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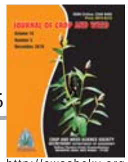

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Nutrient uptake by crop and weed as influenced by the weed management practices in bush type vegetable cowpea, *Vigna unguiculata* sub sp. *unguiculata* (L.) Verdcourt

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ABSTARCT

Field experiment was carried out to study the effect of stale seed bed and weed management practices on nutrient uptake by weeds, nutrient uptake and green pod yield of bush type vegetable cowpea during Kharif season 2019 at Coconut Research Station, Balaramapuram. The experimental was conducted in randomized block design with two factors viz., factor A - seed bed preparation with two treatments and factor B -weed management practices with eight treatments in three replications. Stale seed bed recorded the lowest total weed dry weight, NPK uptake by weeds and the highest NPK uptake by crop and green pod yield. Among the weed management practices, dried banana leaf mulch @ 10 t ha^{-1} fb quizalofop -p-ethyl @ 50 g ha^{-1} on 25 DAS recorded the lowest total weed dry weight, NPK uptake by weeds and the highest total N and P uptake by crop and green pod yield (7589.0 kg ha^{-1}). Pre emergence diclosulam @ 12.5 g ha^{-1} fb hand weeding at 25 DAS recorded the highest K uptake by crop. Interaction effect revealed that the stale seed bed + dried banana leaf mulch @ 10 t ha^{-1} fb quizalofop -p ethyl @ 50 g ha^{-1} on 25 DAS recorded the highest N and P uptake by crop, number of pods per plant, pod weight and green pod yield. The lowest weed dry weight and the lowest NPK uptake by weeds was registered in stale seed bed + pre emergence application of diclosulam @ 12.5 g ha^{-1} fb hand weeding at 25 DAS.

Keywords: Diclosulam, dried banana leaf mulch, green pod yield, imazethapyr, nutrient uptake and quizalofop-p-ethyl

Vegetable cowpea is an important multipurpose leguminous crop which can be grown either as sole crop or intercrop. Though it is grown throughout the year irrespective of season, a huge yield gap exists both in production and productivity due to biotic and abiotic stresses. Among the various biotic stress, weeds are the most prevalent biological constraint which causes severe yield loss. The initial slow growth of cowpea favoured the weeds to emerge first and gain competitive advantage over the crop. Gupta *et al.* (2016) also opined that season long competition of weeds results in 53 to 76 per cent yield reduction in cowpea. For every 100 kg dry weight of weeds a yield reduction of 208 kg ha^{-1} occurred in cowpea (Wilson *et al.*, 1980). Weeds not only cause yield reduction but also remove substantial amount of nutrients from the soil. Research evidences have shown that in the absences of weed management practices the nutrient uptake by weeds was found to be more. Pandya *et al.* (2005) observed that in soybean, weeds removed 21.4 kg N ha^{-1} and 3.1 kg P ha^{-1}. Mawalia *et al.* (2017) also reported that weeds removed 49.3 kg N ha^{-1}, 19.7 kg P ha^{-1}and 44.7 kg K ha^{-1} thereby depriving the same quantity of nutrients for crops. Kaur *et al*. (2010) observed that pre emergence pendimethalin @ 0.75 kg ha^{-1} recoded the lowest uptake of NPK by weeds and the highest NPK uptake in weedy check. Similarly, Choudhary *et al*. (2012) observed that significantly lower uptake by weeds was observed in pre emergence pendimethalin applied @1.5 kg ha^{-1}*fb* hand weeding at 25 DAS. In cowpea, hand weeding at 20 and 40 DAS recorded the lowest NPK uptake by weeds and the highest uptake in weedy check (Kujur *et al*., 2015). In green gram, imazethapyr @ 75 g ha^{-1} + adjuvant @ 2 ml L^{-1} of water recorded the lowest removal of NPK by weeds (Lal *et al*., 2017). Poornima *et al*. (2018) reported that in green gram, two hand weeding at 20 and 40 DAS recorded significantly higher uptake of N, P and K and it was statistically on par with quizalofop-p-ethyl @ 50 g ha^{-1} + imazethapyr @ 75 g ha^{-1}. With this background, an experiment was conducted with an objective to study the effect of weed interference on nutrient removals by weeds, nutrients uptake by weeds and yield of bush type vegetable cowpea.

MATERIALS AND METHODS

A field experiment was conducted during *kharif* season of 2019 at the Coconut Research Station, Balarampuram, Thiruvananthapuram, Kerala which is located at 8°22’52" N latitude and 77º1'47" E longitude and at an altitude of 9 m above mean sea level. The field experiment was laid out in Factorial Randomized Block Design with two factors and in three replications. Factor A- seed bed preparation with two treatments, S_1- stale seed bed and S_2- normal seed bed (no stale). Factor B-

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weed management practices with eight treatments, *viz*., W_1- dried banana leaf mulch @ 10 t ha^{-1} alone , W_2- dried banana leaf mulch @ 10 t ha^{-1}*fb* post emergence application of imazethapyr @ 50 g ha^{-1} at 25 DAS, W_3- dried banana leaf mulch @ 10 t ha^{-1}*fb* post emergence application of quizalofop-p-ethyl @ 50 g ha^{-1} at 25 DAS, W_4- post emergence application of imazethapyr @ 50 g ha^{-1} at 15 DAS, W_5- pre emergence application of diclosulam @ 12.5 g ha^{-1}*fb* post emergence application of quizalofop-p-ethyl @ 50 g ha^{-1} at 25 DAS, W_6- pre emergence application of diclosulam @ 12.5 g ha^{-1}*fb* hand weeding at 25 DAS, W_7- hand weeding at 20 and 40 DAS, W_8- weedy check.

The soil of the experimental field was red loam in texture with high in organic carbon content, low in available N, high in available P and medium in available K content. The total rainfall received during experimentation was 919 mm and the mean maximum and minimum temperature was 32.06 and 17.79 °C respectively.

Short duration variety, Bhagyalakshmy (80 days), released from College of Horticulture, Vellanikara, Thrissur was used as the test crop which is characterized by bushy growth habit with light green medium sized pods. The crop was sown on 08/06/2019 and the spacing adopted was 30 × 15 cm. The final harvest was on 27/08/2019. The crop was fertilized with farm yard manure (FYM) @ 20 t ha^{-1} and NPK @ 20: 30: 10 kg ha^{-1}. Half dose of N and full dose of P and K were applied before sowing the seeds and remaining half dose of N was applied at 20 DAS. Lime was applied @ 250 kg ha^{-1}.

The herbicides were applied as per the treatment schedule. The spray volume used in the study was 500 L ha^{-1}. The herbicide was sprayed with hand operated knapsack sprayer fitted with a flat fan nozzle. In hand weeding treatment, manual weeding was done twice at 20 and 40 DAS.

Weed dry weight was recorded at 45 DAS. For recording the weed dry weight, weeds were collected by placing the quadrate of size 0.25 m^2 randomly at two places in each treatment plot. Weeds fall inside the quadrate were uprooted and dried in shade for one day and then dried in hot air oven at 60 ± 5º C until constant weight was attained and dry weight was expressed in g m^{-2}. After drying, samples were powdered using a grinding machine and sieved through 0.5 mm sieve. The required quantity of samples was weighed accurately and subjected to acid extraction for determining N, P and K content. Total nitrogen content in plant and weeds were estimated by modified Microkjheldal Method (Jackson, 1973), total phosphorus content by vanadomolybdate phosphoric yellow color method (Jackson, 1973) and total potassium content using flame photometer (Jackson, 1973). N, P and K uptake by crop and weed were determined by multiplying the nutrient content with the respective DMP. The total N, P and K uptake by crop was worked out by adding the respective haulm uptake and pod uptake and expressed in kg ha^{-1}. Green tender pods from the observation plants were counted at each harvest, mean was worked out and expressed as number of pods per plant. Five pods were randomly selected from the observation plant on each harvest for recording the pod weight, the average was worked out and expressed in g. Green tender pods harvested from the net plot area of each treatment was weighed and recorded to obtain the pod yield per hectare and expressed as kg ha^{-1}. Data generated were statistically analyzed using analysis of variance technique (ANOVA) and difference between the treatments mean were compared at 5 per cent probability level.

RESULTS AND DISCUSSION

Effect on total weed dry weight

Seed bed manipulation had a significant effect on reducing the dry weight of weeds at 45 DAS (Table 1). Stale seed bed (SSB) recorded the lowest total dry of weeds (9.71 g m^{-2}). This might be due to removal of germinated weeds prior to planting, resulted in the depletion of weed seed bank in the surface soil and subsequent emergence of weeds. Johnson and Mullinix (2000) also observed that SSB brought out significant reduction in weed seed bank and subsequent weed seed emergence.

Weed management practices also significantly influenced the total weed dry weight of weeds (Table 1). At 45 DAS, W_3 recorded the lowest total weed dry weight (3.77 g m^{-2}) which was statistically comparable with W_5 (4.28 g m^{-2}). This might be due to the better control of weeds which provided a favorable environment for the crops to grow vigorously and smother the weeds resulted in significant reduction in weed dry weight. Naidu *et al*. (2012) pointed out that significant reduction in weed growth due to weed management practices enhanced the photosynthesis and DMP of crop which helped to smother the weeds and decreased the weed dry weight. Among the weed management treatments, application of imazethapyr at 15 DAS (W_4) recorded higher total weed dry weight (28.09 g m^{-2}). This might be due to the fact that in W_4 herbicide was applied only at 15 DAS; due to the slow initial development of cowpea, weed seeds emerge fast, grow luxuriantly by utilizing the available resources and gain competitive advantage over the crop resulting in higher biomass accumulation in weeds. The result is in accordance with the observation made by Kumavat *et al*. (2017) who observed that post emergence

Table 1: Effect of seed bed preparation and weed management practices on total weed dry weight and nutrient uptake by weeds at 45 DAS

Treatments	Total weed dry weight ($g\ m^{-2}$)	Nutrient uptake by weeds ($kg\ ha^{-1}$)		
		N uptake	P uptake	K uptake
Seed bed preparation (S)				
S_1: Stale seed bed	3.27 (9.71)	9.62	0.74	6.18
S_2: Normal seed bed	4.31 (17.58)	18.83	1.38	13.81
SEm (±)	**0.04**	**0.36**	**0.02**	**0.025**
LSD (0.05)	**0.11**	**1.05**	**0.06**	**0.074**
Weed management practices (W)				
W_1: Dried banana leaf mulch @ 10 t ha^{-1} alone	2.98 (7.87)	8.20	0.68	4.82
W_2: Dried banana leaf mulch @ 10 t ha^{-1} *fb* post emergence application of imazethapyr @ 50 g ha^{-1} at 25 DAS	2.59 (5.70)	6.21	0.45	3.68
W_3: Dried banana leaf mulch @ 10 t ha^{-1} *fb* post emergence application of quizalofop-p-ethyl @ 50 g ha^{-1} at 25 DAS	2.18 (3.77)	4.22	0.16	2.17
W_4: Post emergence application of imazethapyr @ 50 g ha^{-1} at 15 DAS	5.39 (28.09)	27.25	2.10	17.92
W_5: Pre emergence application of diclosulam @ 12.5 g ha^{-1} *fb* post emergence application of quizalofop-p-ethyl @ 50 g ha^{-1} at 25 DAS	2.29 (4.28)	4.28	0.27	3.60
W_6: Pre emergence application of diclosulam @ 12.5 g ha^{-1} *fb* hand weeding at 25 DAS	2.61 (5.80)	5.22	0.30	4.16
W_7: Hand weeding at 20 and 40 DAS	2.48 (5.13)	5.03	0.27	3.19
W_8: Weedy check	7.04 (48.53)	53.37	4.23	40.44
SEm (±)	**0.08**	**0.72**	**0.04**	**0.51**
LSD (0.05)	**0.22**	**2.09**	**0.13**	**0.15**

Note: Data in parentheses are original values which are subjected to square root transformation

imazethapyr alone @ 100 g ha^{-1} was not effective in reducing the weed density and dry weight. Lower weed dry weight observed in W_3, W_2, W_5 and W_6 might be due to the better control of weeds achieved by the pre emergence herbicide diclosulam and dried banana leaf mulching followed by application of quizalofop-p-ethyl/ imazethapyr/ hand weeding at 25 DAS. The results clearly indicated that early stage weed control is essential to control the weeds in cowpea. Singh *et al*. (2009) reported that pre emergence diclosulam effectively control sedges, BLW and grasses and recorded higher WCE. Mulching with organic residues suppress the germination of weeds and significantly reduced the weed density and biomass (Akobundu, 1987; Shenk, 1994).

Interaction effect also had significant impact on total weed dry weight at 45 DAS (Table 1a). The treatment combination S_1W_6 recorded the lowest total weed dry weight (1.32 g m^{-2}) which was statistically on par with S_1W_5 (1.77 g m^{-2}) and S_1W_3 (2.50 g m^{-2}). This might be due to the fact that in these treatments adoption of SSB destroyed the initial flushes of weeds prior to planting of seeds and subsequently emerged weeds were better controlled by the pre emergence herbicide diclosulam followed by hand weeding/ quizalofop-p-ethyl application at 25 DAS and dried banana leaf mulching followed by application of quizalofop-p-ethyl/ imazethapyr at 25 DAS. Tehria *et al*. (2015) also reported that SSB + pre emergence herbicide + hand weeding recorded lower weed dry weight in garden pea compared to pre emergence pendimethalin + hand weeding.

Effect on N, P, K uptake by weeds

Uptake of N P K by weeds was significantly influenced by weed management practices at 45 DAS

Table 1a: Interaction effect of seed bed preparation and weed management practices on total weed dry weight and nutrient uptake by weeds at 45 DAS

Treatments	Total weed dry weight (g m^{-2})		Nutrient uptake by weeds (kg ha^{-1})		
			N uptake	P uptake	K uptake
S_1W_1	2.16	(3.70)	2.86	0.28	2.13
S_1W_2	2.07	(3.30)	3.68	0.27	1.79
S_1W_3	1.87	(2.50)	2.57	0.13	1.25
S_1W_4	4.29	(17.43)	17.58	1.37	10.48
S_1W_5	1.67	(1.77)	1.93	0.18	0.88
S_1W_6	1.62	(1.32)	1.44	0.07	0.70
S_1W_7	2.42	(4.89)	4.68	0.25	2.37
S_1W_8	6.60	(42.70)	42.18	3.56	29.85
S_2W_1	3.61	(12.01)	13.54	1.10	7.51
S_2W_2	3.02	(8.09)	8.74	0.64	5.56
S_2W_3	2.45	(5.03)	5.86	0.20	3.09
S_2W_4	6.30	(38.35)	36.91	2.82	25.36
S_2W_5	2.79	(6.79)	6.62	0.37	6.32
S_2W_6	3.36	(10.28)	9.00	0.530	7.63
S_2W_7	2.52	(5.37)	5.39	0.30	4.00
S_2W_8	7.44	(54.35)	64.59	5.10	51.03
SEm (±)	**0.12**	**1.02**	**0.06**	**0.07**	
LSD (0.05)	**0.34**	**2.96**	**0.18**	**0.21**	

Note: Data in parentheses are original values which are subjected to square root transformation

(Table 1). Compared to SSB, normal seed bed recorded the highest uptake of N P K by weeds. By the adoption of SSB, a reduction in the NPK uptake by weeds to a tune of 48.93, 46.37 and 55.24 per cent, respectively was observed. The percentage removal of K was found to be more compared to N and P. Higher dry weight of weeds recorded in normal seed bed (17.58 g m^{-2}) was the reason for higher nutrient uptake by weeds in the treatment. Since nutrient uptake is the function of DMP and nutrient content, higher the dry weight of weeds, higher will be the nutrient uptake by weeds. Rana *et al*. (1999) observed that weeds removed substantial amount of nutrients from the soil and adoption of weed management practices significantly improved the nutrient uptake by crop.

Adoption of weed management practices reduced the N, P and K removal by weeds to an extent of 48.96 to 92.1, 50.4 to 96.1 and 55.6 to 94.6, respectively at 45 DAS (Table 1). The result is in conformity with the observation made by Raj (2016) who reported that adoption of weed management practices significantly reduced the nutrient removal by weeds in wet seeded rice. Weedy check recorded the highest NPK uptake by weeds (53.37, 4.23 and 40.44 kg ha^{-1}, respectively). This was the due to higher weed dry weight (48.53 g m^{-2}) observed in the treatment. Choudhary *et al*. (2012) also reported that the highest removal of NPK (5.9, 2.8 and 7.1 kg ha^{-1} respectively) was recorded in weedy check. The lowest uptake of NPK by weeds were observed in W_3 (4.22, 0.16 and 2.17 kg ha^{-1}, respectively). Mulching with dried banana leaf effectively suppresses the growth of weeds during the initial stages of crop growth and the later emerged grassy weeds were effectively controlled by post emergence quizalofop-p-ethyl at 25 DAS. Samant and Mishra (2014) revealed that post emergence quizalofop-p-ethyl @ 1 kg ha^{-1} at 15 DAS was found effective in minimizing the N, P and K removal by weeds to an extent of 91.2, 84.1 and 89.7 per cent, respectively. Among the weed management treatments, W_4 recorded the highest uptake of N, P and K by weeds (27.25, 2.10 and 17.92 kg ha^{-1}, respectively). This could be attributed to higher dry matter accumulation of weeds due to the poor control of weeds in the treatment. The result is in accordance with the observation made by Singh *et al*. (2014) who observed that application of imazethapyr at 15 DAS recorded higher dry matter of weeds in mung bean.

The interaction was also found significant (Table 1a). The treatment combination S_2W_8 recorded higher uptake of NPK by weeds (64.59, 5.10 and 51.03 kg ha^{-1}, respectively). This was due to higher dry matter weight of weeds registered in the treatment (54.35 g m^{-2}). The lowest uptake of NPK by weeds was observed in S_1W_6 (1.44, 0.07 and 0.7 kg ha^{-1}, respectively). This was due to the effective control of weeds by SSB, application of pre emergence broad-spectrum herbicide diclosulam and

Table 2: Effect of seed bed preparation and weed management practices on nutrient uptake of cowpea

Treatments	**Nutrient uptake by crop (kg ha^{-1})**		
	N uptake	**P uptake**	**K uptake**
Seed bed preparation (S)			
S_1: Stale seed bed	154.64	33.66	40.30
S_2: Normal seed bed	137.50	25.26	37.07
SEm (±)	**3.26**	**0.54**	**0.44**
LSD (0.05)	**9.45**	**1.56**	**1.26**
Weed management practices (W)			
W_1: Dried banana leaf mulch @ 10 t ha^{-1} alone	161.01	32.02	41.62
W_2: Dried banana leaf mulch @ 10 t ha^{-1} *fb* post emergence application of imazethapyr @ 50 g ha^{-1} at 25 DAS	154.68	34.06	40.39
W_3: Dried banana leaf mulch @ 10 t ha^{-1} *fb* post emergence application of quizalofop-p-ethyl @ 50 g ha^{-1} at 25 DAS	181.30	38.67	40.74
W_4: Post emergence application of imazethapyr @ 50 g ha^{-1} at 15 DAS	115.87	21.11	33.36
W_5: Pre emergence application of diclosulam @ 12.5 g ha^{-1} *fb* post emergence application of quizalofop-p-ethyl @ 50 g ha^{-1} at 25 DAS	153.31	31.11	41.54
W_6: Pre emergence application of diclosulam @ 12.5 g ha^{-1} *fb* hand weeding at 25 DAS	154.18	33.64	41.85
W_7: Hand weeding at 20 and 40 DAS	151.23	31.06	38.54
W_8: Weedy check	97.01	14.02	31.45
SEm (±)	**6.51**	**1.07**	**0.87**
CD (0.05)	**18.89**	**3.11**	**2.53**

hand weeding at 25 DAS. The result is in line with the observation of Tehria *et al.* (2015) who observed that SSB *fb* pre-emergence pendimethalin *fb* hand weeding recorded the lowest uptake of nutrients by weeds in peas.

Effect on nutrient uptake by crop

Nutrient uptake by crop was significantly influenced by seed bed manipulation (Table 2). Stale seed bed recorded significantly higher total N, P and K uptake by crop (154.64, 33.66 and 40.30 kg ha^{-1}, respectively). Adoption of SSB enhanced the total N, P and K uptake by 12.47, 33.25 and 8.71, per cent respectively over normal seed bed (Table 2). Nutrient uptake by crop is directly related to nutrient content and DMP. Higher uptake of nutrients recorded in SSB might be due to higher DMP and higher N, P and K content recorded in the treatment. Better control of weeds resulted in lesser weed competition which might have provided a favorable environment for the development of roots. Better development of roots might have increased the foraging area of roots and enhanced the uptake of nutrients. Increased availability of nutrients due to minimum crop weed competition also might have enhanced the uptake of nutrients in SSB. Tehria *et al*. (2015) reported that adoption of SSB significantly increased the nutrient uptake by crop over weedy check in pea.

Weed management practices also significantly influenced the NPK uptake by crop (Table 2). Adoption of weed management practices increased the total N uptake by 86.88 per cent, P uptake by 64.74 per cent and K uptake by 32.34% over control. Increased uptake of nutrients registered in weed management treatments might be due to the reduced crop weed competition and nutrient removal by weeds. Reduced availability of nutrients due to season long crop weed competition and higher nutrient removal by weeds (Table 1) might be the reason for the lowest uptake of NPK by crop in weedy check (97.01, 14.02 and 31.45 kg ha^{-1}, respectively). Weeds removed substantial amount of nutrients, if weeds are effectively controlled that much amount of nutrients removed by weeds can be utilized by the crop. In the present experiment also weeds removed 53.37 kg N, 4.23 kg P and 40.44 kg K from the weedy check treatment (Table 1). Raj and Syriac, (2017) and Poornima *et al*. (2018) reported that severe competition for growth factors resulted in reduced uptake of nutrients by crop. It was revealed from the data that compared to application of imazethapyr at 15 DAS (W_4), banana leaf mulching followed by application of herbicides (imazethapyr or quizalofop-p-ethyl) (W_2 and W_3) or application of diclosulam followed by hand weeding or

Table 2a: Interaction effect of seed bed preparation and weed management practices on nutrient uptake by crop

Treatments	Nutrient uptake (kg ha^{-1})		
	N uptake	**P uptake**	**K uptake**
S_1W_1	176.46	35.27	43.91
S_1W_2	169.19	38.49	41.96
S_1W_3	200.95	44.65	42.50
S_1W_4	113.39	21.18	34.28
S_1W_5	147.51	38.08	43.45
S_1W_6	159.16	37.88	44.58
S_1W_7	163.01	38.53	41.64
S_1W_8	107.47	15.16	30.09
S_2W_1	145.56	28.77	39.38
S_2W_2	140.16	29.63	38.83
S_2W_3	161.66	32.68	38.98
S_2W_4	118.34	21.04	32.43
S_2W_5	159.11	24.13	39.64
S_2W_6	149.20	29.39	39.11
S_2W_7	139.44	23.60	35.45
S_2W_8	86.56	12.87	32.81
SEm (±)	**9.21**	**1.52**	**1.23**
LSD (0.05)	**NS**	**4.40**	**3.57**

Table 3: Effect of seed bed preparation and weed management practices on yield attributes and green pod yield of bush type vegetable cowpea

Treatments	Yield attributes		Green pod yield (kg ha^{-1})
	No. of pods per plant	**Pod weight (g)**	
Seed bed preparation (S)			
S_1: Stale seed bed	36.9	2.44	6286.2
S_2: Normal seed bed	32.6	2.35	5638.1
SEm (±)	0.42	0.03	60.90
LSD (0.05)	1.2	0.07	176.73
Weed management practices (W)			
W_1: Dried banana leaf mulch @ 10 t ha^{-1} alone	39.2	2.50	7009.3
W_2: Dried banana leaf mulch @ 10 t ha^{-1} *fb* post emergence application of imazethapyr @ 50 g ha^{-1} at 25 DAS	42.3	2.47	7337.3
W_3: Dried banana leaf mulch @ 10 t ha^{-1} *fb* post emergence application of quizalofop-p-ethyl @ 50 g ha^{-1} at 25 DAS	44.0	2.56	7589.0
W_4: Post emergence application of imazethapyr @ 50 g ha^{-1} at 15 DAS	30.0	2.41	5103.2
W_5: Pre emergence application of diclosulam @ 12.5 g ha^{-1} *fb* post emergence application of quizalofop-p-ethyl @ 50 g ha^{-1} at 25 DAS	33.5	2.32	5883.3
W_6: Pre emergence application of diclosulam @ 12.5 g ha^{-1} *fb* hand weeding at 25 DAS	32.0	2.39	5631.8
W_7: Hand weeding at 20 and 40 DAS	36.7	2.35	6024.3
W_8: Weedy check	21.2	2.17	3113.7
SEm (±)	**0.84**	**0.05**	**121.79**
LSD (0.05)	**2.6**	**0.15**	**353.47**

Table 3a: Interaction effect of seed bed preparation and weed management practices on yield attributes and green pod yield of bush type vegetable cowpea

Treatments	Yield attributes		Green pod yield ($kg\ ha^{-1}$)
	No. of pods $plant^{-1}$	Pod weight (g)	
S_1W_1	40.7	2.56	7226.3
S_1W_2	43.0	2.63	7483.3
S_1W_3	44.7	2.68	7731.7
S_1W_4	31.3	2.49	5490.7
S_1W_5	37.7	2.31	6047.0
S_1W_6	32.0	2.50	5986.0
S_1W_7	39.3	2.28	6429.0
S_1W_8	26.7	2.07	3895.3
S_2W_1	37.7	2.44	6792.3
S_2W_2	41.7	2.31	7191.3
S_2W_3	42.0	2.43	7446.3
S_2W_4	28.7	2.32	4715.7
S_2W_5	29.3	2.32	5729.7
S_2W_6	32.0	2.27	5277.7
S_2W_7	34.0	2.42	5619.7
S_2W_8	15.7	2.27	2332.0
SEm (±)	**1.2**	**0.07**	**172.24**
LSD (0.05)	**3.5**	**0.21**	**499.9**

quizalofop-p-ethyl application (W_5 and W_6) recorded higher uptake of N, P and K by crop. This could be due to reduced crop weed competition in the early as well as later stages of the crop growth resulted in higher uptake of nutrients. Bhutada and Bale (2015) reported that pre emergence pendimethalin followed by hand weeding at 40 DAS recorded higher uptake of N, P and K by chick pea compared to post emergence imazethapyr @ 75 g ha^{-1}. Among the weed management treatments, the highest total N and P uptake by crop was reported in W_3 (181.30 and 38.67 kg ha^{-1}, respectively) and K uptake in W_6 (41. 85 kg ha^{-1}) (Table 2) owing to significant reduction in weed biomass which might have reduced the nutrient removal by weeds and enhanced the availability of nutrients. Though W_6 recorded the highest K uptake it was statistically on par with all other treatments except W_7, W_4 and W_8. Increased availability of nutrients and higher root growth allowed the crop to absorb and translocate adequate amount of nutrients which favoured the crop growth with higher nutrient uptake.

The interaction effect was significant only for total P and K uptake by crop (Table 2a). Compared to S_1W_8, S_2W_8, S_1W_4 and S_2W_4, the other treatment combinations registered higher P and K uptake by crop, might be due to better control of weeds which reduced the crop weed competition and enhanced the crop growth, availability and uptake of nutrients, photosynthesis and translocation of assimilates from source to sink which ultimately resulted in higher DMP with respective increase in P and K content. The result is in accordance with the observation made by Shruthi *et al*. (2015) who observed that effective control of weeds right from sowing provided a weed free situation which enabled the crop to enhance the uptake of nutrients.

Effect on yield attributes and yield

Seed bed preparation significantly influenced the number of pods $plant^{-1}$, pod weight and green pod yield (Table 3). Stale seed bed recorded the highest number of pods $plant^{-1}$ (36.9) and pod weight (2.44 g). The enhancement in green pod yield observed in SSB over normal seed bed was 11.50 per cent. Increase in yield attributes and yield observed in SSB over normal seed bed was due to lesser crop weed competition especially in the early stages of crop growth. Control of first flushes of weeds before the sowing of cowpea enabled the crop to grow vigorously with greater number of branches and green leaves and produce more roots which resulted in increased uptake of nutrients, photosynthesis and translocation of assimilates from source to sink. Higher availability and uptake of nutrients which helped the plants to produce pods with higher weight, higher number of pods per plant which finally contributed to higher green pod yield in SSB.

Weed management practices also significantly influenced the number of pods per plant, pod weight and green pod yield (Table 3). Due to the adoption of weed management practices green pod yield of bush type vegetable cowpea was enhanced from 3313.7 to 7589.0 kg ha^{-1}. Weed competition caused a reduction in yield to a tune of 58.97 per cent in bush type vegetable cowpea. The finding is in accordance with the observations made by Osipitan *et al.* (2016) who reported that 25 to 76 per cent yield loss occurred in cowpea due to weed infestation alone depending upon the variety used and environmental condition. Weedy check recorded significantly lower number of pods plant^{-1}, pods with lesser weight and green pod yield among the treatments. Season long crop competition affects the crop growth which might have reduced the green pod yield in weedy check. Among the weed management treatments, W_4 recorded the lowest green pod yield (5103.2 kg ha^{-1}). This was ascribed to fact that post emergence application of imazethapyr alone was not effective in controlling the weeds as manifest from the data on weed dry weight (Table 1). The result is in accordance with the observations of Kaur *et al*. (2016) who observed that post emergence imazethapyr @ 50 g ha^{-1} failed to create a weed free situation up to 40 DAS due to its poor efficacy in controlling grassy weeds and sedges and resulted in lower seed yield in green gram. The results clearly revealed that mulching or pre emergence herbicide application was essential to check the weeds which emerged fast and gain competitive advantage over the crop due to slow initial growth of cowpea. The treatment W_3 recorded the highest green pod yield (7589.0 kg ha^{-1}), might be due to the production of higher number of pods plant^{-1} (44.0) and pods with higher weight (2.56 g). Mulching with dried banana leaf followed by post emergence quizalofop-p-ethyl provided a weed free period during the critical stages of the crop which enabled the crop to grow without any competition and resulted in the production of higher number of pods plant^{-1} and led to higher pod yield. Mani *et al*. (2016) reported that mulching with straw much @ 6 t ha^{-1} reduced the density and dry weight of weeds by 50 per cent and increased the yield by 34 per cent compared to no mulch.

The interaction between seed bed preparation and weed management practices was found significant for number of green pods plant^{-1}, pods weight and green pod yield (Table 3a). The treatment combination, S_1W_3 recorded the highest green pod yield (7731. 7 kg ha^{-1}) owing to the fact that low crop weed competition provided a stress-free environment for the best utilization of resources resulted in the production of higher number of pods plant^{-1} (44.7) and pods with higher weight (2.68 g).

The study revealed that adoption of SSB significantly reduced the weed dry weight and NPK uptake by weeds and improved the nutrient uptake and green pod yield of bush type vegetable cowpea. Among the different weed management practices tried, dried banana leaf mulch @ 10 t ha^{-1} *fb* application of quizalofop -p-ethyl @ 50 g ha^{-1} on 25 DAS recorded the lowest weed dry weight and NPK uptake by weeds and the highest N and P uptake by crop, number of pods plant^{-1} and green pod yield. The interaction effect between the seed bed preparation and weed management practices revealed that the treatment combination, stale seed bed + dried banana leaf mulch @ 10 t ha^{-1} *fb* post emergence application of quizalofop-p-ethyl @ 25 g ha^{-1} (S_1W_3) recorded the highest nutrient uptake by crop, number of pods per plant, pods with higher weight and green pod yield. The lowest weed dry weight was recorded in pre emergence application of diclosulam @ 12.5 g ha^{-1} *fb* hand weeding at 25 DAS (S_1W_6) which was statistically on par with S_1W_3. Hence, stale seed bed + dried banana leaf mulching @ 10 t ha^{-1} *fb* post emergence application of quizalofop-p-ethyl @ 25 g ha^{-1} could be considered as the best management practice for better weed control, higher nutrient uptake and green pod yield in bush type vegetable cowpea.

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