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EFFECT OF MULCHING AND BORON APPLICATION ON GROWTH, PRODUCTIVITY AND WATER USE OF WINTER NIGER UNDER RED-LATERITIC BELT OF WEST BENGAL

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ABSTRACT

A field experiment was conducted at Agriculture Farm, Visva-Bharati, West Bengal, India($23^0 39^{/}$N latitude and $87^0 42^{/}$E longitude and average altitude of 58.9m MSL) during winter (rabi) season of 2010-11 and 2011-12 to investigate the effect of mulching and boron on the growth, yield and water use of rainfed Niger [Guizotia abyssinica (L.f.) Cass]. The design of the experiment was Split-plot with three replications. Four levels of mulching (no mulching, soil dusting, straw mulching @ 2 t/ha and 7 t/ha) were alloted in the main plots and three levels of 0.2% borax spraying viz. control, at branching only, branching and flowering stages were allocated randomly in the sub-plots. The recommended dose of NPK was 50 kg kg/ha N, 25 kg/ha P_2O_5 and 25 kg/ha K_2O respectively applied as basal. Results showed a significant influence of mulching and boron on growth, yield vis-a-vis water use of winter niger under purely rainfed situation. The highest plant height, dry matter accumulation, leaf area index, crop growth rate, seed yield and stick yield were documented with the application of straw mulching @ 7 t/ha as well as boron spraying @ 0.2% borax at branching and flowering stages. No mulched plots unable to conserve sufficient moisture to grow satisfactory crop and hence recorded the lowest results. Maximum consumptive use and minimum consumptive use efficiency were noticed under no mulching treatment whereas spraying of boron @ 0.2% borax at both the stages recorded higher water use and water use efficiency as comparison to other treatments.

Key words: Mulching, Boron, Niger, growth, yield and water use.

I. INTRODUCTION

Agriculture forms the backbone of the Indian economy, in which rainfed farming has a distinct place, occupying more than 60% of the cultivated area, contributing 44% of the food grains and supporting 40% of the population. Being an agriculture country India should have a good respect towards conservation strategies especially of water. Everyday soil moisture is also lost in various ways by evaporation from the soil, through deep percolation below the root zone, transpiration by sprouting weeds and so on. So, conserving soil moisture is a great and most important deal now a day especially through agricultural aspects. Soil moisture conservation by mulching is one of the most significant practices in rainfed agriculture. Mulching not only checks evaporation but it also reduces the soil degradation through reducing the runoff and soil loss and minimizes the weed infestation. It increases soil water retention capacity and controls soil temperature fluctuations. Mulching adds nutrients to the soil and improves the physical, chemical and biological properties of soil resulted in increase in growth and yield of crops. Under rainfed situation, mulching increased yield by 50-60 % over without mulched treatment (Patil *et al*., 2013). Straw mulching usually decreases the daytime soil temperature and retains the heat during night and thus help in increasing residual soil moisture (Bragagnolo and Mielniczuk, 1990).

India holds a major position in the global oilseed scenario where more than 76% of the oilseeds area is under rainfed condition. Oilseed crops need balanced nutrition for higher seed as well as oil yield. Great efforts are needed to increase the oilseeds production to meet up the increasing demand of oil (Hegde, 2009). Niger, one of such important oilseed crop with high oil content 35-40 %, has a great contribution in the national economy of India. It is an essential crop under poor soils of coarse texture. Niger cultivation under rainfed condition with some soil conservation measures like mulching and application of micronutrient like boron provides an immense effect on its growth and productivity. Boron nutrition is not only increases the yield of oil seed crops but also improves the quality of crops. Hence, an experiment was conducted to study the effect of mulching and boron on growth and productivity of winter niger under red and lateritic belt of West Bengal, India.

II. MATERIALS AND METHODS

The field experiment was conducted during two consecutive winter season of 2010-2011 and 2011-12 at the Agriculture Farm, Palli Siksha Bhavana (Institute of Agriculture), Visva-Bharati, Sriniketan, West Bengal. The location of the farm is $23^{0}39^{/}$ North latitude and $87^{0}42^{/}$ East longitude with altitude of 58.9m above MSL. The Agricultural Farm is situated at the heart of the sub-humid, subtropical belt in the Western part of West Bengal, having loamy sand soil (pH 5.8, Organic carbon 0.36%, Available N, P_2O_5 and K_2O are 225.6, 38.5 and 143.8 kg/ha respectively). Birsa Niger-1 variety was used in the experiment and sown at 30 cm row to row distance. The experiment was laid out in Split Plot Design (SPD) having three replications consisting of four levels of mulching allotted in the main-plot and three levels of boron were allocated randomly in the sub-plots. The main-plot treatments were- M_0 : without mulching (control plot), M_1 : Soil dust mulching made with hand hoe in between rows at 15 days interval after seed germination, M_2 : Dry straw mulching done by spreading rice straw of 2t/ha on seeded rows just after sowing, M_3 : Dry straw mulching done by spreading rice straw of 7t/ha in between rows just after sowing and the sub-plot treatments are; B_0 : without boron application, B_1 : Application of borax @ 0.2% at branching time, B_2 : Application of borax @ 0.2% at branching and flowering stages. There were 12-treatment combinations and three replications giving a total of thirty-six unit plots each measuring 4m x 3m. Plant height, dry matter accumulation, leaf area index (LAI) and crop growth rate were (CGR) estimated during the crop growth stages. Seed and stick yields and were measured. Harvest index (HI), consumptive use (CU) and consumptive use efficiency (CUE) were also worked out by using standard formulae. Finally collected data were statistically analyzed as per procedures. The crop received 37.4 and 12.2mm rainfall effectively during 2010-11 and 2011-12 respectively.

III. RESULTS AND DISCUSSIONS

Growth parameters

From the experimental findings it is quite evident that mulching significantly influenced growth parameters of winter niger such as plant height, dry matter accumulation, leaf area index and dry matter production (Table 1 & 2). Plant height, dry matter accumulation, leaf area index was significantly higher under straw mulching @7t/ ha during the growth period of the niger except 30DAS during 2011-12(Table 1 & 2) than that of other mulching treatments. Crop growth rate was also found maximum with the straw mulching @7t/ ha though the effect was found not significant except 30-45 DAS in 2010-11 and 45-60DAS in 2011-12. Application of straw mulching improved conserve soil moisture which was supplemented by occasional precipitation especially during first year and therefore recorded maximum growth parameters of the crop. Similar results on growth attributes were also observed by Sachen *et al*. (1997) and Yadav *et al*. (2006)

Boron application also influenced the growth attributes markedly (Table 1 & 2). Initial growth of the crop was found unaffected as borax spraying was done at branching and flowering stages. Spraying of borax (0.02%) at branching and flowering stages recorded higher plant height, dry matter production and leaf area index. Though crop growth rate of the crop was found statistically at par boron application twice at branching and flowering stages showed better results as compared to control and borax spraying at branching only. The results on growth attributes were also corroborated with data recorded by Sarkar and Saha (2005) and Nadian *et al*.

Yields

Mulching significantly influenced the seed y and stick yield of the niger. Though mulched plots recorded higher harvest index as compared to control the effect was found not significant (Table.3). The straw mulch @7t/ha performed the best result and it was followed by straw mulch 2t/ha whereas no mulch treatment produced minimum seed and stick yield of niger under the study. Improvement of growth parameters due to straw mulching caused maximum seed and stick yields as well as harvest index of winter niger. Straw mulching produced 18.10, 21.59% higher seed yield over control and 6.22 and 14.92% over soil dust mulching in 2010-11 and 2011-12 respectively. Similar results were also reported by Saren *et al.* (2008).

Application of born as borax 0.02% at branching and flowering stages recorded statistically significant higher seed yield and stick yield of the crop than that of control and single application at braching . Harvest index of crop was also found maximum with two times boron application but the effect was found statistically at par. The results supported by the findings of Moradi-Telavat *et al.* (2008) and Hosaini *et al.* (2009).

Consumptive use and consumptive use efficiency

Consumptive use and consumptive use efficiency of niger crop was also influenced greatly by mulched treatment. Maximum loss of water was recorded under no mulching condition and therefore, consumptive use of water was also found higher than mulched treatment. In other words, application of mulching in the plots reduced evaporation loss of water from the field and the crop completed its growth successfully with conserved soil moisture. Hence, conservation of soil moisture under mulched condition mostly contributed to improve the growth and yield of the crop. Similar results were reported by Chaudhary *et al*. (2003).

Consumptive use efficiency (CUE) of the crop was also influenced by the mulching treatments. It was found that consumptive use efficiency of the crop increased gradually in response to straw mulching with respect to soil dusting and no mulching. Straw mulching @7t/ha and 2t/ha increased consumptive use efficiency by 23.64 and 15.54% over no mulching treatment.

It may be safely opined that on both the experimental years spraying of borax @ 0.2% at branching and flowering stages showed the best result and the next best result was expressed by the crop receiving 0.2% borax spray at branching stage only. Spraying of borax @ 0.2% twice at branching and flowering stages escalated the chlorophyll content of leaves increased the photosynthetic activity of the crop and hence produced maximum yields. Borax 0.2% spraying at branching and flowering stages used the highest quantity of water consumptively though it was in proximity with the results shown by one spraying and control. On the other hand borax spraying (0.2%) twice at branching and flowering stages has shown maximum water use efficiency and it was recorded minimum under control.

From the summarized experimental data it can be concluded that the application of straw mulch along with micronutrient (B) is beneficial to increase the water use efficiency and the yield of the rainfed winter niger under lateritic belt of West Bengal. Lastly, the experiment showed that niger can be one of the remunerative crop under limited irrigation resources, uncertain rainfall and short, mild winter situation with adopting suitable soil moisture conservation technique and micronutrients application.

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Table 1. Effect of mulching and boron spraying on plant height and dry matter accumulation of rain-fed winter niger.

Treatments	Plant height (cm)								Dry matter accumulation (gm^{-2})							
	30DAS		**45DAS**		**60DAS**		**75DAS**		**30DAS**		**45DAS**		**60DAS**		**At harvest**	
Mulching	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**
M_0	27.9	20.2	47.9	35.0	60.8	41.6	64.4	52.0	74.0	67.8	135.6	134.7	223.7	209.3	248.0	223.2
M_1	28.7	20.4	49.6	35.2	60.9	43.5	65.6	54.4	74.1	67.9	141.8	135.1	229.2	213.4	254.1	228.7
M_2	32.3	20.6	55.1	37.2	70.4	44.5	68.0	55.6	74.4	68.3	154.00	136.0	243.4	220.4	269.5	235.7
M_3	32.7	20.8	56.3	38.9	71.3	46.1	71.30	57.6	75.8	70.0	170.50	137.9	262.6	226.0	289.7	242.7
S Em (±)	0.83	0.49	0.80	0.57	2.24	0.51	1.20	0.64	1.23	0.70	2.79	1.50	7.48	1.44	8.53	1.28
C D (P=0.05)	2.04	NS	1.95	1.98	5.50	1.77	4.16	2.21	NS	NS	6.83	NS	18.30	4.98	20.86	4.45
Boron spraying (0.2% borax)																
B_0	29.9	20.4	49.2	36.1	62.7	42.9	65.6	53.6	74.2	68.4	143.7	135.6	230.8	216.0	255.3	229.8
B_1	30.0	20.4	52.0	36.5	65.8	43.8	67.5	54.8	74.0	68.5	148.1	136.0	238.1	217.6	263.6	232.8
B_2	31.4	20.7	55.9	37.1	69.9	45.1	68.8	56.4	75.8	68.6	159.6	136.2	250.8	218.1	277.0	235.1
S Em (±)	0.76	0.39	0.70	0.62	0.96	0.54	0.83	0.68	0.81	0.97	3.77	1.01	5.09	1.41	6.96	0.87
CD (P=0.05)	NS	NS	1.48	1.95	2.03	1.63	2.49	2.04	NS	NS	7.99	NS	10.79	4.25	12.63	2.61

M_0 = without mulching (control plot), **M_1** = Soil dust mulching made with hand hoe in between rows at 15 days after sowing, **M_2** = Dry straw mulching done by spreading rice straw of 2 t/ha in between rows at 15 days after sowing, **M_3** = Dry straw mulching done by spreading rice straw of 7 t/ha in between rows at 15 days after sowing.
B_0 = without boron application, **B_1** = Application of borax @0.2% at branching stage and **B_2** = Application of borax @0.2% at branching and flowering stages.

Table 2. Effect of mulching and boron spraying on leaf area index and crop growth rate of rain-fed winter niger.

Treatments	Leaf area index (LAI)								Crop growth rate ($g/m^2/day$)					
	30DAS		**45DAS**		**60DAS**		**75DAS**		**30 – 45 DAS**		**45 – 60 DAS**		**60DAS – At harvest**	
Mulching	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**
M_0	0.42	0.51	1.41	1.03	1.88	1.54	1.85	1.38	4.10	3.35	5.87	3.72	0.81	1.39
M_1	0.45	0.52	1.43	1.09	1.89	1.63	1.94	1.47	4.51	3.36	5.85	3.91	0.81	1.52
M_2	0.45	0.53	1.48	1.14	2.16	1.64	2.25	1.48	5.28	3.38	5.97	4.22	0.87	1.53
M_3	0.46	0.58	1.49	1.17	2.27	1.67	2.52	1.50	6.31	3.40	6.14	4.39	0.90	1.67
S Em (±)	0.02	0.01	0.02	0.03	0.04	0.02	0.06	0.08	0.20	0.04	0.37	0.08	0.05	0.09
C D (P=0.05)	0.06	0.04	0.06	0.09	0.09	0.06	0.21	0.28	0.48	NS	NS	0.29	NS	NS
Boron spraying (0.2% borax)														
B_0	0.45	0.53	1.43	0.97	1.96	1.58	2.03	1.42	4.63	3.36	5.81	4.02	0.82	1.37
B_1	0.44	0.53	1.44	1.10	2.03	1.64	2.15	1.47	4.94	3.38	5.99	4.08	0.85	1.51
B_2	0.45	0.55	1.49	1.25	2.15	1.65	2.25	1.49	5.59	3.38	6.08	4.10	0.87	1.70
S Em (±)	0.01	0.01	0.01	0.03	0.03	0.013	0.05	0.06	0.248	0.05	0.15	0.09	0.04	0.10
CD(P=0.05)	NS	NS	0.03	0.09	0.07	0.04	0.16	0.19	0.53	NS	NS	NS	NS	NS

Table 3. Effect of mulching and boron spraying on seed yield, stick yield, harvest index, consumptive use and consumptive use efficiency of rainfed winter niger.

Treatments	Seed yield (kg/ha)		Stick yield (kg/ha)		Harvest index (%)		Consumptive use (cm)		Consumptive use efficiency (kg/ha-cm)	
Mulching	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**	**2010-11**	**2011-12**
M_0	484.27	423.8	1605.16	1453.4	17.61	19.37	17.67	16.96	30.11	28.90
M_1	502.87	448.4	1714.29	1556.5	17.81	19.63	17.21	16.52	32.12	30.83
M_2	540.65	485.5	1887.96	1714.6	17.85	20.50	17.07	16.38	34.82	33.42
M_3	571.93	515.3	2057.70	1867.4	17.95	21.11	16.94	16.26	37.08	35.59
S Em (±)	11.00	1.88	43.57	2.78	0.17	0.052	-	-	-	-
CD (P=0.05)	26.93	6.50	106.62	9.64	NS	0.183	-	-	-	-
Boron spraying (0.2% borax)										
B_0	465.1	465.1	1643.7	1643.7	20.08	20.08	16.78	16.10	32.12	30.83
B_1	471.4	471.4	1647.4	1647.4	20.17	20.17	17.27	16.57	33.38	32.04
B_2	474.9	474.9	1652.9	1652.9	20.22	20.22	17.62	16.91	35.11	33.70
S Em (±)	1.31	1.31	1.51	1.51	0.05	0.05	-	-	-	-
CD (0.05)	3.94	3.94	4.53	4.53	NS	NS	-	-	-	-

