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RESPONSE OF WHITE RAGI VARIETIES TO NITROGEN UNDER RAINFED SITUATION IN VERTISOLS OF ANDHRA PRADESH

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ABSTRACT

A field experiment was carried out during kharif season of 2012 and 2013 at Regional Agricultural Research Station, Nandyal (A.P) to assess the performance of white ragi varieties in relation to nitrogen levels under rainfed conditions. The experiment was laid out in randomized block design with three replications. The treatments consisted of three white ragi varieties viz., KMR 415, VRW 936, Srichaitanya and four nitrogen levels (20, 40, 60 and 80 kg ha^{-1}) were tested in factorial randomized block design with three replication. Results indicated that significantly higher plant height, yield attributes and grain yield were recorded with Srichaitanya (2.391 and 2.351t ha^{-1}) followed by VRW 936 (2.156 and 2.191t ha^{-1}) and KMR 415(1.444 and 1.690 t ha^{-1}). Application of 80 kg N ha^{-1} to white ragi varieties produced taller plants and highest yield attributes and grain (2.542 and 2.291 t ha^{-1}) and straw (2.417 and 2.224 t ha^{-1}) yields, net returns and B:C ratio (2.84). However, the response was significant up to 60 kg N ha^{-1} (grain yield of 2.201 and 2.178 t ha^{-1} and straw yield of 1.984 and 1.930 t ha^{-1}) during both the years.The maximum gross return, net return and B:C ratio were recorded under Srichaitanay and lowest in KMR 415. The maximum net returns (₹. 42616 ha$^{-1)}$ and B:C ratio (2.84) were recorded with 80 kg N ha^{-1}.

Key words: Finger millet, Genotype, Nitrogen, Yield

INTRODUCTION

Small millets comprising of finger millet, barnyard millet, foxtail millet, proso millet, kodo millet and little millet are referred to as 'Nutricereals' and are used for food, feed and forage all over the world. Among small millets, finger millet is one of the most nutritious crops, with high levels of methionine, an essential amino acid lacking in diets of millions of the poor living on starchy foods (Wanyera 2007), and high content of important minerals, such as calcium and iron. The crop is adapted to a wide range of environments and can be grown in a variety of soils with medium or low water holding capacity and is an important crop in drought-prone regions because of its outstanding ability to withstand adverse weather conditions. In India, finger millet accounts for 60% of area and 75% of total small millet production (Kumar *et al.*, 2007) and is grown on 1.27 million hectares with an annual production of 1.89 million tons (FAI, 2011). Thus, improving productivity of finger millet can contribute significantly to the food and nutrition security of a major portion of poor and deprived people living in drought-prone regions of India. Finger millet is considered as high nitrogen efficient crop especially under marginal and submarginal conditions of soil fertility and limited moisture (Seetharam *et al.*, 1986) and is locally called as ragi in Rayalaseema region of Andhra Pradesh and generally brown varieties are being cultivated in the region. However, White ragi varieties Generally farmers grow brown varieties, however, white ragi varieties have good industrial value as they contain higher content of protein (12.3 mg100mg^{-1}) and iron (12.0 mg 100mg^{-1}) compared to brown varieties and average calcium content (329 mg %) in white varieties was considerably higher than the brown (296 mg%) varieties (Seetharam 2001). Research studies indicated that there was good response of fingermillet to nitrogen even under rainfed condition as nitrogen availability is the key limiting factor in crop production (Shukla *et al.*, 2004). Keeping all these points in view, the present study is taken up with an objective to find suitable variety of white ragi and response of white ragi varieties to nitrogen levels in vertisols under rainfed condition.

MATERIALS AND METHODS

The field experiment was conducted during *Kharif season* of 2012 and 2013 at Regional Agricultural Research Station, Nandyal, Kurnool (Andhra Pradesh) on deep clay soil with pH 8.0, organic carbon 5.6 g kg^{-1}, available N 191, P 20 and K 498 kg ha^{-1}. The experiment was laid out in factorial randomized block design with three replications. The treatments consisted of three white ragi varieties *viz.*, KMR 415, VRW 93, Srichaitanya and four nitrogen levels *viz.*, 20, 40, 60 kg and 80 kg N ha^{-1}. The crop was sown at a spacing of 30 cm x 10 cm. The gross and net plot sizes were 3 m x 4.5 m and 2.4 m x 4.2m, respectively. The crop was sown

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on July, 20 and July, 14 during 2012 and 2013, respectively. Half quantity of nitrogen was applied through urea as per treatment and 20 kg P_2O_5 and 20 kg K_2O ha^{-1} was applied through single superphosphate and muriate of potash as basal dose, remaining half quantity of nitrogen was applied one month after sowing. Need based plant protection measures and standard package of practices were taken up during the crop growth period. SPAD readings were measured by using the chlorophyll meter (SPAD 502). Readings were taken on one side of the midrib of the leaf blade, midway between the leaf base and tip of the youngest fully expanded leaf of a plant. A mean of 15 readings per plot was taken as the measured SPAD value. A rainfall of 763.4 mm and 731.5 mm was received during crop growth in 2012 and 2013, respectively. All data were analyzed statistically following the standard procedures as described by Gomez and Gomez (1984). Growth, yield attributes and yields were recorded at maturity. Economics of various treatments was computed on the basis of prevailing market price of inputs and produce.

RESULTS AND DISCUSSION

Plant height

The plant height at harvest during both the years of study did not vary significantly due to varieties. However, across the years, it was found that application of 80 kg N ha^{-1} resulted in significantly higher plant height (113 and 120 cm during 2012 and 2013 respectively) as compared to 20 and 40 kg N ha^{-1} but was statistically on par with 60 kg N ha^{-1} (118 and 116 cm during 2012 and 2013, respectively). Moreover, plant height recorded with 20, 40 and 60 kg N ha^{-1} was statistically similar (Table.1). The increase in plant height that was observed with increasing rate of nitrogen levels may be due to enhanced rate of translocation of nitrogen from culms to leaves, which lead to improved production of photosynthates. Further, at higher levels of nitrogen, availability of nitrogen is increased and nitrogen, being one of the main constituents of proteins and nucleic acids markedly influences cell division and cell enlargement resulting in increased plant height (Chaturvedi, 2005).

Table 1: Performance of whiteragi varieties under different levels of nitrogen fertilization on plant height (cm), SPAD values, effective tillers $plant^{-1}$ and test weight (g)

Treatment	Plant height (cm)		SPAD values				Effective tillers $plant^{-1}$		Test wt. (g)	
	2012	2013	2012		2013		2012	2013	2012	2013
			55 DAS	65 DAS	55 DAS	65 DAS				
Varieties										
KMR 415	108	110.9	32.8	27.4	30.7	28.2	2.5	2.6	2.8	2.9
VRW 936	111	111.6	34.6	33.0	33.4	31.5	2.8	2.7	3.0	3.0
Srichaitanya	111	114.3	35.4	29.9	34.7	26.4	3.0	3.0	3.2	3.2
SEm±	1.2	1.4	0.6	0.42	0.68	0.58	0.14	0.05	0.34	0.30
CD (p=0.05)	NS	NS	1.8	1.2	2.0	1.8	0.4	0.15	1.1	0.9
Nitrogen (kg ha^{-1})										
20	100	101	31.9	29.1	30.8	27.7	2.3	2.5	2.5	2.7
40	112	111	34.2	28.4	32.3	26.5	2.4	2.7	2.8	2.9
60	118	116	35.5	30.9	34.2	30.0	3.1	3.0	3.1	3.1
80	113	120	35.5	31.9	34.3	30.5	3.2	2.9	3.3	3.1
SEm±	3.4	4.9	0.9	0.8	0.9	0.7	0.2	0.07	0.34	0.30
CD (p=0.05)	11	15	2.7	2.4	2.7	2.1	0.6	0.21	1.1	0.9

SPAD values

Leaf chlorophyll concentration estimated through SPAD meter gives a relative assessment of nitrogen status of the crop. During both the years of experimentation, SPAD values decreased from 55 to 65 DAS and with in each year, varied among varieties and due to nitrogen fertilization levels. Among the varieties, higher SPAD chlorophyll meter readings were recorded with white ragi VRW 936 (32.5) at 65 DAS indicating prolonged greenness of the leaves. Also, application of 80 kg N ha^{-1} resulted in higher SPAD values as compared to 20, 40 kg N ha^{-1} but similar with 60 kg N ha^{-1}.

Yield attributes

In both the years of investigation, the number of effective tillers $plant^{-1}$ and test weight recorded with Srichaitanya was significantly superior as compared to KMR415 but was statistically on par with VRW 936. Increased levels of nitrogen from 20 to 40, 60 and 80 kg N ha^{-1} resulted in increased number of effective tillers $plant^{-1}$ and test weight. Application of 80 kg N ha^{-1} recorded significantly more number of effective tillers plant^{-1} as compared to 20 and 40 kg N ha^{-1} but was statistically similar with 60 kg N ha^{-1} and the same trend was noticed with test weight also. This might be due to enhanced translocation of nutrients at higher levels of nitrogen, resulting in of more effective tillers plant^{-1}. Moreover, nitrogen helps in improving growth and leaf area consequently resulting in more interception of light that aids in increased total photosynthesis and ultimately grain and straw yields (Chopra and Chopra, 2004).

Table 2: Performance of whiteragi varieties under different levels of nitrogen fertilization on grain and straw yields, harvest Index cost of cultivation, gross & net returns and B:C ratio

Treatment	Grain yield (t ha^{-1})		Straw yield (t ha^{-1})		HI (%)	Cost of cultivation (ha^{-1})	Gross returns (₹. ha^{-1})	Net returns (₹.ha^{-1})	B:C ratio
	2012	2013	2012	2013					
Varieties									
KMR 415	1.444	1.690	1.507	1.651	48.9	13000	32823	19823	1.52
VRW 936	2.156	2.191	2.117	2.152	50.5	13000	48914	35914	2.76
Srichaitanya	2.391	2.351	2.449	2.308	49.4	13000	54316	41316	3.18
SEm±	0.129	0.082	0.108	0.091					
CD (p=0.05)	0.380	0.242	0.324	0.273					
Nitrogen (kgha^{-1})									
20	1.246	1.864	1.355	1.818	47.9	13000	28361	15361	1.18
40	1.991	1.977	1.984	1.930	50.1	13700	45191	31491	2.30
60	2.201	2.178	2.190	2.129	50.1	13900	49955	36055	2.59
80	2.542	2.291	2.417	2.240	51.3	15000	57616	42616	2.84
SEm±	0.149	0.095	0.124	0.102					
CD (p=0.05)	0.439	0.280	0.372	0.306					

Grain and straw yields

Srichaitanya variety recorded significantly higher grain yield (2.391 and 2.351 t ha^{-1} during 2012 and 2013 respectively) as compared to KMR 415 (1.444 and 1.690 t ha^{-1}) but was statistically on par with VRW 936 yield (2.156 and 2.191 t ha^{-1}). Higher grain yield of Srichaitanya was attributed to more number of effective tillers plant^{-1} (3.0) and test weight (3.2 g) as compared to KMR 415 (2.5 and 2.8 g, effective tillers plant^{-1} and test weight respectively). Significantly higher grain yield (2.542 and 2.291 t ha^{-1} during 2012 and 2013 respectively) was recorded with 80 kg N ha^{-1} over 20 and 40 kg N ha^{-1} but was found to be statistically on par with 60 kg N ha^{-1} (2.201 and 2.178 t ha^{-1}). Similar findings were reported by Nigade *et al.* (2011).

Similarly, across the years of study, significantly higher straw yield was realised with Srichaitanya variety (2.449 and 2.308 t ha^{-1} during 2012 and 2013 respectively) as compared to KMR 415 (1.507 and 1.651 t ha^{-1}) but was statistically on par with VRW 936 yield (2.117 and 2.152 t ha^{-1}). Further, application of 80 kg N ha^{-1} resulted in significantly higher straw yield (2.417 and 2.240 t ha^{-1}) as compared to 20 and 40 kg N ha^{-1} but was statistically at par with 60 kg N ha^{-1} (2.190 and 2.129 t ha^{-1}). Similar results were reported by Rashmi *et al.* (2010) and Reddy *et al.* (2004) who reported that application of 60 kg N ha^{-1} resulted in significantly higher grain and straw yields. This might be due to increase in nitrate reductase and glutamine synthetase with increasing nitrogen level. Higher nitrate reductase activity indicated that more nitrogen is incorporated into protein and the plant with more nitrogen uptake has higher concentration of protein (Sharma and Ruchi, 2005).

Harvest Index (HI) and Economics

Higher HI was recorded in VRW 936 (50.5%) followed by Srichaitanya (49.4%) and KMR415 (48.9%). The varietal differences in HI are associated with their variable grain straw ratio (Table.1). Increased level of nitrogen from 20, 40, 60 and 80 kg N ha^{-1} resulted in increased HI *i.e* 47.9, 50.0, 50.1 and 51.3% (Table 2). With increase in nitrogen rate, the relative increase in grain yield over straw yield resulted in higher HI. Thus, the data suggested that optimum nitrogen nutrition is essential for effective translocation of photosynthates from source to sink. The higher net returns (₹ 41,316 ha^{-1}) and B:C ratio (3.18) was realized with variety Srichaitanya as compared to other varieties. Maximum net returns (₹. 42,616 ha^{-1}) were obtained with 80 kg N ha^{-1} ha compared to reduced nitrogen levels. Based on the above results, it can be inferred that the farming community can be benefitted by growing white ragi variety Srichaitanya with 60 kg N ha^{-1} in terms of higher yield and profits in Vertisols under rainfed situation.

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