Agric. Sci. Digest., 38(4) 2018: 255-259
Print ISSN:0253-150X / Online ISSN:0976-0547

AGRICULTURAL RESEARCH COMMUNICATION CENTRE
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Effect of irrigation, nitrogen levels and methods of fertilizer application on growth, yield and profitability of yard long bean [*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt]

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Received: 03-02-2016 Accepted: 10-11-2019 DOI: 10.18805/ag.D-4373

ABSTARCT

A field experiment was conducted during the summer, 2014 at College of Agriculture, Vellayani, Kerala to evaluate the influence of irrigation levels, nitrogen stress and method of application of fertilizers on growth and yield of yard long bean. The experiment consisted of four levels of irrigation, two levels of nitrogen and two methods of application. The results indicated that daily irrigation at 10 mm depth and recommended dose of nitrogen (30 kg ha^{-1}) recorded superior values for growth parameters *viz.*, functional leaves per plant and leaf area index The major yield attributes like number of pods per plant and pod yield per plant and total pod yield were not influenced by levels of irrigation and nitrogen indicating that irrigation once in three days at 20 mm depth and nitrogen level of 22.5 kg ha^{-1} is sufficient for yard long bean. Soil and foliar application of nitrogen and potassium recorded superior growth characters, however, the yield was superior when the recommended dose of nutrients were supplied as soil application. Increasing irrigation interval to three days and imparting N stress did not result in any reduction in gross income and net income while, a higher benefit: cost ratio was noted in irrigation at wider intervals. Soil application of nutrients recorded higher gross income, net income and BCR compared to soil + foliar application.

Key words: Foliar application, Irrigation, Nitrogen, Stress, Yard long bean.

INTRODUCTION

Yard long bean [*Vigna unguiculata* subsp. *sesquipedalis* (L.) Verdcourt] is an important vegetable crop of Kerala in area coverage and preference. It is a vigorous climbing annual, growing to a height of three to four meters and produces very long, slender and succulent pods which may be white, light green, dark green or brownish red in colour (George, 2008). The pods are rich in protein (23.52 -26.27%), iron, calcium, phosphorus, vitamin A, vitamin C and dietary fibre (Ano and Ubochi, 2008). Enhanced leafiness due to high vegetative growth leading to reduced productivity is a common problem encountered by yard long bean farmers. Compared to grain cowpea, the indeterminate growth habit of yard long bean results in variation in response to irrigation and nitrogen levels. Inducing a stress in crop management by increasing irrigation interval and controlled nutrient application can reduce the excess foliage growth and will help to prolong the reproductive phase. The present study attempts to find out ideal irrigation and nutrient management practice to improve the growth, yield and profitability of yard long bean.

MATERIALS AND METHODS

The field experiment was conducted during the summer 2014 (24th January 2014 to 16th May), at the Instructional Farm, College of Agriculture, Vellayani, Kerala. The experiment was laid out in split plot design with four replications. The main plot treatments included four different levels of irrigation, *viz.*, daily irrigation at 10 mm depth (I_1), irrigation in alternate days at 20 mm depth (I_2), irrigation once in 3 days at 20 mm depth (I_3) and irrigation once in 3 days up to flowering and then in alternate days at 20 mm depth (I_4). Combinations of nitrogen levels and method of application formed the sub plot treatments. The N levels tested were: recommended dose (RD) of nitrogen (N_0: 30 kg ha^{-1}) and 25 per cent less of recommended dose of N (N_1: 22.5 kg ha^{-1}). The application methods tried were M_1: soil application of N and K in 4 equal splits (basal, at 20, 30 and 40 DAS) and M_2: soil application of one-third of N and K as basal followed by foliar application of complex fertilizer 13:0:45 @ 0.5 per cent at fortnightly interval. Farm yard manure and full P were applied as basal dose, uniformly for all treatments.

The *adhoc* recommendation for yard long bean under Kerala situation is 30:30:20 kg N:P_2O_5:K_2O ha^{-1} in addition to an organic manure dose of 20 t ha^{-1}.

Yard long bean variety *Vellayani Jyothika*, released from the Department of Olericulture, College of Agriculture, Vellayani was selected for the study. The sub plot size was

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3 m x 3.60 m. Within each subplot, two furrows of 20 cm width were taken along the length of the plot at 1.5 m apart. The seeds were dibbled at 45 cm spacing @ two per hole at a depth of 5 cm. The crop was thinned two weeks after emergence and a single plant was maintained at 45 cm spacing. The pre-experiment soil was analyzed and results indicated high organic carbon (0.9%) medium nitrogen (413.95 kg ha^{-1}), high phosphorus (151.4 kg ha^{-1}) and medium potassium (178.98 kg ha^{-1}).

Observations were recorded on growth attributes (primary branches per plant, functional leaves per plant and LAI at flowering) and yield. The number of primary branches per plant and functional leaves per plant were recorded at 30, 60 and 90 DAS. The leaf area of observational plants from each plot was measured at flowering stage (45 DAS) by graph paper method and expressed in cm^2. The yield of green pods obtained from each harvest was recorded separately according to the treatment and totaled up at the end of the cropping period and expressed in q ha^{-1}. The economics of cultivation of the crop was worked out from the net income and benefit cost ratio (BCR).

The net income was calculated by subtracting cost of cultivation from gross income and expressed in ₹ ha^{-1}. BCR was worked out as the ratio of gross income to cost of cultivation.

$$\text{B : C ratio} = \frac{\text{Gross income (₹ ha}^{-1})}{\text{Cost of cultivation (₹ ha}^{-1})}$$

RESULTS AND DISCUSSION

The data presented in Table 1 revealed that the different levels of irrigation, nitrogen and method of application did not have any significant influence on number of branches plant per plant at 30 DAS. In the later crop growth stages (60 and 90 DAS), irrigation levels exhibited differential response on primary branches per plant, functional leaves per plant and LAI at flowering. Irrigating the crop once in three days up to flowering followed by irrigation in alternate days (I_4) registered the highest number of branches at 60 and 90 DAS, while daily irrigation (I_1) produced maximum leaf number and LAI at flowering (1.56). The mild water stress experienced by the crop in alternate day irrigation might have stimulated the production of more number of branches as reported by Fageria and Bajpal (1971) in peas, Subramanian *et al*. (1976) in green gram and Balakumaran (1981) in grain cowpea. The improvement in leaf number with daily irrigation has also reflected in increased LAI in I_1. Mini (1997) also observed similar result.

Effect of nitrogen levels on the number of functional leaves was evident only at 90 DAS when recommended dose of N (N_0) registered the highest value of 79.16. RDN also registered the highest LAI at flowering. Kumawat (2012) also noticed that LAI in yard long bean increased with increase in N level.

Soil + foliar application of nutrients (M_2) was found to be superior in terms of primary branches per plant and functional leaves per plant at later growth stages and LAI at flowering. The readily available N and K from foliar application might have encouraged the vegetative growth attributes. Potassium regulates the osmotic turgor of cells and water balance which is the driving force for cell division and elongation. A similar result of increase in leaf area due to foliar spray of potassium was reported by Besma *et al*. (2011) in potato and Rao *et al*. (2015) in mung bean.

The data presented in Table 2 indicated that method of application and combination of irrigation and nitrogen

Table 1: Effect of irrigation, nitrogen levels and method of application on growth attributes.

Treatment	No. of primary branches			No. of functional leaves			LAI at flowering
	30 DAS	60 DAS	90 DAS	30 DAS	60 DAS	90 DAS	
Irrigation Levels							
I_1 - Daily at 10 mm depth	4.0	6.75	10.69	20.03	81.94	87.94	1.56
I_2 – Alternate days at 20 mm depth	4.0	10.37	11.19	19.99	70.62	84.12	1.18
I_3 - Once in three days, 20 mm depth	3.56	9.31	10.62	18.37	74.25	64.81	1.07
I_4 - I_3 up to flowering followed by I_2	4.0	10.62	12.44	18.97	77.56	68.75	1.06
SEm (±)	0.191	0.295	0.437	0.681	1.800	1.571	0.026
CD (0.05)	NS	0.667	0.989	NS	4.072	3.555	0.060
Nitrogen Levels							
N_0 - RD N	3.78	9.44	11.28	19.12	75.47	79.16	1.40
N_1 - 25 % less of RD N	4.0	9.09	11.19	19.56	76.72	73.66	1.03
SEm (±)	0.211	0.238	0.224	0.438	1.083	1.291	0.016
CD (0.05)	NS	NS	NS	NS	NS	2.619	0.033
Method of application							
M_1 - Soil application	3.94	9.03	11.00	19.63	73.94	74.62	1.15
M_2 – Soil + foliar application	3.84	9.50	11.47	19.05	78.25	78.19	1.28
SEm (±)	0.211	0.238	0.224	0.438	1.083	1.291	0.016
CD (0.05)	NS	NS	0.454	NS	2.196	2.619	0.033

Table 2: Effect of irrigation, nitrogen levels and method of application on pod yield.

Treatment	Pod number plant^{-1}	Pod yield plant^{-1} (g)	Pod yield(q ha^{-1})
Irrigation Levels			
I_1 - Daily at 10 mm depth	45.93	590.85	95.86
I_2 – Alternate days at 20 mm depth	45.56	584.92	94.98
I_3 - Once in three days, 20 mm depth	45.89	590.19	95.76
I_4 - I_3 up to flowering followed by I_2	45.18	578.83	95.39
SEm (±)	0.954	15.259	2.074
CD (0.05)	NS	NS	NS
Nitrogen Levels			
N_0 - RD N	45.30	580.74	94.36
N_1 - 25 % less of RD N	45.98	591.66	96.64
SEm (±)	0.467	7.467	1.146
CD (0.05)	NS	NS	NS
Method of application			
M_1 - Soil application	47.68	618.96	100.03
M_2 – Soil + foliar application	43.59	553.43	90.97
SEm (±)	0.467	7.467	1.146
CD (0.05)	0.946	15.144	2.324

Table 3: Interaction effect of irrigation, nitrogen levels and method of application on pod yield.

I x N	Pod number plant^{-1}	Pod yield plant^{-1} (g)	Pod yield (q ha^{-1})
$I_1 N_0$	46.99	607.88	98.38
$I_1 N_1$	44.86	573.82	93.34
$I_2 N_0$	42.87	541.90	88.61
$I_2 N_1$	48.25	627.93	101.36
$I_3 N_0$	44.38	566.09	92.19
$I_3 N_1$	47.39	614.30	99.34
$I_4 N_0$	46.94	607.08	98.27
$I_4 N_1$	43.41	550.58	92.52
SEm (±)	0.933	14.934	2.292
CD (0.05)	1.893	30.288	4.647

had a favorable influence on the major yield attributes, *viz.* pod number per plant and pod yield per plant. Yield of any plant is being contributed by the summation of the influence of yield attributes and in the present study, the major yield attributes *viz.*, pod yield per plant and pod number per plant were not influenced by irrigation regimes and nitrogen levels which in turn caused non-significant influence on total yield. Being a leguminous plant, yard long bean might have utilized a part of fixed N at later stages. Similarly, in soils with medium nutrient status, N level of 22.5 kg ha^{-1} is sufficient for better yield in yard long bean. Akter *et al*. (1998) and Geetha (1999) reported that 20 kg N ha^{-1} is ideal for enhanced per plant yield of yard long bean.

Soil application of nutrients recorded significantly higher pod yield (618.96 g) and pod number (47.68) over soil + foliar application. The same trend was observed in case of total pod yield, where a yield of 100.03 q ha^{-1} was

Table 4: Effect of irrigation, nitrogen levels and method of application on economic parameters.

Treatment	Gross income (₹)	Net income ()	BCR
Irrigation Levels			
I_1 - Daily at 10 mm depth	383447	273155	3.48
I_2 – Alternate days at 20 mm depth	374934	271602	3.63
I_3 - Once in three days, 20 mm depth	380560	279548	3.77
I_4 - I_3 up to flowering followed by I_2	381574	279402	3.74
SEm (±)	6713.85	6713.85	0.063
CD (0.05)	NS	NS	0.142
Nitrogen Levels			
N_0 - RD N	377456	273211	3.62
N_1 - 25 % less of RD N	382802	278642	3.68
SEm (±)	3754.62	3754.62	0.035
CD (0.05)	NS	NS	NS
Method of application			
M_1 - Soil application	398856	295918	3.88
M_2 – Soil + foliar application	361401	255935	3.43
SEm (±)	3754.62	3754.62	0.042
CD (0.05)	7614.71	7614.71	0.072

registered. The total quantity of N and K applied in soil application were 2.2 and 1.3 times more than soil + foliar application. Moreover, soil application of N and K was given in four splits (basal, 20, 30 and 40 DAS). This split application along with controlled irrigation might have ensured better utilization of nutrients and reduced leaching loss. Oliveria (2003) reported higher pod yield in yard long bean for soil application of N @ 60 kg ha^{-1} compared to its foliar application (@ 1 per cent) after a common basal dose of manure (20 t ha^{-1}), super phosphate (500 kg ha^{-1}) and KCl (68 kg ha^{-1}) was given.

Table 5: Interaction effect of irrigation, nitrogen levels and method of application on economic parameters.

I x N	Gross income (₹)	Net income ()	BCR
$I_1 N_0$	393539	283205	3.57
$I_1 N_1$	373356	263106	3.39
$I_2 N_0$	354445	251071	3.43
$I_2 N_1$	395422	292133	3.83
I_3N_0	368775	267721	3.65
$I_3 N_1$	392346	291376	3.89
$I_4 N_0$	393065	290850	3.85
$I_4 N_1$	370084	267955	3.63
SEm (±)	7509.25	7509.25	0.071
CD (0.05)	15229.40	15229.40	0.144

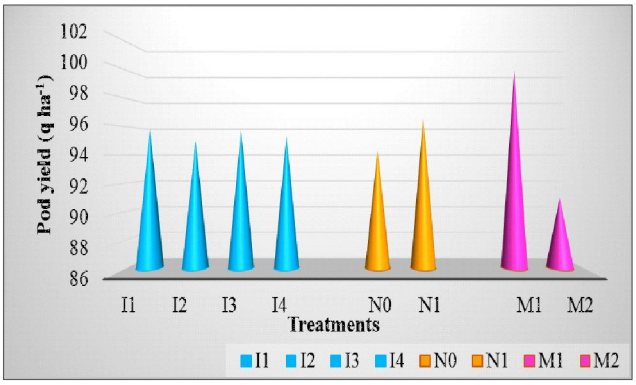


Fig 1: Pod yield as influenced by influenced by irrigation, nitrogen levels and method of application.

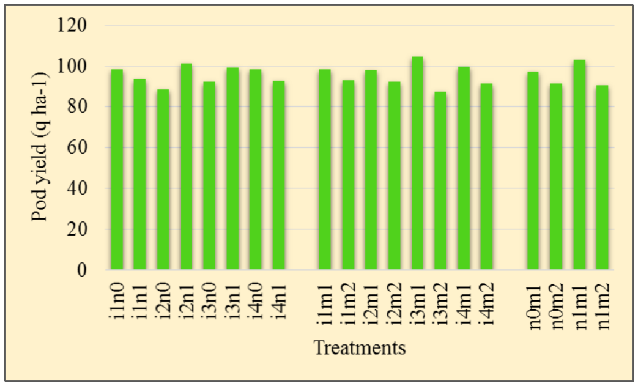


Fig 2: Pod yield as influenced by combined effect of irrigation, nitrogen levels and method of application.

Considering I x N interaction effect, irrigation in alternate days with 25 % less of recommended N (I_2N_1) was found to be superior which was on par with I_3N_1, I_1N_0 and I_4N_0.

The levels of irrigation and N stress had no influence on gross income and net income, while these parameters were significantly superior in soil application of nitrogen and potassium over soil + foliar application (Table 4). A gross income of 3,98,856 and net income of 2,95,918 was registered in soil application of N and K. Irrigating once in three days at 20 mm depth (I_3) recorded the highest BCR (3.77) which was on par with irrigating once in three days up to flowering followed by irrigating in alternate days (I_4) and alternate days irrigation (I_2). Jyothi (1995) observed that irrigating the crop at 75 per cent field capacity recorded higher net income and BCR over daily irrigated treatments. Similar results on high BCR at lower frequency of irrigation was also reported by Mini (1997). Nitrogen levels did not influence the BCR. Soil application recorded higher BCR of 3.88 (15 per cent increase) compared to soil + foliar application. The higher gross income, net income and BCR in soil application of N and K (M_1) is due to the higher yield and lower cost of soil applied fertilizers compared to foliar fertiliser.

Among interactions (Table 5), irrigating once in three days along with 25 per cent less of RD N (I_3N_1) recorded the highest BCR (3.89) and was on par with I_4N_0 and I_2N_1.

From the results of the present study, it could be concluded that irrigating once in three days at 20 mm depth during summer months/rain free periods is sufficient for yard long bean. The nitrogen requirement could be met from a dose of 22.5 kg ha^{-1} which should be supplied in 4 split doses as basal, at 20, 30 and 40 days after sowing.

ACKNOWLEDGEMENT

The authors profoundly acknowledge Kerala Agricultural University for providing necessary financial support and facilities for the experiment.

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