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RESEARCH PAPER

Residual effect of nitrogen levels and its split application on fodder pearl millet [*Pennisetum glaucum* (L.) R.Br. Emend Stuntz] in arid western Rajasthan

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Abstract : A field experiment was conducted during winter and summer season of 2002-03 and 2003-04 to find out the residual effect of nitrogen levels and its split application on fodder pearl millet [*Pennisetum glaucum* (L.) R.Br. Emend Stuntz] in arid western Rajasthan. Application of nitrogen in preceding mustard crop at 100 kg ha^{-1} increased the fresh weight, dry weight, NPK content and their respective uptake fodder pearlmillet in Ist and IInd cutting as well as total of both cutting. The increased of these parameters marginally varied from 163.89 to 177.73 q h^{-1} for fresh weight, 24.59 to 28.60 q ha^{-1} for dry weight, 27.79 to 32.88 kg ha^{-1} for N uptake, 4.67 to 5.60 kg ha^{-1} for K uptake by pearlmillet. However, results indicate that effect of nitrogen levels as well as splitting application was non-significant on succeeding crop pearlmillet. Whereas, 100 kg N ha^{-1} recorded significantly higher net returns (Rs. 31636 ha^{-1}) and higher B:C ratio (2.01). Further application of nitrogen in three equal splits (1/3 as basal + 1/3 at Ist irrigation + 1/3 at IInd irrigation) gave significantly higher net returns (Rs. 6806 and 32217 ha^{-1}) and B:C ratio (1.25 and 2.06), respectively, in fodder pearl millet and pearl millet with mustard over other split and basal applications of nitrogen.

Key Words : Fodder pearl millet, Growth, Nitrogen, Residual effect, Split application

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INTRODUCTION

Pearl millet [*Pennisetum glaucum* (L.) R.Br. Emend Stuntz] is a multipurpose cereal grown for grain, stover and green fodder. It shall continue to play a prominent role in the integrated agricultural and livestock economy of the country particularly in rainfed areas due to its drought hardiness and tolerance to high temperature. Pearlmillet provides an excellent nutritious food because of high biological value, more protein (11.6%), fat (5%) and mineral content (2.3%). It also contains adequate amount of essential amino acids such as tryptophane, threonine, agrinine and lysine. The chemical fertilizers are quit expensive and the small and marginal farmers are unable to use these fertilizers in required quantities in the moisture deficit areas. Nitrogen is one of the basic plant nutrients essential for profuse growth. It increases vegetative growth of plant and herbage quality which is highly desirable for the forage yield and dry matter accumulation (Kumar *et al*., 1997). Nitrogen is an indispensable element for optimum functioning of the crop and generally nitrogen fertilizer account for about half of the cost of cultivation for most of the crops. Application of nitrogen at various times may be an important factor which can be used for exploitation the yield potential as well as nitrogen use efficiency.

Today, intensive cropping system aims at full realization of residual effects of applied fertilizer which not only results in fertilizer economy but also leads to efficient crop production. In irrigated situations, it is an accepted practice of the farmers

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of Rajasthan to grow mustard during winter followed by fodder pearlmillet in summer, which efficiently utilizes farm resources and residual fertility of the soil in augmenting the green fodder productivity during dry months before the onset of monsoon. High price index of fertilizers coupled with their limited production made it imperative that a part of nitrogen may come from recycling of biological nitrogen fixation. Hence, a study was carried out for suitable doses and its application time on mustard and their residual effect on fodder pearl millet.

MATERIAL AND METHODS

The experiment was conducted at College of Agriculture, Bikaner during winter and summer season of 2002-03 and 2003-04. The soil was loamy sand and low in organic matter. The soil pH was 8.2. It was low in organic carbon (0.09 %), available nitrogen (113.13 kg ha^{-1}) and available phosphorus (12.01 kg ha^{-1}) and medium in potassium (200.04 kg ha^{-1}). The treatments comprised of five levels of nitrogen (40, 60, 80, 100 and 120 kg N ha^{-1}) as main plot treatments and five split applications of nitrogen (100 per cent basal, 1/2 at basal + 1/2 at Ist irrigation, 1/3 as basal + 1/3 at Ist irrigation + 1/3 at IInd irrigation, 1/2 at basal + 1/4 at Ist irrigation + 1/4 at IInd irrigation and DAP basal + 1/2 of rest at Ist irrigation + 1/2 of rest at IInd irrigation) as sub pot treatment and were laid out in split plot design with three replications in preceding mustard crop. Nitrogen as per treatments was applied through urea after adjusting the nitrogen (13.7 kg N) supplied through DAP (applied for 35 kg P_2O_5 ha^{-1} as common application through DAP because DAP basal + 1/2 of rest at Ist irrigation + 1/2 of rest at IInd irrigation is the farmers practice). 40 kg/ha K applied through MOP. The calculated quantity of urea for different treatments was applied basal and remaining nitrogen was given at Ist and IInd irrigation as per treatments 30 and 60 days after sowing of mustard, respectively. Indian mustard variety Bio –902 (Pusa Jaikisan) was sown at 30 cm row spacing using 4 kg seed ha^{-1} on 29th and 27th October in 2002 and 2003, respectively. For assessing the residual effect of nitrogen applied at different stages in different splits, fodder pearl millet variety, RCB – 2 was raised on the experimental field in subsequent seasons with same lay out as practiced in the main crop without any fertilizer application.

RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Effect on growth and nutrient status :

The fresh weight, dry weight, NPK content and their respective uptake fodder pearlmillet in Ist and IInd cutting as

Table 1: Residual effect of nitrogen levels and their split application on fresh weight, dry weight and economics of fodder pearl millet

Treatments	Fresh weight (q ha^{-1})			Dry weight (q ha^{-1})			Net return (Rs ha^{-1})		B:C Ratio	
	First cutting	Second cutting	Total	First cutting	Second cutting	Total	pearl millet	Mustard & Fodder	pearl millet	Mustard & Fodder
Nitrogen levels (kg ha^{-1})										
N_{40}	91.04	72.77	163.89	12.26	12.33	24.59	6016	22048	1.10	1.46
N_{60}	94.71	74.67	169.39	13.25	13.13	26.39	6406	27137	1.18	1.77
N_{80}	96.96	76.08	173.05	13.96	13.69	27.66	6662	29867	1.22	1.92
N_{100}	98.44	77.28	175.74	14.39	14.01	28.41	6851	31636	1.26	2.01
N_{120}	99.39	78.39	177.73	14.47	14.12	28.60	6990	32374	1.28	2.03
S.E.±	2.463	2.183	7.390	0.552	0.429	1.087	272.42	509.23	0.046	0.031
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	1526.69	NS	0.095
Split application of N										
Basal 100 %	92.16	73.59	165.75	13.14	13.09	26.24	6152	25193	1.13	1.63
1/2 Basal + 1/2 at Ist irrigation	95.04	75.21	170.26	13.44	13.20	26.65	6467	28350	1.19	1.83
1/3 Basal + 1/3 at Ist irrigation + 1/3 at IInd irrigation	98.20	76.89	175.10	13.89	13.65	27.55	6806	32217	1.25	2.06
1/2 Basal + 1/4 at Ist irrigation + 1/4 at IInd irrigation	96.38	76.44	172.76	13.74	13.62	27.37	6642	31163	1.22	2.00
DAP basal^1 + 1/2 of rest^2 at Ist irrigation + 1/2 of rest at IInd irrigation	98.76	77.07	175.84	14.11	13.72	27.84	6858	26140	1.26	1.68
S.E.±	1.749	1.468	4.232	0.324	0.308	0.653	180.58	465.04	0.028	0.029
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	508.23	1308.80	0.079	0.083

Ist irrigation at 30 and IInd irrigation at 60 days after sowing NS=Non-significant

^{1} = 13.7 kg N ha^{-1} through DAP, ^{2} = Nitrogen remaining after adjustment of 13.7 kg N ha^{-1}

Table 2 : Residual effect of nitrogen levels and their split application on NPK contents at first and second cutting of fodder pearlmillet

Treatments	Nitrogen content (%)		Phosphorus content (%)		Potassium content (%)	
	First cutting	Second cutting	First cutting	Second cutting	First cutting	Second cutting
Nitrogen levels (kg ha^{-1})						
N_{40}	1.193	1.066	0.186	0.193	0.728	0.702
N_{60}	1.199	1.074	0.189	0.195	0.732	0.706
N_{80}	1.203	1.082	0.190	0.197	0.734	0.710
N_{100}	1.206	1.087	0.192	0.198	0.736	0.713
N_{120}	1.207	1.090	0.192	0.199	0.737	0.714
S.E. ±	0.0051	0.0069	0.0014	0.0015	0.0033	0.0035
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS
Split application of N						
Basal 100 %	1.194	1.071	0.188	0.196	0.730	0.704
1/2 Basal + 1/2 at Ist irrigation	1.198	1.078	0.190	0.196	0.732	0.707
1/3 Basal + 1/3 at Ist irrigation + 1/3 at IInd irrigation	1.207	1.082	0.191	0.197	0.735	0.712
1/2 Basal + 1/4 at Ist irrigation + 1/4 at IInd irrigation	1.201	1.082	0.190	0.197	0.734	0.709
DAP basal[1] + 1/2 of rest[2] at Ist irrigation + 1/2 of rest at IInd irrigation	1.208	1.084	0.192	0.197	0.736	0.715
S.E. ±	0.0043	0.0049	0.0014	0.0013	0.0031	0.0035
CD (P = 0.05)	NS	NS	NS	NS	NS	NS

Ist irrigation at 30 and IInd irrigation at 60 days after sowing NS=Non-significant

[1] = 13.7 kg N ha^{-1} through DAP, [2] = Nitrogen remaining after adjustment of 13.7 kg N ha^{-1}

Table 3: Residual effect of nitrogen levels and their split application on nitrogen, phosphorus and potassium uptake of fodder pearlmillet

Treatments	Nitrogen uptake (kg ha^{-1})			Phosphorus uptake (kg ha^{-1})			Potassium uptake (kg ha^{-1})		
	First cutting	Second cutting	Total	First cutting	Second cutting	Total	First cutting	Second cutting	Total
Nitrogen levels (kg ha^{-1})									
N_{40}	14.64	13.15	27.79	2.29	2.38	4.67	8.93	8.65	17.58
N_{60}	15.91	14.11	30.02	2.51	2.56	5.07	9.70	9.28	18.98
N_{80}	16.81	14.81	31.63	2.66	2.70	5.36	10.26	9.73	19.99
N_{100}	17.37	15.23	32.61	2.76	2.77	5.54	10.60	10.00	20.60
N_{120}	17.48	15.39	32.88	2.79	2.81	5.60	10.67	10.09	20.77
S.E.±	0.529	0.537	1.150	0.089	0.101	0.224	0.420	0.386	0.816
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Split application of N									
Basal 100 %	15.71	14.04	29.75	2.47	2.56	5.04	9.59	9.22	18.81
1/2 Basal + 1/2 at Ist irrigation	16.13	14.24	30.37	2.55	2.59	5.15	9.85	9.33	19.18
1/3 Basal + 1/3 at Ist irrigation + 1/3 at IInd irrigation	16.79	14.79	31.58	2.66	2.69	5.35	10.22	9.72	19.94
1/2 Basal + 1/4 at Ist irrigation + 1/4 at IInd irrigation	16.52	14.75	31.27	2.62	2.68	5.30	10.10	9.67	19.77
DAP basal[1] + 1/2 of rest[2] at Ist irrigation + 1/2 of rest at IInd irrigation	17.07	14.89	31.96	2.71	2.70	5.42	10.40	9.81	20.21
S.E.±	0.427	0.338	0.678	0.062	0.062	0.134	0.258	0.242	0.497
C.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Ist irrigation at 30 and IInd irrigation at 60 days after sowing NS=Non-significant

[1] = 13.7 kg N ha^{-1} through DAP, [2] = Nitrogen remaining after adjustment of 13.7 kg N ha^{-1}

well as total of both cutting increased with the increasing levels of nitrogen from 40 to 120 kg ha^{-1} and their split application (Table 1, 2 and 3). The increase of these parameters marginally varied from 163.89 to 177.73 q h^{-1} for fresh weight, 24.59 to 28.60 q ha^{-1} for dry weight, 27.79 to 32.88 kg ha^{-1} for N uptake, 4.67 to 5.60 kg ha^{-1} for K uptake by pearlmillet. However, results indicate that effect of application of nitrogen to mustard on growth and yield of succeeding fodder pearlmillet was non-significant. Further, examination of data in Table1,2 and 3 reveals that nitrogen application in different splits to preceding mustard crop had not any significant variation in fresh weight, dry weight, NPK content, NPK uptake of fodder pearlmillet in I^{st} and II^{nd} cutting as well as total of both cutting during both the experimental years and in pooled mean over years.

It has been an established fact that efficiency of N use by most of the crops ranges from 20-60 per cent and commonly average around 50 per cent (Aulakh *et al.*, 1992). Low recovery of applied nitrogen by crops raises question of the fat of the fertilizer N that is not absorbed by the crops. The unaccountable N might get an explanation in the well-established phenomenon that is a continuous exchange of N from available to unavailable (fixed) pool and *vice-versa*. Besides, the transformation from the unavailable capacity factor to available intensity factor will be more if there will be dearth and higher demand for available N in the rhizosphere. On the other hand, if the available N in soil is in excess of the crop need, the transformation of N to its unavailable form will be more (Russel, 1963). This can be attributed to the beneficial influence of fertilizer N on root ramification which caused more exploitation of soil N by mustard in addition to the so called priming effect or added nitrogen interaction effect Jenkinson *et al.* (1985). Similar findings were also reported by Prasad Babu and Sarkar (2002), Sachdev (1988) and Kumar *et al.* (2000).

Effect on economics :

Results indicate that application of nitrogen in preceding crop mustard from 40 to 120 kg ha^{-1} increased the net returns and B:C ratio of pearlmillet with mustard and 100 kg N ha^{-1} recorded significantly higher net returns (Rs. 31636 ha^{-1}) and higher B:C ratio (2.01) (Table 1). This might be due to increase in seed yield in diminishing manner under the increasing levels of nitrogen. These results corroborate the findings of Bali *et al.* (2000). However, the application of nitrogen in three equal splits (1/3 as basal + 1/3 at I^{st} irrigation + 1/3 at II^{nd} irrigation) gave significantly higher net returns (Rs. 6806 and 32217 ha^{-1}) and B:C ratio (1.25 and 2.06), respectively, in fodder pearl millet and pearl millet with mustard over other split and basal applications of nitrogen. This was probably due to significantly higher yield of fodder pearl millet and mustard in three split applications (1/3 as basal + 1/3 at I^{st} irrigation + 1/3 at II^{nd} irrigation) which is supposed to be the main contributors to net returns and B: C ratio. Similar findings were also reported by Balasubramaniyan (1996) and Sidlauskas (2000).

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