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Effect of weed management and fertility levels on productivity of clusterbean [*Cyamopsis tetragonoloba* (L.)Taub]

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ABSTRACT

A field experiment was conducted during *Kharif* seasons of 2014 and 2015 at Udaipur (Rajasthan) to find out the effect of weed management on productivity of clusterbean under varying fertility levels. The results revealed that among various weed management practices, two hand weeding 20 and 40 DAS recorded significantly lower weed dry matter, higher weed control efficiency, higher values of yield attributes, seed, haulm and biological yield during both the years over rest of the treatments except sequential application of pendimethalin *fb* imazethapyr which was statistically at par. Further, application of Imazethapyr *fb* hand weeding and pendimethalin *fb* hand weeding also gave comaparable results with pendimethalin *fb* imazethapyr in terms of weed control efficiency and yields. Among the fertility levels application 20 Kg N + 40 Kg P_2O_5 ha^{-1} significantly increased pods $plant^{-1}$ (24.04), seeds pod^{-1}, (7.12), test weight (25.33 g), seed (1035 kg ha^{-1}), haulm (2161 kg ha^{-1}) and biological (3196 kg ha^{-1}) yield and harvest index (31.98 %) of clusterbean 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}. Therefore, clusterbean should be fertilized with 20 Kg N + 40 Kg P_2O_5 ha^{-1} and weeds must be controlled with pendimethalin (PE) *fb* imazethapyr 0.1 kg ha^{-1} 20 DAS .

Key words: Clusterbean, Hand weeding, Imazethapyr, Pendimethalin, Weed management.

INTRODUCTION

Clusterbean *[Cyamopsis tetragonoloba* (L.) Taub.*]* commonly known as guar, is an important drought hardy leguminous crop of arid and semiarid areas. It is grown for various purposes *viz.,* vegetable, green fodder, green manuring and seed. Now-a-days, it has acquired the status of industrial crop because of high galactomanan content (gum) in the endosperm of its seed (28-33 %) which has multiple industrial uses *viz*. textiles, paper, petroleum, pharmaceuticals, food processing, cosmetics, mining explosives, oil drilling *etc*. uses, thus making it a main foreign exchange earner. India accounts for more than 80 per cent of the total world clusterbean production. This crop has occupied sizable areas in arid and semi-arid regions encompassing Rajasthan, Gujarat, Haryana and Punjab state. Rajasthan has emerged as a major clusterbean growing state of India and it ranks first with respect to both area and production of clusterbean. The area under this crop in Rajasthan is 47.87 lac ha with production of 22.23 lac tonnes and average productivity of 465 kg ha^{-1}, (Govt, of Rajasthan, 2015-16).

It is well known that weeds are ubiquitous but their presence in cropped area particularly in rainy season crops like clusterbean act as major limiting factor in achieving potential harvest. Inadequate weed control is one of the main factors related to decrease in clusterbean production. In India, farmers rely predominantly on mechanical /manual methods of weed control. But these practices alone do not ensure weed free conditions and are expensive, cumbersome and time-consuming too; further reducing the profit margin. Most often protracted rains do not allow or delay the conventional farm operations during the critical weeding season. The pre-emergence herbicides like pendimethalin were found effective in controlling the weeds during early stages but late flushes and escaped/regenerated weeds in later stages also hamper the crop yield to certain extent possible (Devi Dayal, 2004). This warrants the use of post emergence herbicide for weed control. So herbicides with no longer residual activity such as imazethapyr which provide season long weed control is being used in many legumes. Further, diversification in herbicide use is being increasingly desired for herbicide rotations to tackle the emerging cross and multiple resistances to herbicides in weeds.This necessitates for an alternative cost-effective integrated weed-management strategy involving the pre- and post -emergence application of herbicides and intercultural operations considering the present situation of labour scarcity, quality of weed control, productivity and profitability concerns. Hence, it is

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worthwhile to use different herbicides at varying doses in conjunction with hand weeding to made effective weed control.

The judicious use of fertilizer also plays a vital role to achieve higher yield of clusterbean. 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. Clusterbean being a leguminous crop can meet its nitrogen requirement through symbiotic nitrogen fixation. However, starter dose of nitrogen is needed to meet its initial requirement. Next to nitrogen, phosphorus is of paramount importance for root development, nodule formation, disease resistance, yield and quality of crops.

Keeping in view, the nutrient requirement of clusterbean and higher cost involved in weed control, the present study was undertaken to find out suitable weed control measures in relation to varying fertility regime for improving the productivity of clusterbean.

MATERIALS AND METHODS

A field experiment was carried out at Rajasthan College of Agriculture, Udaipur. 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 weedings 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}. The weed flora emerged during the period of experimentation comprised of narrow-leaved weeds mainly *Cyanadon dactylon, Echinochloa colona, Brachiraria ramosa* broad-leaved weeds like *Amarathus viridis, Digera arvensis, Commelina benghalensis and Trianthema portulacustrum* etc.

The weeds under 0.25 m^2 area were removed at harvest and dried at 65^0 C temperature in oven till a constant weight was obtained which was expressed as weed dry matter. Weed control efficiency was calculated using the following formula (Mani *et al*., 1968).

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

Where
WCE = Weed control efficiency

Table 1: Effect of weed management and fertility levels on weed dry matter at harvest

Treatments	Dry matter (g m^{-2})								
	Narrow-leaved weeds			Broad- leaved weeds			Total weeds		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
Weed management									
Weedy check	209.99	193.98	201.98	239.18	219.54	229.36	449.17	413.52	431.34
Pendimethalin	95.75	84.10	89.93	114.74	103.32	109.03	210.49	187.42	198.96
One hand weeding	78.06	71.01	74.54	97.38	82.86	90.12	175.44	153.87	164.66
Two hand weeding	29.82	25.10	27.46	41.60	32.85	37.22	71.42	57.95	64.69
Imazethapyr	73.78	69.01	71.40	92.23	78.45	85.34	166.01	147.47	156.74
Imazethapyr *fb* hand weeding	39.93	32.95	36.44	48.85	41.16	45.00	88.78	74.10	81.44
Pendimethalin *fb* hand weeding	40.54	33.38	36.96	49.37	41.66	45.51	89.91	75.04	82.47
Pendimethalin *fb* imazethapyr	38.11	31.68	34.90	47.49	39.25	43.37	85.60	70.93	78.27
S.Em.±	2.28	1.72	1.42	2.59	2.56	1.82	3.45	2.35	2.09
C.D. (P=0.05)	6.91	5.21	4.13	7.87	7.76	5.28	10.48	7.13	6.05
Fertility levels									
10 Kg N + 20 Kg P_2O_5 ha^{-1}	75.14	67.30	71.22	90.82	79.46	85.14	165.96	146.76	156.36
20 Kg N + 40 Kg P_2O_5 ha^{-1}	75.88	67.76	71.82	91.71	79.99	85.85	167.59	147.75	157.67
30 Kg N + 60 Kg P_2O_5 ha^{-1}	76.23	67.90	72.06	91.54	80.20	85.8	167.7	148.1	157.9
S.Em. ±	1.18	0.64	0.67	1.030	0.821	0.65	1.67	1.04	0.98
C.D. (P=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 2: 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

X = Weed dry matter in weedy check
Y = Weed dry mater in treated plot

The crop was harvested at physiological maturity when plants turned golden yellow. After threshing, winnowing and cleaning was done and seeds were weighed separately to record seed yield and all the yield attributing parameters.

The harvest index (HI) was calculated as per formula referred by Donald and Hamblin (1976) and expressed in per cent.

$$\text{Harvest Index (\%)} = \frac{\text{Seed yield (kg ha}^{-1})}{\text{Biological yield (kg ha}^{-1})} \times 100$$

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). 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. Correlation studies were carried out with a view to determine interrelationship between various characters as described by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

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

Different weed management practices significantly reduced the dry weight of both narrow-leaved and broad-leaved weeds over weedy check at harvest (Table 1). During both the years and on pooled basis, two hand weeding 20 and 40 DAS recorded maximum reduction in total weed dry weight as compared to all other treatments but remained statistically at par with sequential application of pendimethalin with imazethapyr in this regard. Further, treatments imazethapyr *fb* hand weeding and pendimethalin *fb* hand also brought about significant reduction in weed dry weight and both these treatments were statistically at par with treatment pendimethalin *fb* imazethapyr. Alone application of imazethapyr, pendimethalin and one hand weeding also gave significant reduction in total weed dry matter as compared to weedy check. On pooled basis two hand weeding, pendimethalin *fb* imazethapyr reduced the dry matter of both narrow-leaved and broad-leaved weeds by 86.39, 82.71, 83.68 and 81.09 per cent over weedy check, respectively. The pooled results further indicate that highest weed contol efficiency for narrow-leaved, broad –leaved and total weeds was registered with two hand weeding (86.41, 85.01 & 85.02 %) followed by sequential application of pendimethalin with imazethapyr (82.74, 82.10 & 81.89%) , imazethapyr *fb* hand weeding (81.99, 80.36 81.14 %) and pendimethalin *fb* hand weeding (81.72, 80.14 & 80.91) (Table 2). Lower weed dry matter and 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 and 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. These results are in close conformity with the findings of Dhakar *et al.* (2009), Kumar *et al.* (2015) and Malunjkar *et al.,* (2012). There was no significant effect of fertility levels on weed dry matter of both narrow and broad leaved weeds during both the years of study as well as on pooled basis.

Highest number of yield attributes *viz.* pods plant^{-1}, seeds pod^{-1}, 1000-seed weight, weight of seeds pod^{-1} were recorded with two hand weeding which was significantly higher over weedy check, pendimethalin, one hand weeding, imazethapyr, pendimethalin *fb* hand weeding and imazethapyr *fb* hand weeding but statistically at par with pendimethalin *fb* imazethapyr on pooled basis (Table 3). Similarly two hand weeding also recorded maximum seed, haulm and biological yield which was significantly higher

Table 3 : Effect of weed management and fertility levels on yield attributes of clusterbean

Treatments	Yield attributes											
	Pods plant^{-1}			Seeds pod^{-1}			Weight of seeds (g pod^{-1})			Weight of 1000-seeds (g)		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
Weed Management												
Weedy check	15.67	16.36	16.01	4.82	4.95	4.88	0.11	0.12	0.12	21.10	21.95	21.53
Pendimethalin	21.66	22.08	21.87	6.18	6.25	6.22	0.17	0.17	0.17	22.60	23.12	22.86
One hand weeding	21.93	22.68	22.30	6.40	6.48	6.44	0.20	0.20	0.20	22.97	23.25	23.11
Two hand weeding	25.34	26.27	25.80	7.83	7.98	7.90	0.23	0.23	0.23	25.75	26.07	25.91
Imazethapyr	21.95	22.76	22.36	6.48	6.56	6.52	0.20	0.20	0.20	23.29	23.54	23.41
Imazethapyr *fb* hand weeding	23.93	24.52	24.23	7.34	7.42	7.38	0.22	0.22	0.22	24.15	24.52	24.33
Pendimethalin *fb* hand weeding	23.87	24.35	24.11	7.25	7.37	7.31	0.22	0.22	0.22	23.99	24.35	24.17
Pendimethalin *fb* Imazethapyr	24.87	25.61	25.24	7.58	7.68	7.63	0.23	0.23	0.23	24.95	25.31	25.13
S.Em. ±	0.47	0.63	0.39	0.19	0.13	0.12	0.003	0.004	0.003	0.53	0.42	0.34
C.D. (P=0.05)	1.45	1.91	1.14	0.59	0.41	0.34	0.010	0.012	0.008	1.63	1.29	0.99
Fertility levels												
10 Kg N + 20 Kg P_2O_5 ha^{-1}	19.57	20.20	19.88	5.94	6.02	5.98	0.18	0.18	0.18	20.10	20.48	20.29
20 Kg N + 40 Kg P_2O_5 ha^{-1}	23.72	24.36	24.04	7.07	7.17	7.12	0.20	0.21	0.20	25.13	25.54	25.33
30 Kg N + 60 Kg P_2O_5 ha^{-1}	23.92	24.68	24.30	7.21	7.31	7.26	0.21	0.21	0.21	25.57	26.02	25.80
S.Em. ±	0.23	0.33	0.20	0.11	0.06	0.06	0.002	0.002	0.001	0.25	0.28	0.19
C.D. (P=0.05)	0.67	0.95	0.57	0.33	0.19	0.19	0.005	0.006	0.004	0.740	0.80	0.53

Table 4 : Effect of weed management and fertility levels on yields and harvest index of clusterbean

Treatments	Yield (kg ha^{-1})											
	Seed yield			Haulm yield			Biological yield			Harvest index (%)		
	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled	2014	2015	Pooled
Weed Management												
Weedy check	447	463	455	1195	1199	1197	1642	1662	1652	26.90	27.97	27.44
Pendimethalin	821	831.	826	1915	1909	1912	2735	2740	2738	29.99	30.48	30.24
One hand weeding	857	869	863	1984	1993	1988	2840	2861	2851	30.11	30.32	30.21
Two hand weeding	1292	1315	1304	2550	260	2577	3843	3919	3881	33.60	33.48	33.54
Imazethapyr	860	867	863.	1991	1999	1995	2851.	2866	2857	30.09	30.18	30.14
Imazethapyr *fb* hand weeding	1214	1227	1221	2338	2383	2360	3552	3610	3581	34.15	33.97	34.06
Pendimethalin *fb* hand weeding	1219	1221	1220	2336	2381	2358	3555	360	3578	34.28	33.87	34.07
Pendimethalin *fb* Imazethapyr	1263	1269	1266	2475	2479	2477	3738	3748	3743	33.98	33.83	33.91
S.Em. ±	23.75	28.76	18.65	69.84	71.96	50.14	79.80	80.88	56.82	1.15	1.06	0.78
C.D. (P=0.05)	72.04	87.24	54.03	211.8	218.2	145.25	242.07	245.3	164.6	3.49	3.22	2.27
Fertility levels												
10 Kg N + 20 Kg P_2O_5 ha^{-1}	911	917	914	1987	2004	1996	2898	2921	2909	30.58	30.67	30.62
20 Kg N + 40 Kg P_2O_5 ha^{-1}	1026	1044	1035	2148	2174	2161	3174	3218	3196	31.93	32.03	31.98
30 Kg N + 60 Kg P_2O_5 ha^{-1}	1054	1062	1058	2159	2177	2168	3213	3239	3226	32.41	32.58	32.50
S.Em. ±	12.91	15.26	9.99	19.62	19.68	13.89	21.15	24.56	16.21	0.38	0.45	0.29
C.D. (P=0.05)	37.19	43.95	28.23	56.51	56.70	39.25	60.94	70.75	45.79	1.09	1.30	0.83

over other treatments except pendimethalin *fb* imazethapyr which was statistically at par with it during both the years and on pooled basis. Further, application of imazethapyr *fb* hand weeding and pendimethalin *fb* hand weeding also recorded significantly higher yields (seed, straw and biological) as compared to weedy check and alone application of pendimethalin and imazethapyr but both these treatments were statistically at par with pendimethalin *fb* imazethapyr. Sharma *et al*. (2015) reported that application of pendimethalin 0.9 kg ha^{-1} as pre-emergence + Imazethapyr 75 g ha^{-1} as post emergence 20 DAS resulted in significantly yield attributes, yield over unweeded control and was found at par with inter-culturing at 20 and 40 DAS. Positive effect of pendimethalin alone and in combination with one hand weeding on yield and yield attributing characters was observed by Kumar and Sharma (1997).

On pooled basis (Table 4), increase in seed yield by two hand weedings, pendimethalin *fb* imazethapyr, imazethapyr *fb* hand weeding and pendimethalin *fb* hand weeding was higher by 186.59, 178.24, 168.35 and 168.13 percent over weedy check, respectively. Increase in seed yield might be due to the direct influence of various weed management treatments on the suppression of weeds. The results corroborate with the findings of Kumar and Sharma (1996), Kumar *et al.* (1996) and Tiwari *et al* .(2014). Weed management treatments also brought about significant increase in harvest index of clusterbean. Highest harvest index was recorded with application of pendimethalin *fb* hand weeding and imazethapyr *fb* hand weeding which was statistically at par with two hand weeding and sequential application of pendimethalin *fb* imazethapyr.

All the yield attributing parameters were significantly increased by the application of 20 Kg N + 40 Kg P_2O_5 ha^{-1} and 30 Kg N + 60 Kg P_2O_5 ha^{-1} However, application of 30 Kg N + 60 Kg P_2O_5 ha^{-1} didn't bring about any significant increase in yield attributing parameters of clusterbean over 20 Kg N + 40 Kg P_2O_5 $ha^{-1.}$ Increasing the fertility levels tended to increase seed, haulm, biological yield and harvest index of clusterbean during both the years. 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 13.61 and 11.69 per cent over the fertility level of 10 Kg N + 20 Kg P_2O_5 ha^{-1}, respectively. The increases in seed and haulm yield with increased rates of nitrogen and phosphorus might be due to better nutritional status of the crop and increased carbohydrate accumulation and their remobilization to reproductive parts of the plants, being the closest sink and hence, resulted in increased flowering, fruiting and seed formation. The increased supply of nitrogen and phosphorus to crop might have stimulated the rate of various physiological processes in plant and led to increased growth and yield. Singh and Buttar (2012) reported that application of 10 Kg N + 20 Kg $P_2O_5$$ha^{-1}$ and 20 Kg N + 40 Kg P_2O_5 ha^{-1} increased the mean seed yield of clusterbean to the tune of 10.7 and 19.6 per cent over the control, respectively. The fertility levels 20 Kg N + 40 Kg P_2O_5 ha^{-1} and 30 Kg N + 60 Kg P_2O_5 ha^{-1} were statistically comparable in respect of yield and yield attributing parameters. This might be ascribed to the fact that cluster bean, being a leguminous crop, fixes atmospheric N and thus requires only a starter dose of N. Similar results were also reported by Rajput (2002) and Rathore *et al* (2007).

CONCLUSION

The result of two years investigation reveals that weed management by two hand weeding 20 and 40 DAS resulted in highest weed control efficiency and seed yield however pre-emergence application of pendimethalin 0.75 kg ha^{-1} *fb* post emergence application of imazethapyr 0.1 kg ha^{-1}gave comaparable results with it. So looking to the laborious pressure of hand weeding, cost effectiveness ease of application of chemical herbicides, application of pendimethalin *fb* imazethapyr can be an effective weed control option in cluster bean crop with higher seed and haulm yield under rainfed agroecosystem in semi arid and arid regions of Rajasthan.

REFERENCES

Devi Dayal. (2004). Weed management in groundnut. (In:) *Groundnut Research in India*,. (Basu, M.S. and Singh, N.B.) pp 248–259.

Dhaker, H., Mundra, S.L. and Jain, N.K. (2009). Weed management in clusterbean [*Cyamopsis tetragonoloba* (L.) Taub.]. *Indian Journal of Weed Science* **41**: 224-227.

Donald, C.M. and Humblin. (1976). The biological yield and harvest index of cereals as agronomic and plant breeding criteria. *Advances in Agronomy* **28** : 361-405.

Gomez, K.A. and Gomez. A.A.(1984). Statistical Procedures for Agricultural Research (2nded.) John Willey and Sons. Singapore.

Government of Rajasthan (2015-16). Agricultural Statistics at a Glance, Directorate of Agriculture, Rajasthan, Jaipur.

Kumar, R. and Sharma, O.L. (1997). Economics of integrated weed management in sunflower (*Helianthus annus* L.). *Crop Research* **13**: 217-219

Kumar, R. and Sharma, O.L. (1996). Integrated weed management in sunflower (*Helianthus annus* L.). *Crop Research* **11**: 381-382.

Kumar, R., Sharma, O.L., Singh, H.P. and Singh, S.P. (1996). Weed control in sunflower (*Helianthus annus* L.). *Annals of Biology* **12**: 264-269.

Kumar, G., Singh, M; Kumar, R.; Yadav, R.K; Datt, C; Paul, K; Soni, PG and Chauhan, A. 2015. Yield and quality of Fodder Turnip as affected by Nitrogen application and Weed management during Winter Lean Periods. *Indian Journal of Animal Nutrition* **32**: 57-62.

Malunjkar, B.D., Mulik, B.B. and Patil, S.C. 2012. Evaluation of post-emergence herbicides in rainy season groundnut. *Indian Journal of Weed Science* **44**: 95-97.

Mani, V.S., Gautam, K.C. and Chakraberty, T.K. 1968. Losses in crop yield in India due to weed growth. *PANS* **42**: 142-158.

Mishra, S.K. and Baboo, R. 2002. Effect of nitrogen and phosphorus on yield and quality of cowpea. *Annals of Agricultural Research* **23** (3): 387-90

Panse, V.G. and Sukhatme, P.V. 1985. Statistical Methods for Agricultural Workers. ICAR, New Delhi.

Rajput, R.S. (2002). Response of clusterbean (*Cyamopsis tetragonoloba* L. Taub) varieties to varying fertility levels and row spacing in northern Madhya Pradesh. M.Sc. (Agri.) thesis submitted to JNKVV, Jabalpur.

Rathore, V.S., Singh, J.P., Soni, M.L. and Beniwal, R.K. (2007). Effect of nutrient management on growth, productivity and nutrient uptake of rainfed clusterbean (*Cyamopsis tetragonoloba*) in arid region. *Indian J. Agric. Sci.,* **77**(6): 349-53.

Sharma S. K., Jat, Ram A. and Sagarka, B.K. 2015. Effect of weed-management practices on weed dynamics, yield and economics of groundnut (*Arachis hypogaea*) in black calcareous soil. *Indian Journal of Agronomy* **60**: 312-317.

Singh S. and Buttar, G.S. 2012. Integrated nutrient management in cluster bean (*Cyamposis tetragonoloba*) uner irrigated condition *Crop Research* (Hisar) **43**:55-56.

Tiwari V.K., Nagre S.K., Chandrakar D.K. and Sharma M.K. 2014. Effect of weed management practices on yield attribution of urdbean under late sown condition.p. In: *Biennial Conference of Indian Society of Weed Science on Emerging Challenges in* Weed Management. (Eds. Sushilkumar, Dubey RP, Choudhury PP, Rathor Meenal and Sarathambal C)*"* February 15-17, 2014. Directorate of Weed Science Research, Jabalpur. 208.