Effect of Different Levels of Nitrogen and Foliar Spray of DAP on Toria Grown as *Utera* Crop in Rice-Toria Cropping System

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Article History

Manuscript No. 322
Received in 19th May, 2012
Received in revised form 19th December, 2012
Accepted in final form 1st March, 2013

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Keywords

Toria, *utera*, nitrogen, foliar spray, DAP, seed yield

Abstract

An experiment was conducted to study the effect of different levels of nitrogen and foliar spray of 2 % DAP at Pre-flowering stage on toria, grown as *utera* crop during 2003-2004 in rice-toria cropping system in the lateritic belt of West Bengal. The treatments were control (No fertiliser), 20 kg N ha^{-1}, 40 kg N ha^{-1}, 60 kg N ha^{-1} and 80 kg N ha^{-1} alone and in combination with foliar spray of 2% DAP at Pre-flowering stage. The experiment was laid out in a randomized block design with three replications. Plant height at 60 DAS and at maturity and dry matter production at 60 DAS increased with increasing level of N up to 80 kg ha^{-1}. Application of 80 kg N ha^{-1} though produced higher plant height at 60 DAS and at maturity, dry weight of plants at 60 DAS but 40 kg N ha^{-1} in combination with foliar spray of 2% DAP at Pre-flowering stage produced the highest number of seeds $siliqua^{-1}$ (16.1), seed yield (364 kg ha^{-1}), gross return (₹ 7470 ha^{-1}), net return (₹ 3532 ha^{-1}) and benefit:cost ratio (0.9). Though, seed yield increased significantly with increasing level of nitrogen up to 40 kg N ha^{-1}, further increase in nitrogen level above 40 kg resulted in reduction in seed yield of toria.

1. Introduction

The rice-fallow lands in India are estimated to be about 15 million hectares which can favourably be exploited for successful cultivation of pulses and oilseeds with selection of appropriate varieties of rice and succeeding pulse/oilseed crops. Eastern India accounts for approximately 10% of this area. Lathyrus, gram, lentil, field pea, linseed, rapeseed-mustard, etc. are the crops which are generally grown in rice fallows as *utera* crop. The areas in which this system is widely prevalent are West Bengal, parts of Orissa, U. P., M. P., Bihar and Chhatisgarh (Bhowmick et al., 2006). In West Bengal, it is a general practice of the farmers to sow various winter crops like lentil, lathyrus, chickpea field pea and linseed in the standing rice crop field, just before the harvest to ensure germination using the residual moisture and to avoid tillage operations. Such *utera* cropping is very popular for growing lathyrus specially in coastal districts of West Bengal. However, growing of yellow sarson as *utera* crop is comparatively new. Toria is a crop of shorter duration, requiring less water and nutrient as compared to other oilseeds in the rapeseed-mustard group. Thus it may also fit well in rice falows as *utera* crop. There is a need to find newer niches and situations where oilseeds can be introduced (Reddy and Suresh, 2009 and Bhowmick et al., 2012). Suitable varieties of rapeseed-mustard with appropriate technologies can successfully be grown on the rice-fallow lands due to its low water requirements (80-240 mm) (Bhowmick et al., 2012 and Shekhawat et al., 2012). Toria can be raised successfully in rice-fallows under limited moisture conditions, which otherwise are left uncultivated. Timely sowing of the crop is one of the most important factors determining the yield of the crop. The yield of toria is reduced drastically if the crop is sown beyond October. Broadcasting seeds of yellow sarson after land preparation in rice-fallow was found uneconomic due to severe infestation of aphid & diamond back moth and the prevalence of high temperature at later stage of crop growth due to delayed sowing in West Bengal. *Utera* cropping of rapeseed-mustard in between two rice crops in rice-rice system has gained popularity (Samui, 2005). Growing of toria under this technique can be practiced to facilitate the optimum sowing time. *Utera* cropping of yellow sarson in the standing *aman* paddy has been found economic when the seeds of *utera* crop were sown broadcast before rice harvest. The yellow sarson performed well as *utera* crop in alluvial zone of West Bengal (Duary and Pradhan, 2000, Duary, 2001 and Bhowmick et al., 2012). In the alluvial soil of Bhubaneswar, toria sown under *utera* cropping recorded significantly higher seed yield over

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line sown and broadcast method (AICRP-RM, 1999). As no tillage operation is done for sowing crops as *utera*, it is difficult to apply fertilizer either through placement or through top dressing and consequently, no fertilizer application is done by the farmers to the succeeding *utera* crops (Bhowmick et al, 2005). Therefore, the scope of fertilization becomes confined to foliar spray or top dressing. With foliar application technique, nutrients can reach to the site of food synthesis directly, leaving no wastage. But foliar nutrition is supplementary to and cannot replace the basal fertilization or top dressing. Application of nutrient elements through foliar spray at appropriate stages of growth becomes important for their efficient utilization and better performance of the *utera* crop. It has been well established that the fertilizer elements which are absorbed through roots can also be absorbed with equal efficiency through foliage (Ganapathy et al., 2008). Information on performance of toria and its nutrient management as *utera* crop is lacking specially in the lateritic belt of West Bengal. In the present investigation, effort has been made to study the effect of different levels of nitrogen, foliar spray of DAP at Pre-flowering stage and their combined effect on growth, productivity and economics of toria as *utera* crop in lateritic belt of West Bengal.

2. Materials and Methods

The field experiment was conducted at Agricultural Farm of Palli Siksha Bhavana (Institue of Agriculture), Visva-Bharati, Birbhum, West Bengal during the *rabi* season of 2003-2004 to study the influence of levels of nitrogen, 2% DAP foliar spray at Pre-flowering stage and their combination on yield and economics of yellow sarson cv. *Aghrani* grown as *utera* crop in rice–toria cropping system. Ten treatments *viz*., T_1- No fertiliser, T_2- 2% DAP spray at Pre-flowering stage, T_3- 20 kg N ha^{-1}, T_4- T_3+T_2, T_5- 40 kg N ha^{-1}, T_6- T_5+T_2, T_7 - 60 kg N ha^{-1}, T_8- T_7+T_2, T_9- 80 kg N ha^{-1}, T_{10} - T_9+T_2 were assigned in a randomized block design with three replications. The texture of the soil was silty loam with a pH of 6.3 and low in available nitrogen (193.0 kg N ha^{-1}), available phosphorus (19.4 kg P_2O_5 ha^{-1}) and available potash (132.8 kg K_2O ha^{-1}). The seeds of toria were broadcasted 6 days before harvesting of paddy during first week of November, 2003. The N in the form of urea was applied in two equal doses, half at 7 days after sowing (DAS) and half at 25 days after sowing. A 2% DAP solution was prepared and the solution was used for spray at Pre-flowering stage (Ali and Kumar, 2006 and Ganapathy et al., 2008).The crop was harvested at 73 days after sowing.

3. Results and Discussions

3.1. Growth attributes

Plant height at 60 DAS and maturity varied significantly in different treatments. Application of 80 kg N ha^{-1} registered the highest plant height at 60 DAS and was at par with that of 80 kg N ha^{-1}+2% DAP at Pre-flowering stage, 60 kg N ha^{-1} alone and in combination with 2% DAP at Pre-flowering stage and 40 kg N ha^{-1} alone. But at maturity the plant height was significantly superior in the treatment 80 kg N ha^{-1} over all other treatments. Significant variations in branches $plant^{-1}$ of toria was recorded for the effect of nitrogen and foliar spray of DAP. Highest numbers of branches were obtained with the treatment 80 kg N ha^{-1} in combination with 2% DAP spray at Pre- flowering stage and was at par with that of 80 kg N ha^{-1} alone and 60 kg N ha^{-1}+2% DAP. Higher level of nitrogen might have ensured the favourable condition for growth of toria resulting in the maximum number of branches. Buttar and Aulakh (1999) and Mahiuddin et al. (2011) also reported the similar results. Application of 80 kg N ha^{-1} alone recorded significantly higher dry matter at 60 DAS over other treatments but it was at par with 80 kg N ha^{-1}+2% DAP (Table 1). Highest LAI at 60 DAS was found in the treatments with 60 and 80 kg N ha^{-1} in combination with 2% DAP spray at Pre- flowering stage and it was at par with 60 and 80 kg N ha^{-1} alone and 40 kg N ha^{-1} in combination with 2% DAP. This might be ascribed due to the fact that the soil fertility status in terms of available N and P was low to medium in range as a result of which there was significant response to higher levels of fertiliser leading to over all improvement of crop growth. Foliar spray of 2% DAP in combination with fertiliser N always increased the dry weight of plant upto 40 kg N ha^{-1} as compared to fertiliser N alone.

3.2. Yield components

Application nitrogen at different levels showed a statistically significant variation in number of siliqua $plant^{-1}$. Number of siliqua $plant^{-1}$ increased significantly up to 40 kg N ha^{-1}+2% DAP. The highest number of siliqua $plant^{-1}$ was obtained from 40 kg N ha^{-1}+2% DAP which was at par with 60 kg N ha^{-1} alone, 80 kg N ha^{-1} alone and 80 kg N ha^{-1}+2% DAP. Foliar spray of 2% DAP when applied with 40 kg N ha^{-1} significantly increased the number of siliqua per plant as compared to nitrogen alone. Similar results of increased number of siliqua with higher nitrogen level were reported by Duary (2001) and Mohiuddin et al. (2011). The highest number of seeds $siliqua^{-1}$ was produced by the application of 40 kg N ha^{-1}+2% DAP, however, it was at par with 20 kg N ha^{-1}+2% DAP and 40 kg N ha^{-1}. No significant difference was obtained in case of 1000 seed weight (Table 2).

3.3. Seed yield, straw yield and harvest index

Application of nitrogen at different levels showed significant variation in seed yield of toria (Table 2). Seed yield increased significantly with increasing level of nitrogen upto 40 kg N ha^{-1}+2% DAP at Pre-flowering stage. Further increase in fertiliser level above 40 kg resulted in reduction of seed yield. The seed

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Table 1: Effect of treatments on growth parameters of toria grown as *utera* crop in rice-toria cropping system.					
Treatment	Plant height (cm)		No. of branches plant^{-1}	Dry weight of plant (g m^{-2})	Leaf Area Index (LAI)
	60 DAS	At maturity		60 DAS	60 DAS
Control (no fertilizer)	15.4	16.3	0.4	6.9	0.6
2% DAP	20.3	21.4	0.3	9.9	0.5
20 kg N ha^{-1}	30.3	30.9	0.5	19.4	0.6
20 kg N ha^{-1}+2% DAP	32.7	33.5	0.7	25.5	0.7
40 kg N ha^{-1}	34.6	36.2	2.1	34.0	0.6
40 kg N ha^{-1}+2% DAP	30.9	32.1	2.2	37.2	0.7
60 kg N ha^{-1}	35.2	36.7	2.5	43.3	0.8
60 kg N ha^{-1}+2% DAP	37.4	38.5	2.9	37.6	0.9
80 kg N ha^{-1}	42.0	44.2	2.8	68.8	0.8
80 kg N ha^{-1}+2% DAP	37.5	38.6	3.1	60.6	0.9
SEm±	3.02	1.86	0.11	3.71	0.08
CD (p=0.05)	9.06	5.55	0.30	11.14	0.24

Table 2: Effect of treatments on yield components and yield of toria grown as *utera* crop in rice-toria cropping system						
Treatment	Number of siliqua plant^{-1}	Number of seeds siliqua^{-1}	1000 seed weight (g)	Seed yield (kg ha^{-1})	Straw yield (kg ha^{-1})	Harvest Index (%)
Control (no fertilizer)	2.1	7.5	2.2	69.0	250	21.6
2% DAP	4.3	7.0	2.3	89.0	300	22.9
20 kg N ha^{-1}	10.4	10.4	2.1	149	480	23.7
20 kg N ha^{-1}+2% DAP	12.5	16.0	2.2	267	1270	17.4
40 kg N ha^{-1}	13.0	15.0	2.0	308	1510	16.9
40 kg N ha^{-1}+2% DAP	21.0	16.1	1.9	364	1530	19.2
60 kg N ha^{-1}	17.5	11.1	1.8	335	1490	18.4
60 kg N ha^{-1}+2%DAP	15.0	11.2	2.0	343	1550	18.1
80 kg N ha^{-1}	19.0	10.0	1.9	339	1520	18.2
80 kg N ha^{-1}+2% DAP	18.0	12.2	1.8	340	1540	18.1
SEm±	1.66	1.03	0.03	3.5	10.9	-
CD (p=0.05)	4.96	3.09	NS	10.4	32.7	-

yield decreased significantly with 60 kg N ha^{-1} which was statistically at par with all other higher levels of nitrogen. The highest seed yield was recorded in the treatment 40 kg N ha^{-1}+2% DAP. This was 6.12, 7.05, 7.37, 8.65 and 18.18 % higher over that of 60 kg N ha^{-1}+2% DAP at Pre-flowering stage, 80 kg N+2% DAP, 80 kg N alone, 60 kg N ha^{-1} alone and 40 kg N ha^{-1} alone respectively. The highest yield advantage (79.19%) was noticed with 2% DAP spray applied with 20 kg N ha^{-1} as compared to without DAP and it was 18.18% when applied with 40 kg N ha^{-1}. Higher seed yield with 40 kg N ha^{-1}+2% DAP might be due to more number of seeds siliqua^{-1}. Similar results were reported by Mohan and Sharma (1992) and Buttar and Aulakh (1999). Highest straw yield was obtained from the application of 60 kg N ha^{-1}+2% DAP and was statistically at par with the application of 80 kg N ha^{-1}+2% DAP, 40 kg N ha^{-1}+2% DAP and 80 kg N ha^{-1} alone. However, the highest harvest index was recorded in 20 kg N ha^{-1} alone. The foliar spray of DAP when applied in combination with nitrogen level reduced the harvest index in all the cases except when applied with 40 kg N ha^{-1}.

3.4. Economics

Highest cost of cultivation was incurred in the treatment 80 kg N ha^{-1}+2% DAP at Pre-flowering stage due to obvious reason of higher quantity of fertilizer used and thereby higher cost involved in the treatment. But the gross and net returns were highest from the treatment with application of 40 kg N ha^{-1}+2% DAP, followed by 60 kg N ha^{-1}+2% DAP. The application of

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40 kg N ha^{-1}+2% DAP also recorded the highest benefit:cost ratio, followed by 40 kg N ha^{-1} alone. Negative net returns and thereby negative benefit:cost ratio were computed from the treatments having no fertiliser, 2% DAP and 20 kg N ha^{-1} alone (Table 3).

Table 3: Effect of treatments on economics of toria grown as utera crop in rice-toria system

A	B	C	D	E
Control (no fertilizer)	3005	1392	-1613	-0.54
2% DAP	3183	1782	-1401	-0.44
20 kg N ha^{-1}	3357	2970	-387	-0.12
20 kg N ha^{-1}+2% DAP	3535	5568	2033	0.58
40 kg N ha^{-1}	3760	6450	2690	0.72
40 kg N ha^{-1}+2% DAP	3938	7470	3532	0.90
60 kg N ha^{-1}	4063	6924	2861	0.70
60 kg N ha^{-1}+2% DAP	4241	7104	2863	0.68
80 kg N ha^{-1}	4665	7014	2349	0.50
80 kg N ha^{-1}+2% DAP	4793	7044	2251	0.47

A= Treatment; B= Cost of cultivation (₹); C= Gross return (₹); D= Net return (₹); E= Benefit: cost ratio; Market Price: Seed: ₹ 2500 q^{-1}; straw: ₹ 20 q^{-1}

4. Conclusion

From the result, it can be concluded that the yield of toria under *utera* cropping in the lateritic belt of West Bengal increased with the application of 40 kg N ha^{-1}+2 % DAP at Pre-flowering stage. Further increase in fertilizer level above 40 kg ha^{-1} resulted in reduction of seed yield. Application of 40 kg N ha^{-1}+2% DAP significantly produced highest seed yield, gross return, net return and benefit cost ratio of toria grown as *utera* crop in rice-toria cropping system.

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