Annals of Plant and Soil Research 16 (3): 229-233 (2014)

ECONOMICS AND ENERGETICS OF URDBEAN VARIETIES UNDER AGRO-INPUT MANAGEMENT PRACTICES IN *VERTISOLS*

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Received: May, 2014; Revised accepted: July, 2014

ABSTRACT

A field experiment was carried out at Instructional cum Research Farm, IGKV, Raipur during kharif season of 2010. The soil of the experimental field was neutral in pH with low nitrogen, medium phosphorus and high potassium contents. The experiment was laid out in factorial randomized block design with three replications and seven agro inputs. Results revealed that the growth characters (plant height and branches plant^{-1}) tended to increase up to harvest irrespective of various treatments. The leaves plant^{-1} increased up to 60 days after sowing followed by a reduction at harvest. Azad-1 recorded significantly highest pods plant^{-1} (29.60), seeds pod^{-1} (6.59), seed (7.55 q ha^{-1}) and stover yield (19.86 q ha^{-1}), net return (₹ 19010.31 ha^{-1}) and net return rupee^{-1} invested (1.56), protein yield, energy output, energy output-input ratio and energy use efficiency. Application of 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP recorded significantly highest plant height, branches, leaves, pods plant^{-1} (34.68), seeds pod^{-1} (6.70), seed (8.83 q ha^{-1}) and stover yield (20.91 q ha^{-1}), net return (₹ 23322.49 ha^{-1}) and net return rupee^{-1} invested (1.79), protein content and yield, highest energy output of seed, stover and total biomass. The lowest values of these parameters were recorded under 100% RDF treatment.

Keywords: Urdbean, yield, economics, energetics, agro-inputs

INTRODUCTION

Urdbean (*Phaseolus mungo* L.) is the third important pulse crop in India. Among the *Kharif* pulses, urdbean is one of the leading pulse crops of Chhattisgarh. It is highly priced and nutritionally rich crop having good source of protein (20-24%), carbohydrates (59.6%), fat (1.4%), calcium, iron and niacin and has medicinal importance (Upadhyay *et al.,* 2007). It has some medicinal properties, like curing diabetes, sexual dysfunction, nervous disorder, hair disorders, digestive system disorders and rheumatic afflictions (Hussain *et al.,* 2013). Like other pulses, urdbean has unique characteristics of maintaining and restoring soil fertility through biological nitrogen fixation and its deep root system also maintains physical properties of soil. But there are many agro-ecological, biological and management related constraints that are responsible for low productivity of urdbean. Non-availability of proper biofertilizers and inadequate use of macro and micronutrients are some of the important factors that are responsible for low yield of urdbean. The growth and development of any crop depends upon the various genetic and environment factors. The different varieties sowing under the same condition and fertilizer dose having different yield both in terms of biomass and grain production (Khawas and Bhattacharjee, 1996). By the introduction of numerous short duration varieties in urdbean it had been feasible to introduce urdbean in single as well as in multiple cropping systems for increasing pulse production. The cropping system of Chhattisgarh depends on rainfall, so short duration and high yielding varieties matching with the effective rainfall duration are required for boosting the urdbean production. In Chhattisgarh, very meagre research work has been done on agro-input management like foliar nutrition, growth regulator along with nutrient management. Several new varieties have been developed which needs location specific evaluation with regard to agro-input management. Keeping the above points in view, the present investigation was carried out to study the effect of agro-input management practices on urdbean.

MATERIALS AND METHODS

A field experiment was carried out during *kharif* season of 2010 at Instructional-cum-Research Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (Chhattisgarh), India. Soil of the experimental field was neutral in pH, low in available nitrogen (215 kg ha^{-1}), medium in phosphorus (13 kg ha^{-1}) and high in available potassium (360 kg ha^{-1}). The experiment was laid out in factorial randomized block design with three replications. The treatment consisted of two varieties *viz.*, V_1- Azad-1 and V_2- TU 94-2 and seven agro-input *viz.*, 100% RDF (A_1), 100% RDF + 5 t FYM ha^{-1} (A_2), 100% RDF + 40 ppm NAA as foliar spray at 30 and 40 DAS (A_3), 100% RDF + PSB + 40 ppm NAA as foliar spray at 30 and 40 DAS (A_4), 100% RDF + 2% DAP as foliar spray twice: (Ist

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spray at flower initiation and IInd at 15 days after Ist spray) (A_5), 100% RDF + PSB + 2% DAP as foliar spray twice: (Ist spray at flower initiation and IInd at 15 days after Ist spray) + 40 ppm NAA as foliar spray at 30 and 40 DAS (A_6) and 100% RDF + 5 t FYM ha^{-1} + PSB + 2% DAP as foliar spray twice: (Ist spray at flower initiation and IInd at 15 days after Ist spray) + 40 ppm NAA as foliar spray at 30 and 40 DAS (A_7). Urdbean crop with seed rate of 20 kg ha^{-1} was sown on July 14, 2010 with a row and plant spacing of 30 x 10 cm. The crop was harvested on September 30, 2010. The economics of urdbean was worked out based on the current market price of inputs and outputs. Energy use efficiency and output/ input ratio were calculated by using the following formula:

Energy use efficiency (q MJ x 10^{-3}) = Total produce (q)/ Energy input (MJ x 10^{-3})

Energy output-input ratio (EOIR) = Energy output (EO)/ Energy input (EI)

At harvest, biological yield was recorded. The weight of cleaned seeds obtained from each net plot after threshing was converted into q ha^{-1} by using appropriate factor. Stover yield was calculated by subtracting the seed yield from the bundle weight of the respective plot. After analysis for nitrogen by Kjeldahl method, protein content was computed by multiplying N content with a factor of 6.25.

RESULTS AND DISCUSSION

Growth attributes

It is obvious from the data (Table 1) that plant height progressively increased with the advancement of the age of the crop. Variety TU 94-2 recorded significantly taller plants as compared to Azad-1 at 20, 40 and 60 DAS. However, at harvest stage there was non-significant variation in plant height of both varieties. Use of 100% RDF + 5 t FYM ha^{-1} produced significantly taller plants at 20 DAS, however, it was at par with the application of 100% RDF + 2% DAP and 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP. At 40, 60 DAS and harvest stage, significantly taller plants was recorded under 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP. Sharma and Abraham (2010) have also reported similar type of effect of nitrogen and FYM application. It is due to adequate nutrient availability from FYM through mineralization process.

Table 1: Plant height, branches and leaves of urdbean varieties as influenced by agro-input management practices

Treatments	Plant height (cm)				Branches plant^{-1}			Trifoliate leaves plant^{-1}			
	20 DAS	40 DAS	20 DAS	40 DAS	60 DAS	At harvest	At harvest	20 DAS	40 DAS	20 DAS	40 DAS
Varieties											
V_1- Azad-1	10.69	26.27	47.22	68.87	2.48	2.75	3.66	9.4	37.5	63.9	40.0
V_2- TU 94-2	11.41	29.03	52.64	66.83	2.71	2.90	3.49	9.7	39.2	62.67	37.2
SEm±	0.10	0.45	0.87	0.86	0.05	0.05	0.10	0.17	0.47	0.75	0.69
CD (P = 0.05)	0.29	1.32	2.54	NS	0.15	0.14	NS	NS	1.38	NS	2.00
Agro-inputs											
A_1	10.12	21.79	49.94	59.02	2.50	2.67	2.87	8.8	35.6	56.1	22.6
A_2	12.22	28.95	51.76	66.50	2.53	2.70	3.33	9.7	39.1	63.6	30.6
A_3	10.74	24.64	45.07	69.94	2.77	2.73	3.40	9.3	28.9	55.7	40.4
A_4	10.62	25.97	42.62	63.74	2.03	2.27	3.35	9.0	31.6	59.2	40.5
A_5	11.48	28.17	50.53	70.84	2.87	3.13	3.62	9.7	45.9	67.9	44.5
A_6	10.58	30.22	52.60	71.12	2.70	3.10	4.10	9.7	39.78	69.0	45.8
A_7	11.58	33.83	57.16	73.79	2.77	3.18	4.33	10.6	47.5	71.5	45.8
SEm±	0.27	1.20	2.31	1.90	0.14	0.13	0.26	0.45	1.26	1.97	1.82
CD (P = 0.05)	0.78	3.49	6.72	5.51	0.41	0.37	0.75	1.30	3.65	5.73	5.29

***Note:** A_1 -100% RDF, A_2 -100% RDF + 5 t FYM ha^{-1}, A_3 -100% RDF + 40 ppm NAA as FS at 30 and 40 DAS, A_4 -100% RDF + 40 ppm NAA as FS at 30 and 40 DAS + PSB, A_5 -100% RDF + 2% DAP as FS twice: (FI and 15 DA Ist spray), A_6 -100% RDF + 40 ppm NAA as FS at 30 and 40 DAS + PSB + 2% DAP as FS twice: (FI and 15 DA Ist spray), A_7 -100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA as FS at 30 and 40DAS + PSB + 2% DAP as FS twice: (FI and 15 DA Ist spray)*

The significant difference was observed in branches due to varieties at all the stages of growth, except at harvest stage. At 40 and 60 DAS, variety TU 94-2 recorded the highest branches plant^{-1} as compared to Azad-1. Application of 100% RDF + 2% DAP produced significantly highest number of branches at 40 DAS. All the other treatments were found statistically at par except 100% RDF + 40 ppm NAA + PSB, which recorded the lowest number of branches. Application of 100% RDF + 5 t FYM ha^{-1}

+ 40 ppm NAA + PSB + 2% DAP registered significantly higher number of branches plant^{-1} at 60 DAS and at harvest as compared to others. The significantly lowest number of branches plant^{-1} was recorded with 100% RDF + 40 ppm NAA + PSB at 60 DAS and 100% RDF at harvest. Similar results were reported by Das *et al.* (2005). It may be due to with exogenous application of auxin which would have enhanced concentration of cytokinins leading to increased metabolic activity which in turn influenced auxiliary bud and resulting in increased number of branches.

The data reveals that the number of leaves of urdbean increased up to 60 DAS and decreased thereafter (Table 1). Both the varieties of urdbean did not influence number of leaves plant^{-1} significantly at 20 and 60 DAS. At 40 DAS, significantly highest number of leaves was recorded under TU 94-2, however, at harvest, significantly highest number of leaves was recorded under Azad-1 due to different genetic characters and growth habits. Significantly higher number of leaves plant^{-1} was recorded under 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP at all the stages. At 40 DAS, it was found at par with 100% RDF + 2% DAP. At 60 DAS and at harvest, with 100% RDF + 40 ppm NAA + PSB + 2% DAP and 100% RDF + 2% DAP. The lowest number of leaves plant^{-1} was recorded at 100% RDF. Similar results were observed by Prakash *et al.* (2003). It could be due to their negative influence on plant height and diversion of nutrients leading to more number of leaves.

Yield attributes

The significantly highest number of pods plant^{-1} (29.60) and seeds pod^{-1} (6.59) were recorded under Azad-1 variety of urdbean (Table 2). However, the test weight did not differ significantly in these two varieties due to different genetic characters and growth habits. Significantly highest number of pods plant^{-1} (34.68) was recorded under 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP and lowest (21.31) in 100% RDF. The higher numbers of seeds pod^{-1} (6.70) was observed with 100% RDF + 40 ppm NAA + PSB and rest other treatment were found comparable, except 100% RDF. Similar observations were reported by Patel and Thakur (2003) who stated that the PSB and FYM significantly improved the pods plant^{-1}, seeds pod^{-1} and number of seeds plant^{-1} over control.

Table 2: Yield attributes yields and economics of urdbean as influenced by varieties and agro-input management practices

Treatment	Pods plant^{-1}	Seeds pod^{-1}	Test weight (g)	Seed yield (q ha^{-1})	Stover yield (q ha^{-1})	Net return (₹ ha^{-1})	Net return rupee^{-1} invested
Varieties							
V_1- Azad-1	29.60	6.59	4.14	7.55	19.86	19010.31	1.56
V_2- TU 94-2	26.53	6.33	4.12	7.13	19.07	17130.65	1.39
SEm±	0.29	0.09	0.08	0.11	0.24	440.68	0.04
CD (P = 0.05)	0.84	0.25	NS	0.32	0.68	1281.04	0.11
Agro-inputs							
A_1	21.31	5.70	3.95	6.30	18.13	13936.99	1.15
A_2	25.35	6.37	4.06	7.15	19.84	16909.41	1.33
A_3	26.62	6.70	4.16	6.71	18.93	15858.49	1.33
A_4	27.62	6.90	4.16	6.93	19.78	16772.33	1.40
A_5	28.85	6.40	4.08	7.34	19.09	18310.99	1.52
A_6	32.02	6.47	4.25	8.11	19.58	21382.66	1.78
A_7	34.68	6.70	4.27	8.83	20.91	23322.49	1.79
SEm±	0.77	0.23	0.20	0.29	0.62	1165.93	0.10
CD (P = 0.05)	2.22	0.67	NS	0.84	1.81	3389.30	0.28

Yields

The variety Azad-1 produced significantly higher seed yield (7.55 q ha^{-1}) as compared to TU 94-2 (7.13 q ha^{-1}) due to different genetic characters and growth habits (Table 2). Application of 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP registered significantly highest seed yield (8.83 q ha^{-1}) followed by 100% RDF + 40 ppm NAA + PSB + 2% DAP and lowest (6.30 q ha^{-1}) in 100% RDF. These results are in agreement with Kachave *et al.* (2009). Higher yield of urdbean with FYM may be due to the fact that it contains other major and micro nutrients which helped in better availability of nutrients and thereby growth and development of the crop (Patel and Thakur, 2003). Anbumani *et al.* (2003) revealed that, this might be due to good response to the extra nitrogen through the foliar spray of DAP on standing crop. Data (Table 2) reveal that variety Azad-1 gave significantly higher stover yield (19.86 q ha^{-1}) in comparison to TU 94-2 (19.07 q ha^{-1}) which may be due to different genetic characters and growth habits. Application of 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP registered significantly highest stover yield (20.91 q ha^{-1}) followed by 100% RDF + 5 t FYM ha^{-1}, 100% RDF + 40 ppm NAA + PSB and 100% RDF + 40 ppm NAA + PSB + 2% DAP. The lowest stover yield (18.13 q ha^{-1}) was recorded at 100% RDF. Shashikumar *et al.* (2013a) also noted similar results. Foliar application of nutrients using water soluble fertilizer is one of the possible reasons to enhance the productivity of pulses.

Economics

Data (Table 2) reveal that the highest net return was noted with variety Azad-1 (₹ 19010.31 ha^{-1}) followed by TU 94-2 (₹ 17130.65 ha^{-1}). The highest net return (₹ 23322.49 ha^{-1}) was obtained with 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP, which was followed by (₹ 21382.66 ha^{-1}) 100% RDF + 40 ppm NAA + PSB + 2% DAP. The lowest net return (₹13936.99 ha^{-1}) was noted at 100% RDF. Similar results were reported by Sharma and Gupta (2006); Tuti *et al.* (2013) and Shashikumar *et al.* (2013b). Significantly highest net return $rupee^{-1}$ invested was recorded under Azad-1 (1.56) in comparison to TU 94-2 (1.39). The highest net return $rupee^{-1}$ invested (1.79) was recorded with 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP. The lowest net return $rupee^{-1}$ invested (1.15) was noted at 100% RDF.

Content and yield of protein

Data (Table 3) reveal that variety Azad-1 proved superior to TU 94-2 in respect of content and yield of protein. Use of 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP gave the maximum protein content in seed which was significantly superior to other treatments, except treatment 100% RDF + 40 ppm NAA + PSB + 2% DAP. Application of 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP significantly excelled to other treatments in respect of content and yield of protein. The lowest content and protein yield were recorded under 100% RDF. The higher protein yield may be attributed to higher yield and protein content (Kumar and Rana, 2007).

Table 3: Content and yield of protein and energetics of urdbean as influenced by varieties and agro-input management practices

Treatment	Protein content (%)	Protein yield (kg ha^{-1})	Energy input (MJ x 10^{-3} ha^{-1})	Energy output (MJ x 10^{-3} ha^{-1})			Energy output input ratio	Energy use efficiency (q MJ x 10^{-3} ha^{-1})	
				Seed	Stover	Total		Seed	Biomass
Varieties									
V1- Azad-1	20.98	159.83	-	11.1	24.8	35.9	6.7	1.4	5.1
V2- TU 94-2	20.61	148.53	-	10.5	23.8	34.3	6.4	1.3	4.9
SEm±	0.09	2.47	-	0.16	0.29	0.37	0.07	0.02	0.05
CD (P = 0.05)	0.28	7.19	-	0.47	0.86	1.07	0.20	0.06	0.15
Agro-inputs									
A_1	18.36	116.01	5.30	9.3	22.7	31.9	6.0	1.2	4.6
A_2	19.30	138.04	5.30	10.5	24.8	35.3	6.7	1.4	5.1
A_3	19.88	133.46	5.42	9.9	23.7	33.5	6.2	1.2	4.7
A_4	20.18	139.83	5.43	10.2	24.7	34.9	6.4	1.3	4.9
A_5	20.34	149.36	5.36	10.8	23.9	34.7	6.5	1.4	4.9
A_6	23.42	190.01	5.49	11.9	24.5	36.4	6.6	1.5	5.1
A_7	24.07	212.58	5.49	13.0	26.1	39.1	7.1	1.6	5.4
SEm±	0.25	6.54	-	0.43	0.78	0.98	0.18	0.08	0.14
CD (P = 0.05)	0.73	19.02	-	1.24	2.26	2.84	0.53	0.22	0.41

A_1 -100% RDF, A_2 -100% RDF + 5 t FYM ha^{-1}, A_3 -100% RDF + 40 ppm NAA as FS at 30 and 40 DAS, A_4 -100% RDF + 40 ppm NAA as FS at 30 and 40 DAS + PSB, A_5 -100% RDF + 2% DAP as FS twice: (FI and 15 DA I^{st} spray), A_6 -100% RDF + 40 ppm NAA as FS at 30 and 40 DAS + PSB + 2% DAP as FS twice: (FI and 15 DA I^{st} spray), A_7 -100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA as FS at 30 and 40 DAS + PSB + 2% DAP as FS twice: (FI and 15 DA I^{st} spray)

Energetics

Significantly highest energy output, energy output-input ratio and energy use efficiency was recorded under Azad-1 as compared to TU 94-2 (Table 3). Highest energy output of seed, stover and total biomass was noted at 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP. The energy output of seed and total biomass were comparable at 100% RDF + 40 ppm NAA + PSB + 2% DAP; and the energy output through stover was at par with 100% RDF + 5 t FYM ha^{-1}, 100% RDF + 40 ppm NAA + PSB and 100% RDF + 40 ppm NAA + PSB + 2%

DAP. The lowest energy output was recorded at 100% RDF. The highest energy output-input ratio and energy use efficiency of seed and biomass were recorded with 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP. Paikra and Dwivedi (2012) reported similar results in urdbean under agro-inputs management. The energy output-input ratio and energy use efficiency from stover was at par with 100% RDF + 40 ppm NAA + PSB + 2% DAP and 100% RDF + 5 t FYM ha^{-1}; whereas the energy use efficiency from seed was found comparable with 100% RDF + 40 ppm NAA + PSB + 2% DAP. The lowest energy output-input ratio and energy use efficiency of seed and biomass was observed under 100% RDF. Tuti *et al.* (2013) reported similar findings in pigeonpea-based cropping system.

Urdbean variety Azad-1 with 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP or 100% RDF + 40 ppm NAA + PSB + 2% DAP proved best in not only producing maximum growth, yield attributes and yield but also fetched higher net return and net return $rupee^{-1}$ invested. Thus in order to harness maximum productivity of urdbean Azad-1 should be grown with 100% RDF + 5 t FYM ha^{-1} + 40 ppm NAA + PSB + 2% DAP application in *Vertisols* of Chhattisgarh.

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