.

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