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WEED DYNAMICS, NUTRIENT DEPLETION AND QUALITY OF CLUSTERBEAN (*CYAMOPSIS TETRAGONOLOBA* L. TAUB) AS INFLUENCED BY WEED MANAGEMENT AND FERTILITY LEVELS

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ABSTRACT

A field experiment was conducted at Udaipur (Rajasthan), during the *Kharif* seasons of 2014 and 2015 in split plot design using 24 treatment combinations of weed management and fertility levels in three replications. The study aimed to explore weed control measures and fertility levels to mitigate weed infestation and improve clusterbean quality. The findings revealed that two hand weeding 20 and 40 DAS recorded the lowest density of both narrow- and broad-leaved weeds, lowest nitrogen and phosphorus depletion by weeds, highest seed yield (1304 kg ha^{-1}) and the next treatment in terms of effectiveness was the sequential application of pendimethalin with imazethapyr which also recorded lowest weed index (2.91). Application of 20 kg N + 40 kg P_2O_5 ha^{-1} recorded significantly higher nitrogen and phosphorus depletion by weeds, seed yield, protein and gum content of seed over application of 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}.

Keywords **:** Clusterbean, hand weeding, imazethapyr, pendimethalin, weed management.

Introduction

Clusterbean also known as 'guar' is one of the most important commercial crop of arid and semi-arid regions of India. It is grown as a cover crop, dry pod, fodder, and green manure crop. It is grown in Rajasthan, Uttar Pradesh, Gujarat and Haryana. In terms of area and production of clusterbean, Rajasthan takes the top spot in India. The crop yields guar gum, a type of gum that is exported to other nations. Its seeds have an endosperm that has around 30–33% gum and 18–28% protein. The gum is used in a variety of foods including ice cream, baked items, and dairy products. Furthermore, its gum is utilized in a variety of different industries, including medicines, cosmetics, mining, textiles, paper, oil drilling, and explosives. Weeds are the major obstacle to sustainable crop production. Weeds play an important role in determining crop yield and huge losses (37%) are due to weed infestation**.** Weeds compete for water, light, nutrients, space and harbours insects, pests and diseases resulting into yield reduction. A sound weed management programme is crucial to maintain agricultural productivity (Verma, 2014) and to ensure the food security to the burgeoning population. Therefore, timely weed removal using proper weed control techniques is crucial to obtain maximum yield of clusterbean.

Hand weeding is laborious, time consuming, costly and tedious job, furthermore, timely unavailability of labour as well as season continuous rains do not permit timely hand weeding. Looking to situation, use of herbicides offers an alternative for possible effective control of weeds in clusterbean. In addition, there is a growing need for diversity in herbicide use to combat the increasing resistance to herbicides in weeds. This requires an alternative and integral weed management strategy encompassing use

of herbicides and their combinations with cultural practices which would be more time saving, economical and efficient to curb early crop-weed interference.

Apart from weed management, poor nutrient management and low soil fertility are the other reasons of low productivity of clusterbean. Being a leguminous crop, clusterbean needs a small quantity of nitrogen as a starter dose during early growth period. Nitrogen is required for synthesis of chlorophyll, amino acids and other organic compounds of physiological significance in plant system. Phosphorus has an essential role in photosynthesis, respiration, energy storage, cell elongation and improves the quality of crops. It stimulates early root development and has a positive and significant effect on nodulation and crop yield (Tilak *et al.,* 2006). Keeping in mind the nutrient requirements of clusterbean and the higher cost involved in weed control, the current experiment was carried out to identify effective weed control measures to minimize weed infestation with minimal nutrient depletion by weeds and to improve the productivity and quality of clusterbean.

Materials and Methods

During the *Kharif* seasons of 2014 and 2015, a field experiment was conducted at the Rajasthan College of Agriculture, Udaipur to assess the impact of various weed management practices and fertility levels on weed dynamics, nutrient depletion and clusterbean quality. The mean weakly meteorological observations recorded during cropping periods are depicted in Fig. 1 and 2. The perusal of data reveal that the maximum and minimum temperatures during the crop growth period ranged between 27.8 ºC to 35.4 ºC and 16.6 ºC to 25.5 ºC, respectively during the *kharif,* 2014. The corresponding fluctuations during second year (*kharif,* 2015) of experimentation were 28.5 ºC to 35.9 ºC and 16.1 ºC to 26.2 ºC. The total rainfall received during the crop season of the year 2014 was 648.0 mm and 657.6 mm in 2015. The soil at the experimental site had a clay loam texture and had a pH between 8.1 and 8.0. In the years 2014 and 2015, the soil had medium levels of available nitrogen (285.0 and 279.61 kg ha^{-1}), phosphorus (20.42 and 19.27 kg ha^{-1}), and high levels of available potassium (324.16 and 318.15 kg ha^{-1}).The experiment included eight weed management treatments, including weedy check, pendimethalin 1.0 kg ha^{-1}, one hand weeding 20 DAS, two hand weeding 20 and 40 DAS, imazethapyr 0.1 kg ha^{-1}, imazethapyr 0.1 kg ha^{-1} *fb* hand weeding 40 DAS, pendimethalin 0.75 kg ha^{-1} *fb* hand weeding 20 DAS, and pendimethalin 0.75 kg ha^{-1} *fb* imazethapyr 0.1 kg ha^{-1} 20 DAS with 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}), thereby making 24 treatments combinations.. The trial was set up using a split plot design, with fertility levels assigned to sub plots and weed management treatments assigned to the main plots. Three replication of the each treatment were made. As a test crop, the clusterbean variety RGC-1031 was grown in accordance with a set of best practises for Rajasthan's agroclimatic zone IVa. After two weeks of sowing, the plant-to-plant gap was maintained by thinning at 10 cm. The furrows were first opened at a spacing of 30 cm. In two years of field study, clusterbean was mainly infested with mixed flora of narrow and broad-leaved weeds viz. *Cynodon dactylon* (L.) Pers., *Echinochloa colona* (L.) Link., *Cyperus rotundus* L., *Brachiaria reptans* (L.) Gardner & Hubbard, *Amaranthus viridis* L., *Commelina benghalensis* L., *Digera arvensis* Forsk. and *Trianthema portulacastrum* L. Pendimethalin was sprayed as part of the prescribed treatment one day after sowing (as a pre-emergence measure), and imazethapyr was applied twenty days later. The herbicides were sprayed with knapsack sprayer fitted with flat fan nozzle using 750 litres of water per hectare. In the plots involving hand weeding treatment, the weeds were removed manually at 20 and 40 DAS. As per treatment whole amount of nitrogen and phosphorus were applied through urea and DAP as basal application. All the plant protection measures were adopted to ensure a healthy crop.

In each plot broad-leaved weeds and narrow-leaved weeds were counted from two randomly selected area of 0.25 m^2 using 0.5 m X 0.5 m quadrate at 20, 40 DAS and at harvest. The mean data were converted to per square metre and subjected to square root transformation $\sqrt{X+0.5}$ to normalize their distribution (Gomez and Gomez, 1984). Weed samples collected at 20, 40 DAS and at harvest were oven dried at 65ºC till a constant weight was achieved and then ground in laboratory mill. Chemical analysis of these samples was done to determine N and P contents. The following standard methods for analysis were adopted.

(i) Nitrogen : Nessler's reagent colorimetric method (Lindner, 1944)

(ii) Phosphorus : Ammonium vanadomolybdate yellow colour method (Richards,1968)

Depletion of N and P by weeds was estimated by using following formula:

$$\text{Nutrient} = \frac{\text{Nutrient content in weeds (\%)} \times \text{Weed dry matter (kg ha}^{-1}\text{)}}{\text{depletion by weeds (kg ha}^{-1}\text{)}} \times 100$$

The seed samples were analysed for gum content by phenol sulphuric acid method (Das *et al.,* 1977). The protein content of seed was estimated by multiplying nitrogen content of seed with conversion factor of 6.25 (A.O.A.C., 1960).

Weed index was computed by the formula given below-

$$\text{Weed Index (WI)}\ \% = \text{WCE} = \frac{X - Y}{X}$$

(Where, X = seed yield (kg ha^{-1}) in treatment which has the highest yield and

Y = seed yield (kg ha^{-1}) in treatment for which weed index is to be calculated).

Statistical analysis of the experimental data was done by using the standard techniques of analysis of variance, pooled analysis of the data was also carried out to establish the trend of treatments applied as per Gomez and Gomez (1984). Mean comparison was performed based on critical difference at the 5% probability level.

Results and Discussion

Weed Flora

The predominant weed flora in clusterbean field were *Cynodon dactylon* (L.) Pers., *Echinochloa colona* (L.) Link., *Cyperus rotundus* L., *Brachiaria reptans* (L.) Gardner & Hubbard, Amaranthus *viridis* L., *Commelina benghalensis* L., *Digera arvensis* Forsk. and *Trianthema portulacastrum* L. In narrow-leaved weeds, *Echinochloa colona* (L.) Link was the most dominant weed, whereas in case of broad-leaved weeds the population of *Trianthema portulacastrum* L. was higher than other weed flora.

Effect on weed density

All the weed management practices significantly reduced density of different weed species over weedy check during both the years of study. At 40 DAS, sequential application of pendimethalin with imazethapyr resulted in minimum density of narrow-leaved (*Cynodon dactylon* (L.) Pers., *Echinochloa colona* (L.) Link., *Cyperus rotundus* L., *Brachiaria reptans* (L.) Gardner & Hubbard,) and broad-leaved (*Amaranthus viridis* L., *Commelina benghalensis* L., *Digera arvensis* Forsk. and *Trianthema portulacastrum* L.) weeds followed by post emergence application of imazethapyr alone and one hand weeding alone. At harvest, manual weeding twice recorded significantly lower weed count than rest of the treatments. The next treatmemt in the order of superiority was pendimethalin *fb* imazethapyr, however,it was statistically at par with imazethapyr *fb* hand weeding and pendimethalin *fb* hand weeding in terms of reducing the density of narrow-leaved, broad-leaved and total weeds at harvest. On pooled basis, two hand weeding, pendimethalin *fb* imazethapyr, imazethapyr *fb* hand weeding and pendimethalin *fb* hand weeding, imazethapyr, one hand weeding and pendimethalin significantly reduced total weeds density by 85.71, 82.47, 81.77, 81.57, 56.13, 54.94 and 44.15 per cent over weedy check, respectively. The maximum weed density was recorded in weedy check during both the years.

Removal of weeds manually twice in the field controlled early as well as late flushes of weeds up to the most critical stage of crop weed competition resulting in excellent performance compared to herbicides specially applied alone. The results corrobate with the findings of Singh *et al.* (2015) and Yadav and Mundra (2017).

At initial crop growth stage, pendimethalin checked weed seed germination due to its soil activity. While, at later growth stages, imazethapyr controlled both types of weeds. These results also corroborate with the findings of Habimana *et al*. (2013) and Brar (2018) also reported minimum weed density and weed dry weight under the application of pendimethalin *fb* imazethapyr in soybean. Application of fertility levels failed to exhibit any significant effect on the individual and category wise density of weeds during the study period.

Nutrient depletion by weeds

Different weed control practices had no significant impact on nitrogen and phosphorus content in weeds at 40 DAS and harvest. A significant decrease in nitrogen and phosphorus depletion by narrow and broad-leaved weeds was recorded due to various weed management practices as compared to weedy check at 40 DAS and harvest. At 40 DAS, the minimum nitrogen and phosphorus depletion by weeds was obtained under pre-emergence pendimethalin in conjunction with post-emergence imazethapyr. This treatment reduced nitrogen and phosphorus uptake by the weeds to the tune of 55.9 and 8.31 kg ha^{-1} compared to weedy check. Two hand weeding recorded lowest nitrogen and phosphorus depletion by weeds at harvest closely followed by sequential application of pendimethalin with imazethapyr. Further, application of imazethapyr *fb* hand weeding and pendimethalin *fb* hand weeding remained at par with pendimethalin *fb* imazethapyr in this respect. On pooled basis, the reduction in nitrogen and phosphorus depletion by weeds was 68.8 and 9.7 kg ha^{-1} under manual weeding twice over weedy check, respectively.

Reduced nutrient depletion by weeds under different weed control measures in clusterbean have also been reported by Singh *et al.* (2014) and Shruthi and Salakinkop (2015).

Pooled data of 40 DAS and harvest showed that maximum nitrogen and phosphorus content in narrow and broad-leaved was obtained under application of 30 kg N + 60 kg P_2O_5 ha^{-1} but it was found at par with 20 kg N + 40 kg P_2O_5 ha^{-1}. Application of fertility level 30 kg N + 60 kg P_2O_5 ha^{-1} being at par with 20 kg N + 40 kg P_2O_5 ha^{-1}, recorded significantly higher total nitrogen and phosphorus depletion by weeds over fertility level 10 kg N + 20 kg P_2O_5 ha^{-1} at 40 DAS and harvest. Higher removal of nutrients by weeds under different fertility levels might be due to higher nutrient content, as nutrient uptake is product of nutrient content and its biomass. Profound effect of fertility levels on nutrient removal by weeds has also been reported by Jadon (2016).

Effect on yield and quality parameters

The pooled data indicated that among weed management treatments, two hand weeding at 20 and 40 DAS recorded the highest seed yield (1304 kg ha^{-1}), however, it was statistically comparable with pendimethalin *fb* imazethapyr (1266 kg ha^{-1}). Application of imazethapyr and pendimethalin in combination with hand weeding significantly enhanced seed yield compared to their alone application, however, both these treatments differed non-significantly with pendimethalin *fb* imazethapyr in this regard. Different weed control measures failed to affect protein content in seed however, gum content was significantly influenced by weed management practices. Application of two hand weeding recorded maximum gum content (29.17%) closely followed by sequential application of pendimethalin with imazethapyr (28.87 %). Further, sequential application of pendimethalin with imazethapyr recorded lowest weed index (2.91) among all weed management treatments.

Maximum seed (1058 kg ha^{-1} yield was recorded under the application of 30 kg N + 60 kg P_2O_5 ha^{-1} which was significant over 10 kg N + 20 kg P_2O_5 ha^{-1}. However, application of 30 kg N + 60 kg P_2O_5 ha^{-1} remained statistically at par with 20 kg N + 40 kg P_2O_5 ha^{-1} in this regard. Enhancing fertility levels was significantly effective in increasing protein and gum content of clusterbean. The highest protein and gum content was obtained under application of 30 kg N + 60 kg P_2O_5 ha^{-1} which was significantly higher over 10 kg N + 20 kg P_2O_5 ha^{-1} but remained statistically at par with 20 kg N + 40 kg P_2O_5 ha^{-1}. The improvement in protein under the influence of fertility levels seems to be on account of increased nitrogen content of seed. The increase in gum content of seed might be attributed to increased boldness of seed and endosperm which in turn accumulated more carbohydrates (Sharma and Singh, 2004). Increased protein content and gum content with increasing fertility levels are in close conformity with the findings of Singh *et al.* (2014) and Verma *et al.* (2022).

Conclusion

Thus, it can be inferred from the present study that in addition to two hand weeding at 20 and 40 DAS, pre-emergence application of pendimethalin 0.75 kg ha^{-1} *fb* post emergence application of imazethapyr 0.1 kg was the most effective alternative for controlling weeds. Further, it is recommended that in Southern Rajasthan, clusterbean should be fertilized with 20 kg N + 40 kg P_2O_5 ha^{-1} for obtaining optimum seed yield and quality under Southern Rajasthan conditions. By implementing effective weed control measures and adopting appropriate nutrient management practices, clusterbean farmers can promote crop health, maximize yield potential and enhance overall farm productivity.

Table 1: Effect of weed management and fertility levels on individual weed density at 40 DAS (pooled data of two years)

Treatments	Weed density (No. m^{-2})							
Weed management	***Cynodon dactylon***	***Cyperus rotundus***	***Echinochloa colona***	***Brachiaria reptans***	***Amaranthus viridis***	***Commelina benghalensis***	***Trianthema portulacastrum***	***Digera arvensis***
Weedy check	4.60 (20.68)	4.43 (19.14)	9.65 (92.68)	5.01 (24.60)	4.72 (21.84)	5.23 (26.98)	6.84 (46.37)	4.68 (21.48)
Pendimethalin	3.76 (13.70)	3.48 (11.65)	4.97 (24.23)	3.72 (13.36)	4.00 (15.94)	3.97 (15.43)	4.67 (21.40)	3.48 (11.60)
One hand weeding	3.47 (11.57)	2.94 (8.15)	4.25 (17.61)	3.01 (8.60)	3.23 (9.95)	3.37 (10.87)	3.90 (14.75)	3.20 (9.73)
Two hand weeding	3.48 (11.64)	2.91 (8.01)	4.26 (17.69)	3.01 (8.62)	3.23 (9.97)	3.37 (10.92)	3.90 (14.79)	3.20 (9.75)
Imazethapyr	3.43 (11.25)	3.00 (8.51)	4.39 (18.80)	2.92 (8.13)	3.12 (9.24)	3.26 (10.19)	3.84 (14.31)	3.13 (9.30)

Imazethapyr *fb* hand weeding	3.42 (11.25)	3.01 (8.59)	4.38 (18.71)	2.92 (8.07)	3.13 (9.34)	3.28 (10.34)	3.83 (14.24)	3.12 (9.23)
Pendimethalin *fb* hand weeding	3.78 (3.99)	3.51 (11.82)	4.99 (24.48)	3.72 (13.43)	4.01 (15.64)	4.01 (15.64)	4.70 (21.61)	3.52 (11.88)
Pendimethalin *fb* imazethapyr	2.11 (3.99)	2.10 (3.95)	3.27 (10.23)	2.28 (4.52)	2.15 (4.15)	2.38 (5.17)	3.07 (6.35)	1.99 (3.50)
S.Em. .±	0.06	0.04	0.05	0.04	0.05	0.06	0.07	0.03
C.D. (P = 0.05)	0.16	0.12	0.13	0.13	0.15	0.19	0.20	0.10
Fertility levels								
10 kg N + 20 kg P_2O_5 ha^{-1}	3.49 (12.15)	3.15 (9.87)	5.00 (27.88)	3.30 (11.07)	3.43 (11.83)	3.59 (13.10)	4.27 (19.09)	3.28 (10.75)
20 kg N + 40 kg P_2O_5 ha^{-1}	3.51 (12.27)	3.17 (9.98)	5.01 (27.98)	3.33 (11.20)	3.45 (11.95)	3.61 (13.22)	4.29 (19.28)	3.29 (10.81)
30 kg N + 60 kg P_2O_5 ha^{-1}	3.52 (12.34)	3.19 (10.08)	5.04 (28.30)	3.33 (11.23)	3.47 (12.09)	3.62 (13.26)	4.30 (19.31)	3.30 (10.87)
S.Em. .±	0.03	0.03	0.04	0.03	0.03	0.04	0.04	0.02
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS

*Data subjected to $\sqrt{X+0.5}$ transformation and figures in parenthesis are original weed count m^{-2}

Table 2: Effect of weed management and fertility levels on individual weed density at harvest (pooled data of two years)

Treatments	**Weed density (No. m^{-2})**							
Weed management	***Cynodon dactylon***	***Cyperus rotundus***	***Echinochloa colona***	***Brachiaria reptans***	***Amaranthus viridis***	***Commelina benghalensis***	***Trianthema portulacastrum***	***Digera arvensis***
Weedy check	5.00 (25.06)	4.93 (23.89)	9.96 (98.76)	5.35 (28.25)	5.37 (28.40)	5.73 (32.42)	7.27 (52.46)	5.12 (25.73)
Pendimethalin	4.22 (17.42)	4.12 (16.53)	5.97 (35.24)	4.56 (20.45)	4.45 (19.43)	4.60 (20.67)	5.49 (29.71)	4.09 (16.26)
One hand weeding	3.92 (14.94)	3.93 (15.02)	5.29 (27.62)	3.89 (14.74)	3.96 (15.35)	4.00 (15.56)	4.98 (24.39)	3.77 (13.73)
Two hand weeding	2.10 (3.95)	2.13 (4.08)	3.46 (11.56)	2.10 (3.97)	2.11 (3.99)	2.49 (5.73)	3.00 (8.53)	1.92 (3.19)
Imazethapyr	3.87 (14.59)	3.92 (14.90)	5.27 (27.40)	3.89 (14.70)	3.94 (15.12)	3.97 (15.30)	4.78 (22.58)	3.75 (13.59)
Imazethapyr *fb* hand weeding	2.36 (5.07)	2.35 (5.06)	3.58 (12.40)	2.53 (5.95)	2.55 (6.05)	2.86 (7.71)	3.29 (10.36)	2.30 (4.78)
Pendimethalin *fb* hand weeding	2.38 (5.17)	2.37 (5.16)	3.59 (12.44)	2.55 (6.05)	2.54 (6.00)	2.88 (7.80)	3.31 (10.49)	2.33 (4.94)
Pendimethalin *fb* imazethapyr	2.36 (5.07)	2.32 (4.93)	3.46 (11.58)	2.48 (5.69)	2.44 (5.50)	2.73 (6.99)	3.20 (9.81)	2.32 (4.94)
S.Em. ±	0.05	0.05	0.06	0.06	0.07	0.03	0.05	0.03
C.D. (P = 0.05)	0.14	0.14	0.16	0.18	0.19	0.09	0.14	0.09
Fertility levels								
10 kg N + 20 kg P_2O_5 ha^{-1}	3.27 (11.36)	3.24 (11.32)	5.06 (29.47)	3.40 (12.32)	3.40 (12.33)	3.65 (13.92)	4.34 (20.38)	3.18 (10.79)
20 kg N + 40 kg P_2O_5 ha^{-1}	3.28 (11.40)	3.25 (11.30)	5.08 (29.65)	3.42 (12.48)	3.41 (12.44)	3.67 (14.07)	4.44 (21.27)	3.20 (10.87)
30 kg N + 60 kg P_2O_5 ha^{-1}	3.29 (11.47)	3.29 (11.48)	5.09 (29.75)	3.44 (12.62)	3.45 (12.68)	3.66 (14.07)	4.47 (21.47)	3.22 (11.02)
S.Em. .±	0.03	0.04	0.02	0.04	0.04	0.014	0.03	0.01
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS

*Data subjected to $\sqrt{X+0.5}$ transformation and figures in parenthesis are original weed count m^{-2}

Table 3: Effect of weed management and fertility levels on category wise weed density at 40 DAS and harvest (pooled data)

Treatments	Category wise weed density (No. m^{-2})					
	At 40 DAS			At harvest		
Weed management	**Narrow-leaved weeds**	**Broad-leaved weeds**	**Total weeds**	**Narrow-leaved weeds**	**Broad-leaved weeds**	**Total weeds**
Weedy check	12.55 (157.13)	10.82 (116.68)	16.56 (273.81)	13.28 (176.00)	11.81 (139.03)	17.76 (315.03)
Pendimethalin	7.97 (63.18)	8.02 (63.98)	11.29 (127.16)	9.50 (89.87)	9.30 (86.07)	13.28 (175.94)
One hand weeding	6.81 (45.92)	6.76 (45.32)	9.57 (91.24)	8.53 (72.32)	8.33 (69.03)	11.90 (141.34)
Two hand weeding	6.81 (45.96)	6.77 (45.44)	9.58 (91.41)	4.89 (23.56)	4.68 (21.45)	6.73 (45.00)
Imazethapyr	6.87 (46.75)	6.59 (43.05)	9.50 (89.79)	8.48 (71.59)	8.18 (66.61)	11.77 (138.20)
Imazethapyr *fb* hand weeding	6.86 (46.61)	6.60 (43.15)	9.49 (89.77)	5.38 (28.48)	5.42 (28.92)	7.60 (57.40)
Pendimethalin *fb* hand weeding	8.00 (63.60)	8.08 (64.78)	11.35 (128.38)	5.41 (28.82)	5.45 (29.24)	7.64 (58.05)
Pendimethalin *fb* imazethapyr	4.87 (23.36)	4.43 (19.20)	6.55 (42.56)	5.32 (27.93)	5.26 (27.27)	7.45 (55.20)
S.Em. **.±**	0.06	0.06	0.06	0.06	0.06	0.07
C.D. (P = 0.05)	0.17	0.16	0.17	0.17	0.17	0.20
Fertility levels						
10 kg N + 20 kg P_2O_5 ha^{-1}	7.56 (61.05)	7.23 (54.78)	10.44 (115.83)	3.40 (12.32)	3.40 (12.33)	3.65 (13.92)
20 kg N + 40 kg P_2O_5 ha^{-1}	7.58 (61.44)	7.27 (55.27)	10.48 (116.71)	3.42 (12.48)	3.41 (12.44)	3.67 (14.07)
30 kg N + 60 kg P_2O_5 ha^{-1}	7.64 (62.20)	7.29 (55.55)	10.54 (117.75)	3.44 (12.62)	3.45 (12.68)	3.66 (14.07)
S.Em. **.±**	0.04	0.04	0.04	0.04	0.04	0.014
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS

*Data subjected to $\sqrt{X+0.5}$ transformation and figures in parenthesis are original weed count m^{-2}

Table 4: Effect of weed management and fertility levels on nitrogen and phosphorus content in weeds at 40 DAS and harvest

Treatments	Nitrogen content (%)		Phosphorus content (%)		Nitrogen content (%)		Phosphorus content (%)	
	40 DAS				At harvest			
Weed management	Narrow-leaved weeds	Broad-leaved weeds	Narrow-leaved weeds	Broad-leaved weeds	Narrow-leaved weeds	Broad-leaved weeds	Narrow-leaved weeds	Broad-leaved weeds
Weedy check	1.741	2.142	0.248	0.327	1.691	2.057	0.233	0.312
Pendimethalin	1.749	2.151	0.254	0.326	1.707	2.070	0.240	0.315
One hand weeding	1.748	2.151	0.252	0.329	1.712	2.079	0.239	0.321
Two hand weeding	1.752	2.156	0.251	0.332	1.708	2.104	0.235	0.319
Imazethapyr	1.744	2.146	0.254	0.323	1.698	2.066	0.230	0.318
Imazethapyr *fb* hand weeding	1.755	2.148	0.249	0.324	1.711	2.081	0.231	0.315
Pendimethalin *fb* hand weeding	1.742	2.154	0.254	0.328	1.715	2.099	0.239	0.319
Pendimethalin *fb* imazethapyr	1.764	2.158	0.250	0.331	1.718	2.104	0.235	0.317
S.Em. **.±**	0.014	0.011	0.002	0.003	0.011	0.015	0.003	0.003
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS
Fertility levels								
10 kg N + 20 kg P_2O_5 ha^{-1}	1.722	2.119	0.243	0.319	1.675	2.050	0.228	0.309
20 kg N + 40 kg P_2O_5 ha^{-1}	1.762	2.165	0.255	0.331	1.722	2.096	0.238	0.320
30 kg N + 60 kg P_2O_5 ha^{-1}	1.764	2.168	0.256	0.333	1.726	2.101	0.240	0.322
S.Em. **.±**	0.003	0.006	0.001	0.002	0.005	0.004	0.001	0.001
C.D. (P = 0.05)	0.009	0.018	0.003	0.005	0.013	0.013	0.004	0.004

Table 5: Effect of weed management and fertility levels on nitrogen and phosphorus depletion by weeds at 40 DAS and harvest

Treatments	N depletion (kg ha^{-1})			P depletion (kg ha^{-1})			N depletion (kg ha^{-1})			P depletion (kg ha^{-1})		
	40 DAS						At harvest					
Weed management	Narrow-leaved weeds	Broad-leaved weeds	Total Weeds	Narrow-leaved weeds	Broad-leaved weeds	Total Weeds	Narrow-leaved weeds	Broad-leaved weeds	Total Weeds	Narrow-leaved weeds	Broad-leaved weeds	Total Weeds
Weedy check	24.7	36.2	60.9	3.52	5.53	9.05	34.1	47.1	81.3	4.70	7.15	11.8
Pendimethalin	7.98	13.5	21.5	1.15	2.06	3.21	15.3	22.5	37.9	2.15	3.43	5.59
One hand weeding	5.91	11.3	17.2	0.85	1.72	2.57	12.7	18.7	31.5	1.77	2.89	4.67
Two hand weeding	5.92	11.4	17.3	0.84	1.76	2.61	4.69	7.83	12.5	0.64	1.18	1.83
Imazethapyr	6.07	10.8	16.9	0.88	1.62	2.51	12.1	17.6	29.7	1.64	2.71	4.36
Imazethapyr *fb* hand weeding	6.16	10.8	16.9	0.87	1.63	2.50	6.23	9.36	15.5	0.84	1.41	2.25
Pendimethalin *fb* hand weeding	8.12	13.8	21.9	1.18	2.10	3.28	6.34	9.55	15.9	0.88	1.45	2.33
Pendimethalin *fb* imazethapyr	1.95	3.05	5.00	0.27	0.46	0.74	5.99	9.11	15.1	0.82	1.37	2.19
S.Em. **.±**	0.22	0.34	0.55	0.04	0.05	0.08	0.24	0.39	0.43	0.04	0.06	0.09
C.D. (P = 0.05)	0.65	0.98	1.60	0.11	0.14	0.23	0.71	1.14	1.25	0.13	0.20	0.26
Fertility levels												
10 kg N + 20 kg P_2O_5 ha^{-1}	8.16	13.6	21.8	1.15	2.05	3.20	11.9	17.3	29.2	1.62	2.62	4.25
20 kg N + 40 kg P_2O_5 ha^{-1}	8.40	13.9	22.3	1.21	2.13	3.34	12.3	17.9	30.2	1.70	2.73	4.44
30 kg N + 60 kg P_2O_5 ha^{-1}	8.49	14.0	22.5	1.23	2.15	3.39	12.3	17.9	30.3	1.72	2.75	4.47
S.Em. **.±**	0.05	0.09	0.12	0.008	0.01	0.02	0.11	0.15	0.19	0.02	0.02	0.02
C.D. (P = 0.05)	0.15	0.26	0.36	0.02	0.05	0.06	0.31	0.41	0.54	0.05	0.07	0.08

Table 6: Effect of weed management and fertility levels on yield, quality parameters and weed index of clusterbean

Treatments	Seed yield (kg/ha)	Protein content (%)	Gum content (%)	Weed index (%)
Weed management				
Weedy check	455	24.60	25.07	65.10
Pendimethalin	826	24.69	26.36	36.65
One hand weeding	863	24.96	26.56	33.81
Two hand weeding	1304	25.21	29.17	0.00
Imazethapyr	863	25.00	26.83	33.81
Imazethapyr *fb* hand weeding	1221	25.07	27.88	6.36
Pendimethalin *fb* hand weeding	1220	25.06	27.71	6.44
Pendimethalin *fb* imazethapyr	1266	25.10	28.87	2.91
S.Em. **.±**	18.65	0.183	0.303	-
C.D. (P = 0.05)	54.03	NS	0.878	-
Fertility levels				
10 kg N + 20 kg P_2O_5 ha^{-1}	914	24.06	26.02	-
20 kg N + 40 kg P_2O_5 ha^{-1}	1035	25.40	27.87	-
30 kg N + 60 kg P_2O_5 ha^{-1}	1058	25.43	28.03	-
S.Em. **.±**	9.99	0.083	0.159	-
C.D. (P = 0.05)	28.23	0.235	0.450	-

*pooled data of two years

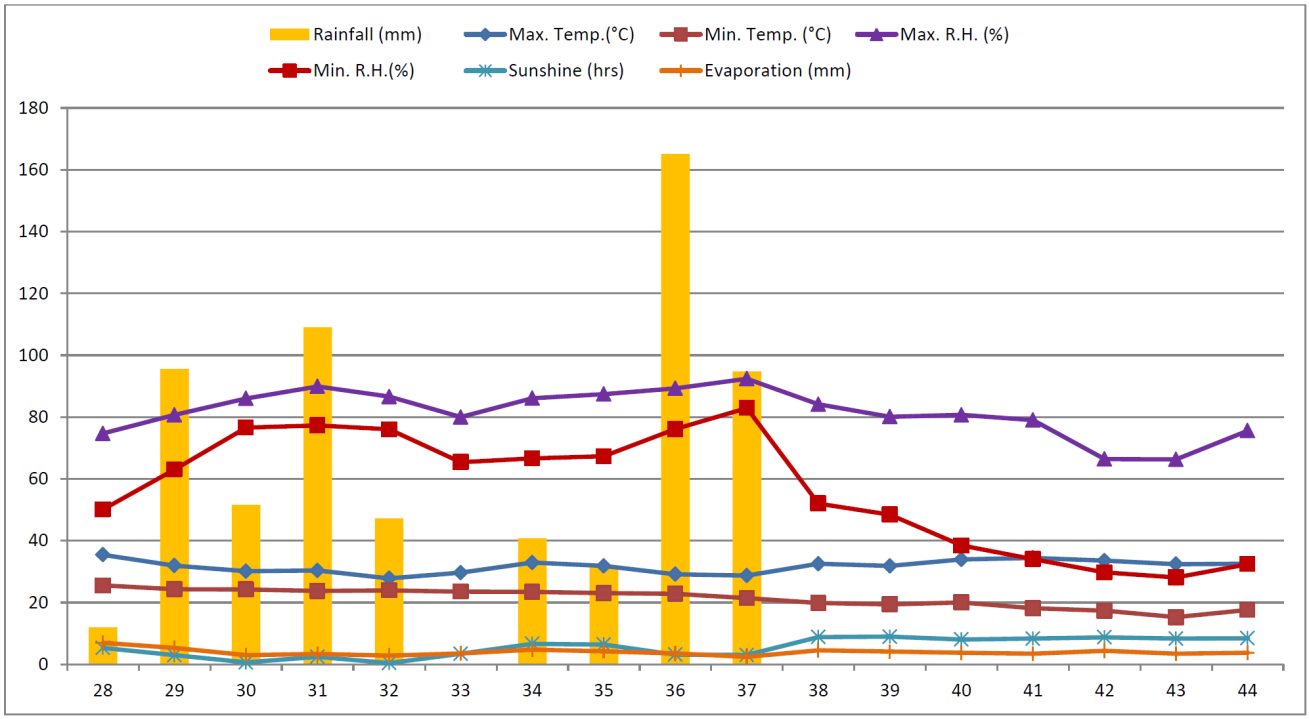

Fig. 1: Weekly average of meteorological data during experimental period for *kharif* 2014

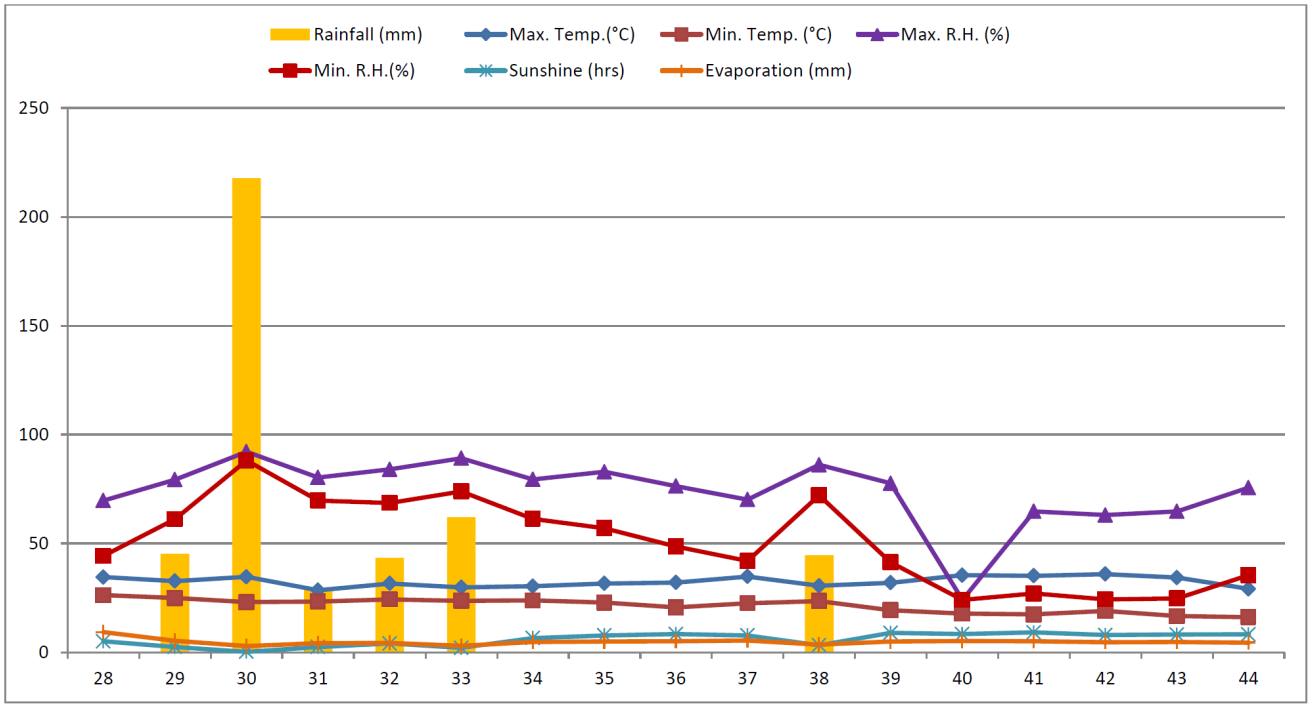

Fig. 2: Weekly average of meteorological data during experimental period for *kharif* 2015

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