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Management of groundnut major disease by tebuconazole alone and in combination with bio-control agent and their impact on yield

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Abstract
A field experiment with nine treatment combinations of chemical and bio control agent were carried out at Main Oilseeds Research Station, Junagadh Agricultural University, Junagadh. Result revealed that the collar rot (2.64%) and stem rot (1.27 %) incidence was minimum in tebuconazole 1.5 g/kg seed treatment and two spray of same fungicide at 15 days interval. Late leaf spot (23.82 %) and rust (21.57%) severity were minimum in seed treatment with *T. viride* @ 10g/kg seed, furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha, Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40 DAS, accompanied by 2 spray of tebuconazole @ 1ml/lit at 15 days intervals. Whereas maximum pod (2230 kg/ha) and haulm (5256 kg/ha) yield was showed in tebuconazole 1.5g/kg seed, furrow application of *T. viride* at time of sowing @ 4 kg enriched in 50 kg FYM/ha same was enriched and applied at 40 DAS and two spray of tebuconazole @ 1ml/lit at fortnightly intervals.
The comparative efficacy of tebuconazole alone and its combination with biological control agent revealed lower collar rot and stem rot diseases in all plots heaving seed treatment of tebuconazole. Similarly, lower tikka and rust were recorded in plots heaving foliar application of tebuconazole. The higher pod and haulm yield were recorded in treatment with tebuconazole and combinations with biocontrol agent treatments.

Keywords: fungicide, bio control agent, tebuconazole, management

Introduction
Groundnut (*Arachis hypogaea* L.) is important oilseed crop. The total area of groundnut cultivation in India is 52.50 lakh ha which accounts for total production of 94.72 lakh tones with productivity of 1804 kg/ha. Among the major groundnut growing states, Gujarat is the most important one accounting for 18.42 lakh ha total area with 49.18 lakh tones production and productivity of 2670 kg/ha (Anon., 2016) [2]. The productivity level of groundnut in India is far below the world average of 1400 kg/ha mainly because it is predominantly grown as a rain fed crop (80% of the total acreage) under various biotic and abiotic constraints that limit crop yield.
A large number of diseases attack to groundnut in India and causes severe damage during any stage of crop growth, and yield losses over 25% have been reported by Mayee and Datar (1988) [9]. Thus other alternative disease management options were considered among which biological control appears promising. Although, now-a-days, many groundnut growing farmers are cultivating groundnut through organic practices like application of FYM or castor cake instead of chemical fertilizers. Application of biological control agents enriched with FYM is also a practice adopted by many farmers. Therefore, this experiment was formulated to evaluate the efficacy of application of organic amendment enriched with biological control agents, application of biological control agents and bio-product as foliar spray and furrow application in managing foliar diseases (tikka and rust) of groundnut.

Materials and Methods
A field experiment was conducted to know the comparative efficacy of tebuconazole alone and in combination with biological control agent in controlling stem rot, collar rot, leaf spot and rust diseases of groundnut on Main Oilseeds Research Station, Junagadh Agricultural University, Jinagadh during *Kharif* 2013-14 to 2015-16. The GG-20 susceptible groundnut varieties was sown adopting a spacing of 60 x 10 cm in 5.0 x 3.0 gross and 4.00 x 1.8m net plot size with 5 replications in redomized block design. Nine treatment *viz.* T_1 seed treatment

with tebuconazole 1.5g/kg seed + two spray of tebuconazole @ 1ml/L, starting from initiation of foliar diseases (LLS/Rust) and 2nd spray at 15 days interval, T_2 seed treatment with *T. viride* @ 10g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha, T_3 seed treatment with tebuconazole @ 1.5g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha, T_4 T2 + Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40 DAS, T_5 T3 + Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40 DAS, T_6 T4 + two spray of tebuconazole @ 1ml/L, starting from the initiation of foliar diseases and 2nd spray at 15 days interval, T_7 T5 + two spray of tebuconazole @ 1ml/L, starting from the initiation of foliar diseases and 2nd spray at 15 days interval, T_8 seed treatment with *T. harzianum* @ 10g/kg seed + furrow application of *T. harzianum* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha+ Broadcasting *T. harzianum* @ 4 kg enriched in 50 kg FYM/ha at 40DAS, and T_9 control were imposed. The crop was managed by applying recommended dose of fertilizer (12.5-25-0 NPK kg/ha). At the time of harvesting, the number of healthy and infected plant were counted in each treatment and per cent disease incidence and per cent disease control were calculate using the following formula given by (Kokalis – Burelle *et al*., 1992) [7].

$$\text{Percent disease incidence} = \frac{\text{No. of plants infected}}{\text{Total no. of plants observed}} \text{x100}$$

Ten plants were selected randomly in each plot and observation on disease severity was recorded individually using 1 to 9 rating scale based on leaf area, stem and fruit covered by spot symptoms following the rating scale described by (Subramaniyam *et al*. 1995) [12]. Disease incidence was calculated on the basis of per cent of infected leaves and stems. Per cent disease index (PDI) will be calculated as follows:

$$\text{Percent disease Index} = \frac{\text{Sum of all individual ratings}}{\text{Total No. of leaves examined x Maximum disease}} \text{x100}$$

Data were statistically analyzed using analysis of variance (ANOVA) at a significance level ($p< 0.05$) using the statistical software.

Results and Discussion

Collar rot

The result presented in Table 1 revealed that all the treatments significantly reduced collar rot disease as compared to control in the pooled analysis. Significantly the lowest collar rot incidence was recorded in T_1 (2.64 %), T_5 (2.85 %), T_8 (2.88 %), T_4 (3.15 %), T_2 (3.21 %) and T_6 (3.64 %, Table 1). These results are accordance with those obtained by Gajera *et al.,* (2011) [5] who demonstrated that *Trichoderma viride* and *T. harzianum* reduced the collar rot (*Aspergillus niger*) incidence in groundnut in a pot culture study.

Stem Rot

In pooled analysis all the treatments, except T_4 (3.75 %) significantly reduced stem rot incidence. Significantly the lowest stem rot disease was noted in T_1 (1.27 %) followed by T_7 (2.12%), T_3 (1.94%), T_6 (2.99 %), T_5 (2.22 %), T_2 (2.74 %), and T_8 (2.62%, Table 1). The present result are in agreement with the results obtained by Adiver and Anahosur (1995) [1], who reported that triazole group of fungicides i.e., tebuconazole and cyperconazole were effective against late leaf spot of groundnut and also reduced colonization of *Sclerotium rolfsii*. In connection to organic amendment *i.e.* FYM and green manuring applied in soil were reported fungitoxic/fungistatics against soil borne pathogen like *S. rolfsii* (Stem rot) of groundnut (Johnson *et al.,* 2003) [6]. Application of *T. harzianum* inoculums to soil at the time of sowing was better than other treatments including seed treatment with antagonist in controlling root rot of groundnut caused by *S. rolfsii* (Muthamilan and Jeyarajan, 1996) [10]. *T. viride* along with *Pseudomonas fluorescens* increased the biocontrol activity against stem rot of groundnut caused by *S. rolfsii* (Manjula *et al.,* 2004) [8].

Tikka

Significantly the lowest tikka disease was recorded in T_6 (23.82 %) followed by T_7 (25.09%) and T_1 (25.41%), where these treatments having seed and foliar application of tebuconazole (Table 4). Our results are harmony with earlier works of Nath *et al.,* (2013) [] found that tebuconazole (0.15%) gave best result and reduced the cercospora leaf spot disease intensity to 52.42%.

Rust

Significantly minimum rust disease intensity of 21.57% was found in T_6 treatment followed by T_7 and T_1 with disease incidence of 23.54% and 23.38%, respectively (Table 2). Similar result was obtained by Brenneman and Culbreath (1994) [4] who had studied a rainfall based advisory programme with 5 sprays of tebuconazole, a substitute for chlorothalonil against foliar diseases of groundnut and reported higher yields and reduced incidence and/or severity of both foliar and soil borne diseases.

Pod and haulm yield

The pooled data of three years revealed that the pod yield (2230 kg/ha) was maximum in treatment T_7 (seed treatment with tebuconazole @ 1.5g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha + broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40 DAS+ two sprays of tebuconazole @ 1ml/l, starting from the initiation of foliar diseases and 2nd spray at 15 days interval) followed by treatment T_6 (2110 Kg/ha) and T_1 (2108 kg/ha). Similarly, the highest haulm yield was recorded in treatment T_7 (5256 kg/ha) followed by T_6 (4913 kg/ha) and T_1 (4870 kg/ha).

The present result corroborated the finding of Bowen *et al*. (1997) [3] who reported that defoliation caused by leaf spots and incidence of southern stem rot (*S. rolfsii*) was inversely related to number of tebuconazole applications, while yield was directly related to number of tebuconazole applications. Similarly Nath *et al.,* (2013) [11] reported that tebuconazole (0.15%) gave best result and increased yield up to 67% as compared to 39% increase by tebuconazole (0.10 %).

Economics

Maximum ICBR was noticed in biological agent treatment T_2 (1:9.82) *i.e.* seed treatment with *T. viride* @ 10 g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM /ha). Next effective treatment was T_1 *i.e.* seed treatment with tebuconazole 1.5g/kg seed + two sprays of tebuconazole @ 1ml/l, starting from initiation of foliar diseases (LLS/Rust) and 2nd spray at 15 days interval followed by seed treatment with tebuconazole @ 1.5g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg

enriched in 50 kg FYM/ha (T_3). However, on the basis of net realization, it is concluded that seed treatment with tebuconazole, furrow application and broadcasting of *T. viride* with two sprays of tebuconazole (T_7) was highly effective in reducing diseases of groundnut and economical followed by Seed treatment with tebuconazole 1.5g/kg seed + two spray of tebuconazole @ 1ml/L, starting from initiation of foliar diseases (LLS/Rust) and 2nd spray at 15 days interval (T_1), Seed treatment with *T. viride* @10/kg seed, furrow application of same bio control agent @ 4 kg enriched in 50 kg FYM/ha, broadcasting of sane biological agent @ 4 kg enriched in 50 kg FYM/ha at 40 DAS and two spraying of tebuconazole (T_6) with Rs. 29685, 25545 and 24207 income increase over control per hector.

Conclusion

It can be concluded from the above studies that collar rot (2.64%) and stem rot (1.27 %) incidence was minimum in tebuconazole 1.5 g/kg seed treatment and two spray of same fungicide at 15 days interval. Late leaf spot (23.82%) and rust (21.57%) severity were minimum in seed treatment with *T. viride* @ 10g/kg seed, furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha, Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40 DAS, accompanied by 2 spray of tebuconazole @ 1ml/lit at fifteen days intervals. Whereas maximum pod (2230 kg/ha) and haulm (5256 kg/ha) yield was showed in tebuconazole 1.5g/kg seed, furrow application of *T. viride* at time of sowing @ 4 kg enriched in 50 kg FYM/ha same was enriched and applied at 40 DAS and two spray of tebuconazole @ 1ml/lit at fortnightly intervals.

The comparative efficacy of tebuconazole alone and its combination with biological control agent revealed lower collar rot and stem rot diseases in all plots heaving seed treatment of tebuconazole. Similarly, lower tikka and rust were recorded in plots heaving foliar application of tebuconazole. The higher pod and haulm yield were recorded in treatment with tebuconazole and combinations with bio control agent treatments. However, T_7, T_1 and T_6 were found equally effective in reducing foliar disease and pod yield.

Table 1: Effect of Tebuconazole alone and combination with biocontrol agent on collar rot, stem rot, tikka disease of groundnut

S. No	Treatments	Per cent disease		
		Collar rot	Stem rot	Tikka
1	Seed treatment with Tebuconazole 1.5g/kg seed + two spray of Tebuconazole @ 1ml/L, starting from initiation of foliar diseases (LLS/Rust) and 2nd spray at 15 days interval	1.24* (1.84)	0.98* (1.27)	29.85** (25.41)
2	Seed treatment with *T. viride** @ 10g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha	1.65 (3.21)	1.51 (2.74)	37.36 (36.95)
3	Seed treatment with Tebuconazole @ 1.5g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha	1.30 (1.93)	1.37 (1.94)	35.92 (34.66)
4	T_2 + Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40 DAS	1.60 (3.15)	1.85 (3.75)	36.85 (36.23)
5	T_3 + Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40DAS	1.54 (2.85)	1.45 (2.22)	36.66 (35.84)
6	T_4 + two spray of Tebuconazole @ 1ml/L, starting from the initiation of foliar diseases and 2nd spray at 15 days interval	1.65 (3.64)	1.40 (2.99)	28.97 (23.82)
7	T_5 + two spray of Tebuconazole @ 1ml/L, starting from the initiation of foliar diseases and 2nd spray at 15 days interval	1.45 (2.64)	1.22 (2.12)	29.81 (25.09)
8	Seed treatment with *T. harzianum*** @ 10g/kg seed + furrow application of *T. harzianum* @ 4 kg enriched in 50 kg FYM/ha at the time of sowing and broadcasting at 40DAS	1.55 (2.88)	1.57 (2.62)	37.99 (37.98)
9	Control	2.28 (6.74)	2.29 (5.67)	42.64 (45.97)
	S.Em±	0.18	0.24	1.41
	C D at 5 %	0.53	0.71	4.23
	C V %	21.02	21.50	4.97
	Y- S.Em.±	0.10	0.14	0.82
	Y-C.D. at 5 %	0.30	0.41	2.44
	YXT-S.Em.±	0.15	0.15	0.78
	YXT-C.D. at 5 %	0.42	0.41	2.20

Numerals in parentheses are retransformed values. * Square root transformation
**Arcsine transformation

Table 2: Effect of Tebuconazole alone and combination with biocontrol agent on rust, pod and haulm yield of groundnut

No.	Treatments	Per cent rust	Yield kg ha^{-1}	
			Pod	Haulm
1	Seed treatment with Tebuconazole 1.5g/kg seed + two spray of Tebuconazole @ 1ml/L, starting from initiation of foliar diseases (LLS/Rust) and 2nd spray at 15 days interval	28.82** (23.38)	2108	4870
2	Seed treatment with *T. viride** @ 10g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha	38.92 (39.79)	1685	4293
3	Seed treatment with Tebuconazole @ 1.5g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha	36.60 (36.51)	1661	4136
4	T_2 + Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40 DAS	38.19 (39.00)	1724	4246
5	T_3 + Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40DAS	37.88 (38.99)	1752	4412
6	T_4 + two spray of Tebuconazole @ 1ml/L, starting from the initiation of foliar diseases and 2nd spray at 15 days interval	27.39 (21.57)	2110	4913

7	T_5 + two spray of Tebuconazole @ 1ml/L, starting from the initiation of foliar diseases and 2nd spray at 15 days interval	28.52 (23.54)	2230	5256
8	Seed treatment with *T. harzianum*** @ 10g/kg seed + furrow application of *T. harzianum* @ 4 kg enriched in 50 kg FYM/ha at the time of sowing and broadcasting at 40DAS	39.48 (40.69)	1603	4219
9	Control	45.71 (51.08)	1451	3833
	S.Em±	2.27	82.53	184.97
	C D at 5 %	6.79	247.44	554.56
	C V %	7.20	8.52	7.87
	Y- S.Em.±	1.31	47.65	106.79
	Y-C.D. at 5 %	3.92	142.86	NS
	YXT-S.Em.±	1.15	69.10	157.18
	YXT-C.D. at 5 %	3.24	194.26	441.91

Numerals in parentheses are retransformed values. **Arcsine transformation

Table 3: Economics of various treatments

S. No	Treatments	Pod Yield (kg/ha)	Haulm Yield (kg/ha)	Gross Income (Rs)	Total cost (Rs)	Income increased over control	Net realization	ICBR
1	Seed treatment with Tebuconazole 1.5g/kg seed + two spray of Tebuconazole @ 1ml/L, starting from initiation of foliar diseases (LLS/Rust) and 2nd spray at 15 days interval	2108	4870	96495	3328	28873	25545	1:8.67
2	Seed treatment with *T. viride** @ 10g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha	1685	4293	78133	1070	10510	9440	1:9.82
3	Seed treatment with Tebuconazole @ 1.5g/kg seed + furrow application of *T. viride* at the time of sowing @ 4 kg enriched in 50 kg FYM/ha	1661	4136	76780	1251	9158	7907	1:7.32
4	T2 + Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40 DAS	1724	4246	79575	1923	11953	10030	1:6.22
5	T3+ Broadcasting *T. viride* @ 4 kg enriched in 50 kg FYM/ha at 40DAS	1752	4412	81110	2103	13488	11385	1:6.41
6	T4 + two spray of Tebuconazole @ 1ml/L, starting from the initiation of foliar diseases and 2nd spray at 15 days interval	2110	4913	96683	4853	29060	24207	1:5.99
7	T5 + two spray of Tebuconazole @ 1ml/L, starting from the initiation of foliar diseases and 2nd spray at 15 days interval	2230	5256	102340	5033	34718	29685	1:6.90
8	Seed treatment with *T. harzianum*** @ 10g/kg seed + furrow application of *T. harzianum* @ 4 kg enriched in 50 kg FYM/ha at the time of sowing and broadcasting at 40DAS	1603	4219	74668	1923	7045	5122	1:3.66
9	1. Control	1451	3833	67623	-	-	-	-

Price: Pod= Rs. 40/kg, Haulm=Rs.2.5/kg, Skill labour Rs. 240/day and Unskill labour Rs. 150/day, FYM = Rs 0.55/kg, Tebuconazole WG 25%=2005/- Rs./kg, Tebuconazole(folicur) MEC 25.9%=2150/- Rs./lit

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