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Effect of spacing and weed management on yield, quality and nutrient uptake of moth bean (*Vigna aconitifolia*)

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Abstract
A field experiment was conducted at the College Farm, Navsari Agricultural University, Navsari to study the "Effect of spacing and weed management on summer moth bean (*Vigna aconitifolia*)" during summer 2017 to evaluate the effect of spacing and weed management on yield, protein content, nutrient uptake by seed, stover & weed and available nutrient in soil after harvest the crop. In case of row spacing, treatment S_1 (45 cm between two rows) of summer moth bean recorded significantly higher seed and stover yield, protein yield and nutrient uptake by seed & stover and nutrient uptake by weed is also lower in treatment S_1 (45 cm between two rows) which was at par with treatment S_2 (60 cm between two rows). In case of weed management, treatment W_5 (weed free) recorded significantly higher seed and stover yield & protein yield but remained at par with W_1 (Pendimethalin 750 g/ha as PE). Whereas, treatment W_5 (weed free) recorded significantly higher uptake of nutrients.

Keywords: Moth bean, spacing, weed management, yield, quality, nutrient uptake

Introduction
Moth bean (*Vigna aconitifolia*) is native to India and Pakistan, grown for food production and as a forage and cover crop. It is drought resistant legume, commonly grown in arid and semi-arid regions of India. It is a short day crop. It is commonly called math, matki, turkish gram or dew bean. Optimum production of moth bean occurs between 24 – 32 ºC during the day. Area and production of moth bean has been highest in Rajasthan (98.25% and 97.04%) followed by Gujarat (1.72% and 2.93%). However, Productivity of Rajasthan (274 kg/ha) was below the National average productivity (277 kg/ha) (Anon., 2016) [1].
Moth bean is a good source of protein (24%) and are high in dietary fiber. Moth bean also contain essential amino acids particularly lysine and leucine and also certain vitamins. 100 g of raw, uncooked moth bean seeds contain 343 calories, 24 g of protein, 62 g of carbohydrate and 1.6 g of fat. The objective of the experiment was to study the individual effect of spacing and weed management on yield, quality and nutrient of summer moth bean.

Materials and Methods
A field experiment was conducted during summer season of 2017 at College Farm, Department of Agronomy, N. M. College of Agriculture, Navsari Agricultural University, Navsari. The NAU is situated at 20º 57' N latitude, 72º 54' E longitude at an altitude of about 10 m above the mean sea level. The experiment comprised 18 treatments combinations consisting of three row spacing and six weed management practices viz., S_1: 45 cm between two rows, S_2: 60 cm between two rows and S_3: 90 cm between two rows and six weed management practices viz., W_1: Pendimethalin 750 g/ha as PE, W_2: Imazethapyr 75 g/ha as PoE, W_3: Quizalofop-p-ethyl 100 g/ha as PoE, W_4: One hand weeding at 20 DAS, W_5: weed free (two hand weeding 20 and 40 DAS) and W_6: unweeded control were evaluated for moth bean crop were tested by employing factorial randomized block design (FRBD) with three replications. Initial Soil of experimental field was clayey in texture, low in Nitrogen (231 kg/ha), medium in available phosphorus (46 kg/ha) and high in available potash (429 kg/ha) and alkaline in reaction (pH 8.14). A basal dose of 20 kg N and 40 kg P_2O_5 was applied at sowing. Moth bean variety GMO 1 was used in the study which was released from Main Pulse Research Station, Sardarkrushinagar Dantiwada Agricultural University, Sardarkrushinagar, Gujarat. The required quantity of herbicides *viz.*, pendimethalin, Imazethapyr and quizalofop-P-ethyl were measured by measuring cylinder at the time of application of solution according to treatments. The protein yield was computed by using the following formula.

$$\text{Protein yield (kg/ha)} = \frac{\text{Protein contenting seed (\%) x seed yield (kg/ha)}}{100}$$

The uptake values of N, P and K for seed and stover as well as weeds were calculated by using the following formula.

$$\text{Nutrient uptake (kg/ha)} = \frac{\text{Nutrient content (\%) x Dry weight seed or stover or weed}}{100}$$

Results and Discussion

Effect of row spacing on yield

In seed and stover yield, treatment S_1 (45 cm between two rows) recorded significantly higher seed and stover yields (913 and 2031 kg/ha, respectively) which was statistically at par with treatment S_2 (854 and 1905 kg/ha, respectively). The higher yields in narrow spacing were mainly due to higher number of plants per unit area. It clearly indicated that lower plant population per unit area under wider spacing cannot compensate the reduction in total yield. Similar observations also recorded by Patel *et al*. (2004) [12], Patel *et al*. (2005) [11], Ahmad *et al*. (2010) [2], Patel *et al*. (2010) [13] and Jakusko *et al*. (2013) [8].

Effect of row spacing on quality parameter

Different spacing did not exert any significant effect on protein content whereas it had significant result on protein yield. Significantly higher protein yield (188.68 kg/ha) was noted under row spacing of 45 cm between two rows (S_1). The increase in protein yield was mainly due to higher seed yield under treatment S_1 (45 cm between two rows).

Table 1: Effect of row spacing and weed management practices on yield, protein content and protein uptake of moth bean

Treatment	Seed yield (kg/ha)	Stover yield (kg/ha)	Protein content (%)	Protein yield (kg/ha)
Spacing between two rows (S)				
S_1: 45 cm	913	2031	20.56	188.54
S_2: 60 cm	854	1905	20.27	173.62
S_3: 90 cm	778	1724	20.21	157.46
S. Em.±	21	45	0.20	4.74
C.D. at 5%	61	130	NS	13.64
Weed management (W)				
W_1: Pendimethalin 750 g/ha as PE	974	2115	20.73	201.97
W_2: Imazethapyr 75 g/ha as PoE at 20 DAS	846	1905	20.59	174.20
W_3: Quizalofop-p-ethyl 100 g/ha as PoE at 20 DAS	788	1800	20.37	160.66
W_4: One HW at 20 DAS	768	1730	19.99	153.92
W_5: Weed free (two HW 20 and 40 DAS)	1050	2219	20.72	218.13
W_6: Unweeded control	664	1551	19.68	130.37
S. Em.±	30	64	0.29	6.71
C.D. at 5%	86	183	NS	19.29
Interaction (S x W)	NS	NS	NS	NS
S. Em.±	51	110	0.50	11.62
C.V. %	10.58	10.14	4.30	11.63

DAS- Days After Sowing, PE- Pre Emergence, PoE- Post Emergence, HW- Hand Weeding

Effect of row spacing on nutrients content and uptake by crop as well as weed and soil fertility status

The present study revealed that N, P and K content in seed, stover of moth bean and weed were not significantly influenced due to different row spacing but their uptake were significantly influenced due to various row spacing. Significantly higher uptake of nutrients recorded under narrow spacing *i.e*. 45 cm between two rows (S_1) as compared to wider spacing 90 cm between two rows (S_3). It might be due to higher seed and stover yield. Nutrients uptake by weeds, increased with increasing row spacing and also due to higher weed population and dry weight of weeds.

The available nutrients status of soil after harvest of crop was influenced non-significantly by various row spacing except Nitrogen. The available nitrogen status of soil after harvest of crop was higher under closer spacing (S_1) and lower under wider spacing (S_3) because of higher weed population under wider row spacing compared to narrow spacing.

Weed Study

Different types of weed flora were observed in experimental field during summer season of 2017. The most common weed species observed on experimental plot were *Echinochloa crus-galli* L. Beauv, *Cynodon dactylon* L. pers, *Sorghum halepense* L. pers, *Alternanthera sessillis* L., *Digera arvensis Forsk* L., *Portulaca oleracea* L. and *Cyperus rotundus* L.

Table 2: N, P and K uptake by moth bean crop as influenced by various treatments

Treatment	Uptake by seed (kg/ha)			Uptake by stover (kg/ha)			Total uptake (kg/ha)		
	N	P	K	N	P	K	N	P	K
Spacing between two rows (S)									
S_1: 45 cm	30.16	2.70	14.21	16.85	3.70	21.46	47.01	6.41	35.68
S_2: 60 cm	27.78	2.36	13.18	15.67	3.42	19.98	43.45	5.78	33.17
S_3: 90 cm	25.19	2.12	11.92	14.10	3.04	18.06	39.30	5.16	29.99
S. Em.±	0.75	0.08	0.33	0.43	0.10	0.59	1.13	0.16	0.88
C.D. at 5%	2.18	0.23	0.95	1.24	0.29	1.72	3.25	0.46	2.55
Weed management (W)									
W_1: Pendimethalin 750 g/ha as PE	32.31	2.83	15.23	18.06	4.02	23.54	50.38	6.86	38.77
W_2: Imazethapyr 75 g/ha as PoE at 20 DAS	27.87	2.35	13.05	15.30	3.30	19.65	43.18	5.66	32.70
W_3: Quizalofop-p-ethyl 100 g/ha as PoE at 20 DAS	25.70	2.18	12.10	14.15	3.04	18.15	39.86	5.22	30.25
W_4: One HW at 20 DAS	24.62	2.06	11.70	13.72	2.94	17.47	38.35	5.00	29.17
W_5: Weed free (two HW 20 and 40 DAS)	34.90	3.21	16.53	20.36	4.47	25.58	55.26	7.68	42.11
W_6: Unweeded control	20.86	1.75	10.01	11.64	2.55	14.63	32.50	4.30	24.65
S. Em.±	1.07	0.11	0.47	0.61	0.14	0.84	1.60	0.22	1.25
C.D. at 5%	3.08	0.33	1.35	1.76	0.41	2.43	4.60	0.65	3.60
Interaction (S x W)	NS	NS	NS	NS	NS	NS	NS	NS	NS
S. Em. ±	1.86	0.20	0.81	1.06	0.24	1.46	2.77	0.39	2.17
C.V. %	11.63	14.60	10.80	11.87	12.65	12.81	11.12	11.90	11.43

DAS- Days After Sowing, PE- Pre Emergence, PoE- Post Emergence, HW- Hand Weeding

Table 3: N, P and K uptake by weeds as influenced by various treatments

Treatment	Uptake by Weeds (kg/ha)		
	N	P	K
Spacing between two rows (S)			
S_1: 45 cm	2.71	1.13	6.81
S_2: 60 cm	2.80	1.21	7.11
S_3: 90 cm	3.06	1.36	7.65
S. Em. ±	0.07	0.05	0.22
C.D. at 5%	0.22	0.14	0.64
Weed management (W)			
W_1: Pendimethalin 750 g/ha as PE	2.16	0.91	5.41
W_2: Imazethapyr 75 g/ha as PoE at 20 DAS	2.02	0.87	5.16
W_3: Quizalofop-p-ethyl 100 g/ha as PoE at 20 DAS	3.17	1.36	7.98
W_4: One HW at 20 DAS	2.56	1.11	6.40
W_5: Weed free (two HW 20 and 40 DAS)	1.65	0.68	4.14
W_6: Unweeded control	5.60	2.46	14.05
S. Em. ±	0.11	0.07	0.31
C.D. at 5%	0.32	0.20	0.91
Interaction (S x W)	NS	NS	NS
S. Em. ±	0.19	0.12	0.55
C.V. %	11.81	17.50	13.33

DAS- Days After Sowing, PE- Pre Emergence, PoE- Post Emergence, HW- Hand Weeding

Effect of weed management practices on yield

Significantly higher seed (1050 kg/ha) and stover (2219 kg/ha) yields were recorded under treatment W_5 (weed free) being at par with treatment W_1 (Pendimethalin @ 750 g/ha as PE) as compared to unweeded control (W_6). This might be due better growth and development measured in terms of various growth attributing characters such as plant height, number of branches per plant and yield attributing characters like number of pods per plant, number of seeds per pod and pod length. All these parameters showed cumulatively positive and significant influence on seed and stover yields of moth bean. These findings are in close agreement with those reported by Begum and Rao (2006) [3], Kumar *et al*. (2006) [9], Sharma and Yadava (2006) [14], Nandan *et al*. (2011) [10], Choudhary *et al*. (2012) [6], Das (2016) [7].

Effect of weed management practices on quality parameters

The results revealed that various weed management practices had non-significant effect on protein content (%) of moth bean. whereas it had significant result on protein yield. Significantly higher protein yield (218.13 kg/ha) was recorded under treatment W_5 (weed free) being at par with W_1 (Pendimethalin @ 750 g/ha as PE). The higher protein yield with these treatments might be due to higher seed yield under those weed management treatments. Similar findings were also reported by Chhodavadia *et al*. (2013) [4].

Effect of weed management practices on nutrients content and uptake by crop as well as weeds and soil fertility status

Different weed management practices had non-significant influence on major nutrients (nitrogen, phosphorus and potassium) content in seed and stover of moth bean. Nutrient uptake by seed and stover were significantly influenced due to varying weed management practices. Treatment W_5 (weed free) recorded significantly higher uptake of N, P and K nutrients. A significant reduction in weed population at critical stage of crop weed competition resulting effective weed control reduced the competition not only for light and water but also for nutrients remarkably, thereby, enhanced the accumulation of nutrients in crop and ultimately increased the

uptake of those nutrients. These results were supported by Choubey *et al*. (1999) [5], Yadav *et al*. (2011) [15], Choudhary *et al*. (2012) [6]

Significantly higher uptake of major nutrients by weeds were register under W_6 (unweeded control), whereas minimum values were noted under treatment W_5 (weed free) This might be due to lesser crop weed competition under these treatments resulted in lesser dry matter production by weeds which ultimately reflected into higher nutrient content and uptake. Similar results were also reported by Choubey *et al*. (1999) [5], Yadav *et al*. (2011) [15]

The results also revealed that available nutrients in soil after harvest of crop were found non-significant due to different weed management practices except nitrogen. While, significantly higher available nitrogen recorded under treatment W_5 (weed free) but it remained at par with treatment W_1, W_2, W_3 and W_4.

Table 4: Available N, P_2O_5 and K_2O status of soil after harvest of moth bean as influenced by various treatments

Treatment	Available nutrients after harvest (kg/ha)		
	N	P_2O_5	K_2O
Spacing between two rows (S)			
S_1: 45 cm	236	14.86	366
S_2: 60 cm	228	14.64	363
S_3: 90 cm	214	14.03	347
S. Em. ±	5.19	0.26	6.67
C.D. at 5%	14.93	NS	NS
Weed management (W)			
W_1: Pendimethalin 750 g/ha as PE	234	15.02	369
W_2: Imazethapyr 75 g/ha as PoE at 20 DAS	231	14.24	361
W_3: Quizalofop-p-ethyl 100 g/ha as PoE at 20 DAS	232	14.02	348
W_4: One HW at 20 DAS	225	14.14	353
W_5: Weed free (two HW 20 and 40 DAS)	236	15.46	382
W_6: Unweeded control	198	14.16	341
S. Em. ±	7.34	0.37	9.43
C.D. at 5%	21.11	NS	NS
Interaction (S x W)	NS	NS	NS
S. Em. ±	12.72	0.64	16.34
C.V. %	9.76	7.75	7.88
Initial	231	46	429

DAS- Days After Sowing, PE- Pre Emergence, PoE- Post Emergence,
HW- Hand Weeding

Conclusion

From the results, it can be concluded that to achieve more profitable yield, higher nutrient uptake by seed and stover of summer moth bean, the crop should be sown at S_2 (60 cm between two rows) spacing and follow W_5 (weed free-two hand weeding at 20 and 40) days after sowing or in case of labour shortage apply pendimethalin @ 750 g/ha as pre emergence.

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