Effect of different weed management practices on weed flora, growth and yield attributes, nutrient content and uptake by crop and weed in Indian bean (\textit{Lablab purpureus} L.) under South Gujarat Condition

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Abstract

A field experiment was conducted at College Farm, Navsari Agricultural University, Navsari during \textit{rabi} season of 2016 to study the "Effect of weed management practices on growth and yield of vegetable Indian bean (\textit{Lablab purpureus} L.) under south Gujarat condition." Application of weed free treatment significantly reduced the weed count and dry weed biomass, increased the weed control efficiency. Nutrient losses by weeds were observed highest under unweeded control treatment and lowest with weed free condition followed by application of pendimethalin (CS) @ 0.5 kg/ha as PE. weed free treatment, three hand weeding (HW) at 20, 40 and 60 DAS, pendimethalin (EC) @ 1.0 kg/ha as PE + HW at 40 DAS (T5), imazethapyr @ 75 g/ha at 20 DAS + HW at 40 DAS (T4) and pendimethalin (CS) @ 0.5 kg/ha as PE + HW at 40 DAS (T3) enhanced the growth characters viz., plant height, number of branches per plant, dry matter accumulation, days to 50% flowering along with the yield attributes like pod length, number of pods per plant and number of seeds per pod. Pod and stover yields of Indian bean were significantly higher under weed free treatment being at par with the application of pendimethalin (EC) @ 1 kg/ha as PE + HW at 40 DAS (T5), pendimethalin (CS) @ 0.5 kg/ha as PE + HW at 40 DAS (T4) and imazethapyr @ 75 g/ha at 20 DAS + HW at 40 DAS (T3) for pod yield, while in addition to these treatments, imazethapyr @ 75 g/ha at 20 DAS (T4) was also found at par for stover yield. Maximum net returns of Rs. 26343/ha were incurred due to the application of pendimethalin (EC) @ 1 kg/ha as PE + HW at 40 DAS (T5), and resulted into maximum beneficial treatment for \textit{rabi} Indian bean.

Keywords: Management, practices, attributes, \textit{Lablab purpureus} L.

Introduction

Pulses in India have unique importance to the vegetarian peoples as nutritionally balanced food defined over thousand years ago, besides cereals, vegetables, fruits and milk products (Ayachit, 2002) \textsuperscript{11}. The term "pulses" is limited to the agronomical crops harvested solely for dry grain, there by excluding crops harvested green for food, classified as vegetable crops. Indian bean (\textit{Lablab purpureus} L. Sweet) is a multipurpose crop grown for pulse, vegetable and forage. It is one of the major of protein in the diets in southern and western states of India. Its fresh green pod contain 86.1% moisture, 3.8% protein, 67% carbohydrates, 0.75% fat, 0.9% mineral matter and vitamin-A (Singh et al., 2004) \textsuperscript{19}, while mature dry seeds contain 23% protein, 625 carbohydrates and 340 calories per 100g of edible portion (Tindall 1983) \textsuperscript{20}. Unlike other agronomical crops, weeds are one of the major problems in limiting the productivity of Indian bean. At initial, Indian bean plants grow slowly and are weak competitors to most of the weeds; even lesser weed infestations in the early growth period reduce Indian bean yields significantly (Bhan and Singh, 1991) \textsuperscript{4}. Weeds emerge fast and grow rapidly competing with the crop severely for growth resources viz., nutrients, moisture, sunlight and space during entire vegetative and early reproductive stages of Indian bean. They also transpire lot of valuable conserved moisture and absorb large quantities of nutrients from the soil which cannot be admired especially during \textit{rabi} season. Even though such huge crop produce losses are caused by the weeds, Indian farmers do not pay a quantifiable attention.
towards weed management as compared to pest, disease, fertilizer and irrigations. This can be observed from the pattern of pesticides usage in agriculture in India. Use of herbicides, insecticides and fungicides in India is 10%, 76% and 13% respectively, while at global level these figures are 30%, 44% and 21%, respectively (Akhtar et al., 2009) [3]. This may be one reason for low crop productivity in India. The traditional methods of inter-cultivating and manual weeding are more effective in controlling weeds, but are tedious and time consuming besides labour intensive and costly. However, chemical method of weed control has become efficient and time saving with the introduction of herbicides this is particularly true under intensive crop production practices. Unavailability of labour at the time of weeding resulting in sever field infestation which make mechanical weeding ineffective, tedious and costly. Under such circumstances, chemical control of weeding may be the viable and cost effective alternative for this crop. Effective herbicide at appropriate rate may prove as an effective weed control method and replace conventional method of weed control. So if weed growth is minimize during the period of crop weed competition, crop yield will be equivalent to that of weed free crop. There for it is essential to control weed by any means during crop weed competition. This paper deals with the objective of to study different weed flora, effect of different weed control practices on growth and yield efficiency of different herbicide for controlling weed in vegetable Indian bean.

Material and Methods
A field experiment was carried out during rabi season of 2016. The experiment was laid out in randomized block design, with three replication and eight treatments comprising of weed management practices. The soil of experimental field was clay in texture and showed low, moderately high and very high rating for available nitrogen (172.50 kg/ha), Phosphorus (38.20 kg/ha), Potassium (323.18 kg/ha), respectively. The soil was slightly alkaline (pH 7.8) with normal electric conductivity (0.36 ds/m). The seed of Indian bean variety GNIB-21 was sown on 16th November 2016 at a row spacing of 45 x 10 cm using seed rate of 40 kg/ha and fertilized with 20-40-00 NPK kg/ha. Pre emergence herbicide spray was done using 500 liters of water per hectare as per treatment. Pre emergence herbicides viz., pendimethalin (EC) was sprayed in respective plots, next days after sowing of Indian bean crop while, pendimethalin (CS) was sprayed to the soil before application of irrigation. The pre-emergence application was made on the soil surface uniformly within respective plots. The crop was grown with recommended package and practices for South Gujarat Heavy Rainfall Agro climatic Zone and was harvested in three picking for green pods.

Result and Discussion
Effect of weed population, dry weight of weed, WCE and WI
Different types of weed flora were observed in experimental field. The dominant weed flora comprise of grassy weeds viz., Echinochloa crus-galli, Cynodon dactylon, Sorghum halepense, Digitaria sanguinalis, Brachiaria spp.; broadleaf weeds viz., Amaranthus viridis, Alternanthera sessilis, Digera arvensis, Convolvulus arvensis, Trianthema portulacastrum, Euphorbia hirta, Phyllanthus maderaspotensis, Physalis minima; and among sedge Cyperus rotundus which were predominantly present during the course of experimentation. Similar weed flora was noticed by Raj et al. (2012) [12] and Reddy et al. (1994) [17].
All weed management treatment significantly reduces the production of weeds as compare to unweeded control (T1). Among the different tried (Table 1), treatment T2 (weed free) recorded significantly lowest number of Grassy (6.67 m²), broadleaf (8.33 m²), sedge (4.00 m²) and total weed population (19.00 m²) at 60 DAS compare to rest of the treatments. This might be due to effect of weed control in respective treatments either manual or herbicidal or both resulted in remarkable reduction in weed population. The findings are confined with those reported by Chandrakar et al. (2015) [6] and Chavan et al. (2016) [9].
Minimum dry weed biomass and maximum weed control efficiency was observed in treatment T2 which was at par with post emergence application of imazethapyr @ 75 g/ha at 20 DAS + HW at 40 DAS (T5). Better weed control efficiency of herbicides along with hand weeding resulted into the lowest weed counts and finally reduced the total dry weed biomass at 60 DAS combined with more number of branches per plant, dry weed biomass (Table 1) which did not allow weeds to grow vigorously due to smothering effect. Similar results were also reported by Chaudhary et al. (2005) [6] and Chavan et al. (2016) [9].
Weed index is the indicator of losses in seed yield due to presence of weeds therefore in this experiment treatment T2 was considered as base for calculating weed index. In this, treatment T5 (pre-emergence application of pendimethalin (EC) @ 1 kg/ha + HW at 40 DAS) and T6 (pre-emergence application of pendimethalin (CS) @ 1 kg/ha + HW at 40 DAS) found to have better weed index value (Table 1) as compared to rest of the treatments. This might be due to effective weed control achieved under these weed management treatments in terms of reduced biomass of weeds and higher weed control efficiency which converted in to higher yields of crop. Similar results were also reported by Chaudhary et al. (2005) [6] and Chavan et al. (2016) [9].

Effect on crop
Growth attributes
The plant height at 60 DAS showed significant effect in all the treatments (Table 2). Significantly taller plant seen in weed free treatment (T2) were also at par with the treatment T5 (pre-emergence application of pendimethalin (EC) @ 1.0 kg/ha followed by HW 40 DAS) and T6 (post-emergence application of imazethapyr @ 75 g/ha followed by HW at 40 DAS). The lowest plant height in unweeded control might be due to more crop–weed competition. The number of branches per plant recorded 60 DAS showed significant effect due to different weed management practices. Highest branches per plant were observed in weed free treatment (T2) which was at par with pre-emergence application of pendimethalin (EC) @ 1.00 kg/ha + HW at 40 DAS (T3) and post-emergence application of imazethapyr @ 75 g/ha +HW at 40 DAS (T6). The results pertaining to the dry matter accumulation per plant at 60 DAS showed significant effect.
The maximum dry matter accumulation per plant obtained in the weed free treatment (T2) and was found at par with treatment T6, T5, T6, T5, T7 and T5. The overall improvement in plant growth under these treatments can chiefly be attributed to greater availability of light, moisture and nutrients resulting from decreased weed competition as evident from significantly lower weed population. These results are in agreement with those reported by Nagender (2014) [12], Sharma et al. (2014) [18] and Chaudhari et al. (2016) [7].
Yield attributes

The results about pod length, number of pod per plant, pod yield per plant, pod yield and stover yield revealed significant effect (Table 2). Maximum pod length, number of pod per plant, pod yield per plant, pod yield and stover yield were recorded in the weed free treatment (T2). Pod length was found statistically at par with treatment T8 and T3 while number of pod per plant was also found at par T6. Weed free treatment (T2) recorded maximum pod yield per plant but remained statistically at par with T5, T1, T2, T3 and T7. The lowest pod yield per plant was found under unweeded control (T1). The results are in close association with the findings of Patel et al. (2006) [14] and (Makwana, 2008) [11]. Significantly higher pod and stover yield was observed in weed free treatment (T2) which remained at par with T5, T2, T3 and T8 while, stover yield was also found at par under T1 and T7 treatment. This might be due to effective control of weeds in terms of reduced weed population and dry weed biomass under these treatments. This may also be attributed with the better growth of crop in terms of higher leaf area index and dry matter accumulation in these treatments, which may have resulted in better translocation of photosynthetic for development of all the yield attributes. These results are in close conformity with Poonia and Pithia (2013) [15] and Vikas et al. (2013) [22].

Nutrient content in crop plant and weed

Nutrient content (Table 3) by crop was found non-significant except for phosphorus. Phosphorus content was found significant higher under weed free treatment (T2) which was found at par with treatment of imazethapyr @ 75 g/ha + HW at 40 DAS (T4). Significantly lowest phosphorus content by Indian bean crop was noted under unweeded control (T1). This might be due to the plant character being legume that enable nitrogen content as stable and differed phosphorus content as per the crop-weed competition within the treated and untreated plots. The nutrient content in weed (nitrogen and phosphorus) was found significantly highest under unweeded control, while minimal contents were observed in T2 treatment. Nitrogen was found at par with treatment T2 for least content due to application of imazethapyr @ 75 g/ha at 20 DAS + HW at 40 DAS (T4) and pre-emergence application of pendimethalin (CS) @ 1 kg/ha + HW at 40 DAS (T4), while in case of phosphorus content, treatments of pendimethalin (CS) @ 0.5 kg/ha + HW at 40 DAS (T4) and pendimethalin (EC) @ 1 kg/ha + HW at 40 DAS (T3) were found at par with T2 for least nutrient content. The reason might be the crop-weed competition under these treatments which resulted in lesser dry weed biomass of weed that ultimately lead to lesser nutrient content and uptake or vice-versa.

Nutrient uptake show non-significant effect for potassium while, nitrogen and phosphorus uptake were found significantly raised in T2 (weed free). However, nitrogen uptake remained at par with T6, T5, T3, T1 and T7. Further, the lowest uptake of nutrients by crop was found was T1 (unweed control). This may have happened due to less competition of weeds, resulting in minimal struggle for nutrients leading to luxurious uptake of nutrients and vice-versa in case of unweeded control (T1). These results may be corroborated with the findings of Kumar et al. (2007) [16], Choudhary et al. (2012) [18] and Singh et al. (2014) [19].

Nutrient status after harvest

N, P2O5 and K2O status after harvesting of Indian bean were not affected significantly due to the various weed control treatments. This might be due to the character of crop being legume to enhance the soil with stable N-fixing and leading to much more organic matter maintaining the soil nutrient status.

Economics

Economics is the major consideration for the farmers while taking a decision regarding the adoption of new technology. Hence, the cost of cultivation, gross realization, net realization and benefit cost ratio were computed for all weed management treatments (Table 5). Although weed free treatment (T2) recorded significantly higher crop yield but owing to the use of labours its cost of production (Rs.36098/ha) increased due to which it fetched lesser net monetary returns of Rs. 24807/ha as compared to T4 treatment fetching Rs. 26343/ha with CBR ratio 1.86, followed by treatment of pendimethalin (CS) @ 0.5kg/ha as PE + HW at 40 DAS (T4) with CBR value of 1.84 and imazethapyr @ 75 g/ha at 20 DAS + HW at 40 DAS (T2). The whole and sole reason for this is the labour cost incurred in treatment T2 which were also observed by Overfield et al. (2001) [13] and Aggarwal et al. (2014) [1].

Table 1: Effect of different weed management treatments on weed population at 60 DAS, dry weed biomass, WCE and WI

| Treatments            | Weed population at 60 DAS (m²) | Dry weed biomass (g/m²) | WCE (%) | WI |
|-----------------------|-------------------------------|-------------------------|---------|----|
|                       | Grass | Broad leaf | Sedge | Total | Grass | Broad leaf | Sedge | Total | Grass | Broad leaf | Sedge | Total | Grass | Broad leaf | Sedge | Total | Grass | Broad leaf | Sedge | Total |
| T1:Unweeded control   | 7.05  | 6.49       | 6.66  | 11.66 | 98.55 | 0.00      | 30.4 |
| T2:Weed free (Hand weeding at 20, 40 and 60 DAS) | 2.65  | 2.96       | 2.09  | 4.14  | 16.95 | 82.79     | 0.0  |
| T3:Pendimethalin (EC) @ 1.0 kg/ha as Pre-emergence | 4.66  | 4.18       | 4.23  | 5.70  | 41.29 | 58.08     | 19.3 |
| T4:Pendimethalin (CS) @ 0.5 kg/ha as PE + HW at 40 DAS | 4.23  | 4.16       | 4.56  | 5.74  | 41.46 | 57.91     | 24.3 |
| T5:Pendimethalin (EC) @ 1.0 kg/ha as PE + HW at 40 DAS | 3.18  | 3.65       | 4.44  | 6.53  | 30.71 | 68.82     | 5.9  |
| T6:Pendimethalin (CS) @ 0.5 kg/ha as PE + HW at 40 DAS | 3.24  | 3.42       | 4.93  | 6.79  | 40.78 | 58.60     | 6.1  |
| T7:Imazethapyr @ 75 g/ha at 20 DAS | 2.96  | 3.18       | 4.22  | 5.99  | 24.32 | 75.31     | 9.1  |
| S.E.m. ±              | 0.30  | 0.29       | 0.41  | 0.33  | 3.37  |
| C.D (P=0.05)          | 0.90  | 0.87       | 1.26  | 1.02  | 10.23 |
| C.V (%)               | 12.78 | 12.53      | 16.34 | 8.36  | 14.23 |

*Figures indicating (√X ± 0.5) transformed values, Figures in parenthesis are indicating original values.

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Table 2: Effect of different weed management treatments on growth and yield attributes of Indian bean

| Treatments | Plant height (cm) at 60 DAS | No. of branches per plant at 60 DAS | Dry matter accumulation (g/m²) at 60 DAS | Pod length (cm) | Number of pods per plant | Pod yield per plant (g) | Pod yield (kg/ha) | Stover yield (kg/ha) |
|------------|----------------------------|-----------------------------------|----------------------------------------|----------------|-------------------------|------------------------|------------------|------------------|
| T1: Unweeded control | 36.80 | 8.93 | 8.33 | 3.53 | 18.93 | 11.70 | 1770 | 2500 |
| T2: Weed free (Hand weeding at 20, 40 and 60 DAS) | 46.00 | 12.47 | 11.20 | 4.60 | 27.60 | 16.37 | 2544 | 3336 |
| T3: Pendimethalin (EC) @ 1.0 kg/ha as Pre-emergence (PE) | 38.93 | 9.80 | 8.93 | 3.80 | 22.00 | 12.93 | 2054 | 2866 |
| T4: Pendimethalin (CS) @ 0.5 kg/ha as PE | 40.53 | 10.40 | 9.65 | 3.73 | 21.67 | 14.73 | 1927 | 2963 |
| T5: Pendimethalin (EC) @ 1.0 kg/ha as PE + HW at 40 DAS | 44.00 | 11.80 | 10.07 | 4.33 | 24.33 | 15.57 | 2395 | 3005 |
| T6: Pendimethalin (CS) @ 0.5 kg/ha as PE + HW at 40 DAS | 40.67 | 10.40 | 9.68 | 3.80 | 24.53 | 15.20 | 2390 | 3050 |
| T7: Imazethapyr @ 75 g/ha at 20 DAS | 40.07 | 9.93 | 9.30 | 3.80 | 23.80 | 14.37 | 2028 | 3140 |
| T8: Imazethapyr @ 75 g/ha at 20 DAS + HW at 40 DAS | 42.20 | 11.13 | 10.37 | 4.27 | 25.60 | 15.00 | 2311 | 3116 |

S.Em. ± 1.72 0.67 0.49 0.22 1.11 0.96 153.91 143.63
C.D (P=0.05) 5.22 2.04 1.51 0.66 3.38 2.66 466.89 435.70
C.V. (%) 7.28 11.02 8.91 9.59 8.19 11.59 12.24 8.3

Table 3: Effect of different weed management treatments on nitrogen, phosphorus and potash content in plant and weed in Indian bean

| Treatments | N Content (%) in plant | P Content (%) in plant | K Content (%) in plant | N Content (%) in weed | P Content (%) in weed | K Content (%) in weed |
|------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| T1: Unweeded control | 1.83 | 0.20 | 2.06 | 1.72 | 0.37 | 1.81 |
| T2: Weed free (Hand weeding at 20, 40 and 60 DAS) | 2.22 | 0.51 | 2.16 | 0.85 | 0.16 | 1.22 |
| T3: Pendimethalin (EC) @ 1.0 kg/ha as Pre-emergence (PE) | 2.12 | 0.25 | 2.07 | 1.38 | 0.24 | 1.63 |
| T4: Pendimethalin (CS) @ 0.5 kg/ha as PE | 3.21 | 0.28 | 2.13 | 1.14 | 0.20 | 1.57 |
| T5: Pendimethalin (EC) @ 1.0 kg/ha as PE + HW at 40 DAS | 2.20 | 0.40 | 2.13 | 1.10 | 0.17 | 1.59 |
| T6: Pendimethalin (CS) @ 0.5 kg/ha as PE + HW at 40 DAS | 2.28 | 0.26 | 2.08 | 1.32 | 0.26 | 1.60 |
| T7: Imazethapyr @ 75 g/ha at 20 DAS | 2.13 | 0.43 | 2.14 | 1.30 | 0.26 | 1.74 |
| T8: Imazethapyr @ 75 g/ha at 20 DAS + HW at 40 DAS | 2.30 | 0.37 | 2.17 | 0.99 | 0.22 | 1.70 |

S.Em. ± 0.15 0.02 0.13 0.10 0.02 0.12
C.D (P=0.05) NS 0.07 NS 0.29 0.05 NS
C.V. (%) 12.30 12.14 10.88 13.51 13.08 12.43

Table 4: Effect of different weed management treatments on NPK uptake by plant and available NPK in soil

| Treatments | N Uptake (kg/ha) | P Uptake (kg/ha) | K Uptake (kg/ha) | Available N (kg/ha) | Available P (kg/ha) | Available K (kg/ha) |
|------------|-----------------|-----------------|-----------------|-------------------|-------------------|-------------------|
| T1: Unweeded control | 77.12 | 8.67 | 88.06 | 167.33 | 39.01 | 308.43 |
| T2: Weed free (Hand weeding at 20, 40 and 60 DAS) | 130.55 | 30.22 | 126.74 | 192.67 | 40.01 | 317.72 |
| T3: Pendimethalin (EC) @ 1.0 kg/ha as Pre-emergence (PE) | 104.49 | 12.30 | 101.78 | 184.00 | 40.34 | 315.50 |
| T4: Pendimethalin (CS) @ 0.5 kg/ha as PE | 122.97 | 13.51 | 104.16 | 186.00 | 41.68 | 316.10 |
| T5: Pendimethalin (EC) @ 1.0 kg/ha as PE + HW at 40 DAS | 118.49 | 21.63 | 115.31 | 188.67 | 40.68 | 312.62 |
| T6: Pendimethalin (CS) @ 0.5 kg/ha as PE + HW at 40 DAS | 123.92 | 14.09 | 113.01 | 190.33 | 42.34 | 313.29 |
| T7: Imazethapyr @ 75 g/ha at 20 DAS | 110.68 | 21.99 | 110.60 | 185.67 | 41.01 | 314.27 |
| T8: Imazethapyr @ 75 g/ha at 20 DAS + HW at 40 DAS | 121.51 | 24.79 | 117.39 | 188.00 | 40.34 | 312.48 |

S.Em. ± 7.15 1.35 7.72 5.60 1.20 3.67
C.D (P=0.05) 21.71 4.12 NS NS NS NS
C.V. (%) 11.03 12.79 12.21 5.25 5.12 2.03

Table 5: Effect of different weed management treatments on economics of Indian bean

| Sr. No | Yield (kg/ha) | Cost of cultivation (Rs/ha) | Gross monetary return (Rs/ha) | Net monetary return (Rs/ha) | B:C ratio |
|--------|--------------|-----------------------------|-----------------------------|-----------------------------|-----------|
| T1     | 1770         | 2500                        | 25418                       | 42907                       | 17489     | 1.69      |
| T2     | 2544         | 3336                        | 36098                       | 60905                       | 24807     | 1.69      |
| T3     | 2054         | 2866                        | 27028                       | 49691                       | 22663     | 1.84      |
| T4     | 1927         | 2963                        | 27461                       | 47439                       | 19978     | 1.73      |
| T5     | 2395         | 3005                        | 30588                       | 56931                       | 26343     | 1.86      |
| T6     | 2390         | 3030                        | 31021                       | 56951                       | 25930     | 1.84      |
| T7     | 2028         | 3140                        | 26796                       | 49996                       | 23200     | 1.87      |
| T8     | 2311         | 3116                        | 30356                       | 55589                       | 25232     | 1.83      |

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