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Influence of Method and Application Time of Nitrogen on Pest Incidence of Sorghum [*Sorghum bicolor* (L.) Moench] Genotypes

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Abstract

An experiment was conducted under open field condition in the month of June to December in the year of 2013 at College of Agriculture, Indore, R.V.S.K.V.V. (M.P.), India. Nitrogen application time and cultivars were significantly effective but their interaction was non-significantly effective for incidence of insect pest (exception of ear head bug), whereas both factor and interaction were significantly effective to growth parameter. CSV20 was recorded with significantly lowest incidence of pests and maximum for growth parameters in comparison to CSH16 in nitrogen application time treatment N_1: 50% at sowing+50% at 30 DAS maximum incidence of Shoot fly (57.87% and 64.39%) at 14 and 21 days, while minimum in stem borer dead hearts (41.15%) at 45 DAE, Ear head pests (3.75 bug & 3.0 worm) at milk stage, N_2: 50% at sowing+25% at 30 DAS+25% at boot leaf stage was found highest height of plant (182.33 cm.), N_3: 25% at sowing+50% at 30 DAS+25% at BLS has been recorded higher stem borer dead hearts (51.42%), N_4: 25% at sowing+50% at 30 DAS+15% at BLS+10% at grain filling stage reported maximum ear head pests (6.78% and 4.27%), treatment N_5: 25% at sowing+45% at 30 DAS+5% foliar spray at 45 DAS+15% BLS+10% GFS) recorded minimum incidence of shoot fly (43.85% and 51.12%). Among the treatment maximum number of grains ear head^{-1} was recorded in the treatment N_4, (2369.33) at GFS and N5 (2111.17) at GFS with and higher yield plot^{-1} and stover yield was recorded in the treatment N_5 (2.79 kg and 2.88 kg) respectively.

Keywords: Sorghum, nitrogen-fertilizers, interaction, insect pest

1. Introduction

Sorghum [*Sorghum bicolor* (L). Moench] is well adapted to sub-tropical and temperate regions of the world and used in different ways in many countries. Sorghum is consumed food and feed and used for sugar, ethanol and paper pulp production. Sorghum is grown in an area of 61.80 mha with a production of 52.80 mt and productivity of 854.4 kg ha^{-1} in India (Anonymous, 2013–14). In Madhya Pradesh, sorghum crop is grown mainly in *Kharif* and covers an area of 307.5 ha and production 542.9 tonnes with productivity of 1809 kg ha^{-1} respectively (Anonymous, 2009–10). Sorghum mainly cultivated in Malwa fallowed by Jhabua, Nimar, Gird and Satpura plateau of Madhya Pradseh. Selection of resistant or tolerant varieties is a very important factor the diversity and intensity of pests in a particular place. Plant Growth Promoting Rhizobacteria (PGPR) used in the production of biofertilizers is an effective and economic means to control plant diseases (Ameer Basha et al., 2013). Plants have their own sophisticated mechanisms to protect from the pest attack. Majority of the traditional varieties are resistant to many pests. Application of nitrogen to the crop increased infestation and damage by headbugs as was the case for shootfly. The importance of N fertilizers to increased Sorghum production was also demonstrated with a caution to limit application rate to below 50 kg to minimize adverse effects of insect pests and maintain or improve grain quality (Tanzubil Paul B., 2014). Nitrogen, phosphorus and potassium are fundamental nutrients for plant growth and development which play a basic role in metabolism and energy production in plants and significantly enhance the grain yield. Considering in the light of above facts the following studies have been under taken to confirm the findings in this zone. The aim of this research is to study the effect of nitrogen levels, plant density and its interaction with sorghum insect pests, nitrogen fertilizer on quantity and quality of sorghum grain.

2. Materials and Methods

2.1. Study sites

An experiment was conducted under open field condition in the month of June to December in the year of 2013 at College

of Agriculture, Indore, R.V.S.K.V.V. (M.P.). The soil of this region medium black cotton soil, Indore is situated in the "*Malwa Plateau*" which is Agro-climatic zone of Madhya Pradesh. Geographical parameters at Indore: Latitude of 22°43' N, Longitude of 75°56'E, Altitude of 555.7 m MSL. The climate of this region is semi-arid, sub-tropical having mid-winter and summer with uncertain winter rains. The rainfall occurs mostly from mid-June to the end of September.

2.2. Method of data collection

In order to explore the effect of various five Nitrogen fertilizer doses including (T_1) N_1 : 50% at sowing+50% at 30 Day after sowing (DAS), (T_2) N_2: 50% at sowing+25% at 30 DAS+25% at Boot leaf stage (BLS), (T_3) N_3: 25% at sowing+50% at 30 DAS+25% at BLS, (T_4) N_4: 25% at sowing+50% at 30 DAS+15% at BLS+10% at Grain filling stage (GFS), (T_5) N_5: 25% at sowing+45% at 30 DAS+5% foliar spray at 45 DAS+15% BLS+10% GFS) and two cultivars CSV20, CSH16, were assessed in a Factorial Randomized Block Design (FRBD) with three replications. Seeds were planted in rows 0.45 m., plants 0.12 m. Nitrogen fertilizer were applied in 4 stages: pre-sowing, 30 day after sowing, boot leaf stage, grain filling stage and observed the major insect pests of sorghum viz.,shoot fly, stem borer, ear head bug and worm. All the data obtained with regard to the pests' incidence, growth, yield and yield attributing were analyzed statistically using the analysis of variance of Fisher and Yates (1963).

3. Results and Discussion

The nitrogen application time and cultivars were significantly effective but their interaction of both the factors (N x C) was non-significantly effective for Incidence of shoot fly, stem borer and ear head worm. However, cultivar and interaction were not significantly effective but nitrogen application was significantly effective for incidence of ear head bug. Cultivar CSV20 has been recorded to be significantly for minimum shoot fly, stem borer and ear head pest incidence in comparison to CSH16.

3.1. Shoot fly (Atherigona soccata Rondani)dead heart percent

The data presented in (Table 1) the nitrogen application time N_1 (50% at sowing+50% at 30 DAS) was found maximum dead hearts (57.87% and 64.39%) at both stage (14 and 21 DAE) followed by N_2 (50% at sowing+25% at 30 DAS+25% at BLS) and N_3 (25% at sowing+50% at 30 DAS+25% at BLS)) with 52.12 and 51.25% dead hearts at 14 DAE and 59.46 and 59.21% dead hearts at 21 DAE. However minimum incidence of shoot fly was reported in N_5 (25% at sowing+45% at 30 DAS+5% foliar spray at 45 DAS+15% BLS+10%GFS) with 43.85 and 51.12% at 14 and 21 DAE. Similar findings are reported by Pandey (2003); Bortoliet al. (2005); Tanzubil et al. (2006); Obonyo et al. (2008); Sarao and Mahal (2008); Karikari et al. (2013).

Table 1: Impact of application time of nitrogen and cultivar on incidence of shoofly dead hearts %

Application time of N_2	Shoot Fly 14 DAE			Shoot Fly 21 DAE		
	CSV20	CSH16	Mean	CSV20	CSH16	Mean
N_1	53.89(47.23)	61.84(51.87)	57.87(49.55)	58.43(49.86)	70.35(57.03)	64.39(53.44)
N_2	49.57(44.75)	54.67(47.68)	52.12(46.22)	57.58(49.36)	61.35(51.56)	59.46(50.46)
N_3	48.95(44.40)	53.54(44.40)	51.25(45.72)	57.58(49.37)	60.84(51.27)	59.21(50.32)
N_4	45.78(42.58)	53.06(46.75)	49.42(44.67)	52.30(46.32)	60.82(51.26)	56.56(48.79)
N_5	42.31(40.58)	45.39(42.35)	43.85(41.46)	48.56(44.17)	53.68(47.11)	51.12(45.64)
Mean	48.10(43.91)	53.70(47.14)	50.90(45.52)	54.89(47.82)	61.41(51.65)	58.15(49.73)
	V	N	V×N	V	N	V×N
SEm±	0.62	0.54	NS	0.60	0.52	NS
CD(*P < 0.05*)	1.84	1.59	NS	1.79	1.55	NS

NS: Non-Significant, V: Variety/Cultivar, N: Nitrogen Application Time, V×N: Interaction Values in parenthesis are transformed (arc sin transformation) value

3.2. Percent leaf injury, dead hearts and stem tunneling due to stem borer

The data presented in (Table 2) the minimum leaf injury (3.28%) was reported in the nitrogen application time N_5(25% at sowing+45% at 30 DAS+5% FS at 45 DAS+15% BLS+10%GFS) which was at par with N_4(25% at sowing+50% at 30 DAS+15% at BLS+10% at GFS) and N_3(25% at sowing+50% at 30 DAS+25% at BLS) with 3.12 and 3.68% leaf injury respectively, while maximum leaf injury (5.05%) was recorded in N_1(50% at sowing+50% at 30 DAS).The lowest incidence of stem borer (dead hearts and stem tunneling) has been recorded in N_1, 50% at sowing+50% at 30 DAS (41.15 and 4.70%) followed by N_5, 25% at sowing+45% at 30 DAS+5% FS at 45 DAS+15% BLS+10% GFS (43.05 and 5.13%) respectively, however N_3, 25% at sowing+50% at 30 DAS+25% at BLS) was found to be maximum (51.42 and 5.95%). The present funding supported by Tanzubil et al.(2006); Dashet al. (2007); Sarao and Mahal (2008); Bhavani et al. (2012); Karikari et al. (2013).

3.3. Ear head bug (Calocoris angustatus Leth.) and worms (Cryptoblabus gnidiella Mab.)

Table 2: Effect of application time of nitrogen and cultivar on incidence of Stem borer

Application time of N_2	Leaf Injury % at 30 DAE			Dead hearts % at 45 DAE			Stem tunneling % at harvest		
	CSV20	CSH16	Mean	CSV20	CSH16	Mean	CSV20	CSH16	Mean
N_1	4.97(12.86)	5.13(13.06)	5.05(12.96)	38.56(38.38)	43.75(41.39)	41.15(39.89)	4.23(11.86)	5.17(13.13)	4.70(12.50)
N_2	4.33(12.01)	4.83(12.67)	4.58(12.34	49.93(44.96)	52.92(46.68)	51.42(45.82)	5.30(13.30)	5.9(14.10)3	5.62(13.70)
N_3	3.33(10.52)	4.03(11.57)	3.68(11.04)	50.83(45.48)	54.66(47.67)	52.74(46.58)	5.67(13.77)	6.23(14.45)	5.95(14.11)
N_4	3.07(10.06)	3.77(11.17)	3.42(10.62)	47.87(43.78)	52.46(46.41)	50.17(45.09)	5.13(13.08)	5.67(13.77)	5.40(13.43)
N_5	2.80(9.60)	3.77(11.18)	3.28(10.39)	40.78(39.69)	45.31(42.31)	43.05(41.00)	4.83(12.69)	5.43(13.44)	5.13(13.07)
Mean	3.70(11.01)	4.31(11.93)	4.00(11.47)	45.59(42.46)	49.82(44.89)	47.71(43.67)	5.03(12.94)	5.69(13.78)	5.36(13.36)
	V	N	V x N	V	N	V×N	V	N	V×N
SEm±	0.29	0.25	NS	0.65	0.56	NS	0.22	0.19	NS
CD (*P< 0.05*)	0.86	0.75	NS	1.93	1.67	NS	0.66	0.57	NS

NS: Non-significant, V: Variety/cultivar, N: Nitrogen application time, V×N: Interaction Values in parenthesis are transformed (arc sin transformation) value

The data presented in (Table 3) the application time of nitrogen minimum ear head pest (bug and worm 3 plants^{-1}) has been counted in N_1, 50% at sowing+50% at 30 DAS (3.75 bug and 3.00 worm) followed by N_2,50% at sowing+25% at 30 DAS+25% at BLS and N_3, 25% at sowing+50% at 30 DAS+25% at BLS (4.42 and 5.20 bug and 3.27 and 3.75 worm), while in N_4, 25% at sowing+50% at 30 DAS+15% at BLS+10% at GFS was found to be maximum (6.78 bug and 4.27 worm). The present funding are partially supported by Bortoliet al. (2005); Tanzubil et al. (2006); Randhawaet al. (2014); Karikari et al. (2013).

3.4. Expression of growth parameters

The data presented in (Table 4) among the treatment in the application time of Nitrogen the maximum higher plant population was found in N_1, 50% at sowing+50% at 30 DAS (86.67) closely followed by N_2, 50% at sowing+25% at 30 DAS+25% at BLS (80.83), while minimum plant population was recorded in N_3, 25% at sowing+50% at 30 DAS+25% at BLS (75.33). Among the treatment, the lowest days for 50% flowering was noticed in N_3, 25% at sowing+50% at 30 DAS+25% at BLS (96.00 days), closely followed by N_2, 50% at sowing+25% at 30 DAS+25% at BLS (96.50 days), while N_4, 25% at sowing+50% at 30 DAS+15% at BLS+10% at GFS was found to be maximum (100.50) days to 50% flowering. Among the treatment of N_1, 50% at sowing+50% at 30 DAS was recorded minimum (129 days) days to 50% maturity closely followed by N_2, 50% at sowing+25% at 30 DAS+25% at BLS (129.67 days). The maximum (131.00 days) days to 50% to maturity was recorded in N_3, 25% at sowing+50% at 30 DAS+25% at BLS. Among the treatment highest height 182.3 was recorded when the Nitrogen application time apply N_2, (50% at sowing+25% at 30 DAS+25% at BLS) followed by N_5, 25% at sowing+45% at 30 DAS+5% FS at 45 DAS+15% BLS+10%GFS (178.67 cm). The present funding is partially supported by Sing et al. (2007a, b); Ananda and Patil (2007).

3.5. Expression of yield parameters

The data presented in (Table 5), the impact of cultivar to obtain yield per five plants of CSH16 was significantly superior to CSV20, while the performance of cultivar to yield kg plot^{-1} and grain ear head^{-1}, cultivar CSV20 was reported significantly superior than CSH16. Among the treatment maximum number of grains per ear head was recorded in the treatment N_4, 25% at sowing+50% at 30 DAS+15% at BLS+10% at GFS (2369.33 grain) followed by N_3, 25% at sowing+50% at 30 DAS+25% at BLS and N_5, 25% at sowing+45% at 30 DAS+5% FS at 45 DAS+15% BLS+10% GFS with 2359.00 and 2111.17 grain earhead^{-1}, while minimum number of grain (1571.50) was recorded in N_2, (50% at sowing+25% at 30 DAS+25% at BLS). Among the treatment maximum yield (221.70 g) per five plant was recorded in N_2, 50% at sowing+25% at 30 DAS+25% at BLS followed by N_5, 25% at sowing+45% at 30 DAS+5% FS at 45 DAS+15% BLS+10% GFS (202.83 g) and N_4, 25% at sowing+50% at 30 DAS+15% at BLS+10% at GFS (199.68 g), while minimum yield per five plant (153.87 g) was recorded in N_1, 50% at sowing+50% at 30 DAS. Among the treatment higher yield per plot was recorded in the treatment N_5, 25%

Table 3: Effect of application time of Nitrogen and cultivar in incidence of Earhead pest's 3 panicle^{-1}

Application time of N_2	Ear head bug			Ear head worm		
	CSV20	CSH16	Mean	CSV20	CSH16	Mean
N_1	3.70(11.08)	3.80(11.22)	3.75(11.15)	2.67(9.39)	3.33(10.52)	3.00(9.95)
N_2	4.43(12.15)	4.40(12.11)	4.42(12.13)	2.83(9.66)	3.70(11.08)	3.27(10.37)
N_3	5.03(12.96)	5.37(13.39)	5.20(13.18)	3.43(10.67)	4.07(11.62)	3.75(11.15)
N_4	6.80(15.11)	6.77(15.06)	6.78(15.09)	4.27(11.76)	4.87(12.73)	4.57(12.25)
N_5	6.10(14.29)	6.43(14.69)	6.27(14.49)	3.80(11.23)	4.73(12.55)	4.27(11.12)
Mean	5.21(13.12)	5.35(13.30)	5.28(13.21)	3.40(10.54)	4.14(11.70)	3.77(11.12)
	V	N	V×N	V	N	V×N
SEm±	NS	0.16	NS	0.35	0.30	NS
CD(*p<0.05*)	NS	0.47	NS	1.04	0.90	NS

NS: Non-significant; V: Variety/cultivar; N: Nitrogen application time; V×N: Interaction values in parenthesis are transformed (square root transformation) value

Table 4: Effect of application time or nitrogen and cultivar on different growth parameters

Application time of N_2	Plant population			Days to 50% flowering			Days to 50% maturity			Plant height (cm)		
	CSV20	CSH16	Mean	CSV20	CSH16	MEAN	CSV20	CSH16	MEAN	CSV20	CSH16	Mean
N_1	104.00	69.33	86.67	98.00	102.33	100.17	130.00	128.00	129.00	168.33	162.00	165.17
N_2	94.33	67.33	80.83	95.00	98.00	96.50	128.00	131.33	129.67	185.00	179.67	182.33
N_3	84.00	66.67	75.33	93.33	98.67	96.00	129.33	132.67	131.00	173.33	182.00	177.67
N_4	85.33	75.00	80.17	100.67	100.33	100.50	130.67	129.67	130.17	172.00	166.33	169.17
N_5	81.67	78.33	80.00	98.33	102.33	100.33	130.67	131.33	131.00	170.00	187.33	178.67
Mean	89.87	71.33	80.60	97.07	100.33	98.70	129.73	130.60	130.17	173.73	175.47	174.60
	V	N	V×N	V	N	V×N	V	N	V×N	V	N	V×N
SEm±	1.166	1.010	2.020	0.313	0.271	0.542	0.370	0.321	0.641	0.415	0.360	0.719
CD(*p<0.05*)	3.465	3.000	6.001	0.930	0.805	1.611	1.100	0.953	1.905	1.234	1.069	2.137

NS: Non- Significant, V: Variety/cultivar, N: Nitrogen application time, V×N: Interaction

Table 5: Effect of application time or nitrogen and cultivar on yield attributes

Application time of N_2	No. of grain earhead^{-1}			Grain yield plot^{-1} (kg)			Stover yield (kg) net plot^{-1}		
	CSV20	CSH16	Mean	CSV20	CSH16	Mean	CSV20	CSH16	Mean
N_1	1981.00	1680.00	1830.50	2.82	1.89	2.36	2.98	1.96	2.47
N_2	1615.00	1528.00	1571.50	3.00	2.30	2.65	3.10	2.53	2.81
N_3	2338.00	2380.00	2359.00	2.54	2.37	2.45	2.91	2.11	2.51
N_4	2419 .00	2319.67	2369.33	2.83	2.71	2.77	2.92	2.43	2.67
N_5	2223.67	1998.67	2111.17	2.79	2.78	2.79	2.82	2.94	2.88
Mean	2115.33	1981.27	2048.30	2.80	2.41	2.60	2.94	2.39	2.67
	V	N	V×N	V	N	V×N	V	N	V×N
SEm±	NS	92.383	NS	0.058	0.050	0.101	0.072	0.063	0.125
CD(*p<0.05*)	NS	274.494	NS	0.173	0.150	0.300	0.214	0.186	0.371

NS: Non-Significant; V: Variety/cultivar; N: Nitrogen application time; V×N: Interaction

at sowing+45% at 30 DAS+5% FS at 45 DAS+15% BLS+10% GFS (2.79 kg) followed by N_4, 25% at sowing+50% at 30 DAS+15% at BLS+10% at GFS (2.77 kg) and N_2, 50% at sowing+25% at 30 DAS+25% at BLS (2.65 kg). The minimum (2.36 kg) yield plot^{-1} was recorded when treated by N_1, 50% at sowing+50% at 30 DAS. The performance of cultivar to stover yield CSV-20 (2.94 kg) was significantly superior compared to CSH 16 (2.39 kg plot^{-1}). The time of nitrogen application and interaction were also significant to stover yield. Among the application time of nitrogen higher stover yield (2.88 kg) was reported in N_5, 25% at sowing+45% at 30 DAS+5% FS at 45 DAS+15% BLS+10% GFS followed by N_2, 50% at sowing+25% at 30 DAS+25% at BLS (2.81 kg). The present funding is supported by Obonyo et al. (2008); Rashid et al. (2008); Yusefzadeh et al. (2013).

4. Conclusion

CSV20 estimated minimum incidence of stem borer dead hearts and ear head pest treatment with N_1 and maximum plant height and yield with N_2 in comparison to CSH 16 while CSH 16 produced maximum days to 50% maturity treatment with N_3 and 50% floweringtreatment with N_4, while maximum grain yield plot^{-1} and stover yield treatment with N_5 as compared to CSV 20.

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