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Effect of Fungicides and Meteorological Factors on Severity of Rust and Tikka Disease of Groundnut in Field

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Abstract: *Groundnut is one of the important oilseed in India as well as in West Bengal next to mustard. Among the various reasons attributed to low productivity, diseases are major constraint and most important fungal foliar diseases are tikka disease and rust caused by Cercospora arachidicola & Phaeoisariopsis personata and Puccinia arachidis respectively and caused loss of 53% pod yield and 27% kernal weight depending upon the environmental condition. Several fungicides were used by the farmers indiscriminately and due to regular use of same fungicides the pathogen developed resistance. So to combat these problems a new premix fungicides formulation consist of Azoxystrobin 7.5 % + Propiconazole 12.5% SE was evaluated with single of these to fungicides (Azoxystrobin 7.5 % and Propiconazole 12.5% SE) and check Tebuconazole 25.9% EC in field against these diseases. The field trial was conducted during Kharif & Rabi seasons of 2015, laidout on RBD with 7 treatments and four replications. Uniform Plant Populations were maintained and three sprays of each chemicals with desired concentrations were given starting from 40DAS at 10 days interval. The result showed that premixture of Azoxystrobin 7.5 % + Propiconazole 12.5% SE @ (65.62+109.38 g a.i. /ha and 75+125g a.i. /ha) significantly reduced both the diseases (8.75 % & 8.70 % for tikka and 9.16% & 9.20% for rust) and increased yield 20.75 and 21.25 qha^{-1} respectively in comparison to untreated control. Rate of spread of the diseases were also low in fungicide applications and minimum in premixture fungicides Azoxystrobin 7.5 % + Propiconazole 12.5% SE @ 75+125 g a.i./ha and 65.62+109.38 g a.i./ha respectively. Maximum temperature, maximum relative humidity and bright sunshine hours(BSH), Vapour pressure evening, soil temperature and total rainfall were the main meteorological factors for disease progression of leaf spot and rust disease of ground nut.*

Key words: *Ground nut, Leaf spots and rust, fungicides and meteorological factors.*

INTRODUCTION

With the ever increasing population and the escalating demand for food and cooking oils, scientist are toiling hard to enhance the production level of both through the introduction of new high yielding cultivars, effective cultural practices and adopting advanced technologies. However with continuous monocropping, intensive use of fertilizers, groundnut production is most often adversely affected by pest and diseases. Among the different diseases, leaf spot caused by *Cercospora arachidicola* Hari. and *Physariopsis personata* (Deighton) V. Arx. are the most important where groundnut is grown under intensive production system. Yield losses due to these diseases have been reported 5.50 g – 6.08g/ 4 sq.m. plot (Das and Roy, 1995) for every one percent increase in disease severity. In the absence of high degree of resistance of these pathogens, chemical management by use of fungicides at present appear to be the only practical solution to control these diseases and achieve the full yield potential of the crop. Fungicidal control and other management procedures of this disease have been reported by several worker (Lokhande *et al.*, 1998 ; Bag *et al.*, 2000; Maity *et al.*, 2005). The continuous use of same

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fungicides pathogen also produced resistant virulent strains (Sengupta, 2004). To combat such problems a constant search is required to find out not only the effective fungicide for the control of leaf spot disease but also for a simultaneous control of other important diseases like rust caused by *Puccinia arachidis*.

An attempt has been made to evaluate the mixture of two fungicides (Azoxystrobin + Propiconazole) to find out the efficacy of different doses and comparison with the individual ones against leaf spot as well as rust of groundnut and increase the pod yield.

In other cases environmental factors plays an important role in diseases development, dissemination, infection and growth (Walker, 1965). The occurrence and development of infection by leaf spot and rust pathogens are favored by availability of different weather parameters prevailing in field. Severity of disease varies in different years in field may be due to changing environmental parameters and other biotic factors of host. Applications of different fungicides to reduce the diseases of crop but its efficacy varies in different years in different places due to prevalence of different meteorological parameters. The work was undertaken to study the influence of important weather factors for the development of leaf spots and rust diseases of groundnut and to formulate the suitable prediction equation through step down multiple regression analysis (MRA) from different chemical applicated plots and to develop a suitable economic management techniques by the use of suitable active fungicide at right time on the basis of predicted disease severity at prevailing weather parameters.

MATERIALS AND METHODS:

The field experiment was conducted at University Instructional Farm Jaguli for the two consecutive seasons (Kharif and Rabi) in the year of 2015-16. The variety of groundnut was Phule Pragati (JL-24) was sown on 5 x 5 M^2 plots during rainy (July,2015) and winter (December,2015) seasons with a spacing of 30 cm in row to row and 5 cm in plant to plant in the year 2015-16. The experiment was laid out in randomized block design with four replications with other recommended agronomic practices. The crop was harvested on November, 2015 in rainy season and April 2016 in winter season.

Two fungicides Azoxystrobin 23% SC and Propiconazole 25% EC individually at a formulation concentration of 500g/ha and three concentration of the above two mixture fungicides 750 g; 875 g and 1000 gha^{-1} with a check fungicide Tebuconazole at a concentration of 750 $mlha^{-1}$. And untreated control plot was also maintained to compare efficacy of above mentioned fungicides and their doses.

Fungicides were sprayed in water volume of 500 litre/ha in the field, three times at ten days intervals after initial appearance of symptom (40 days after sowing). Disease observations were taken from individual plant by the using 1-6 rating scale (Lewin *et al.*,1973). Ten days before harvest by using a schematic diagram and computed as per McKinney (1925).

$$PDI = \frac{Sum\,of\ numberical\ ratings}{Total\,no.\,of\ leaves\,observed \times ma \times umum\,rating\,scale} \times 100$$

Ten plants per plot per replication were selected randomly to assess the disease severity per plot (maximum rating=6). All plants in a plots were harvested to compute the total yield after harvest. Growth abnormalities or phytotoxicity, if any were also recorded at 1,3,5,7 and 10 days after spraying of these fungicides. The cost benefit ratio was obtained by calculating the actual cost of production including the cost of fungicide, fertilizers and manures and their applications and the actual market price of the produce.

Data on weather factors viz., maximum temperature (Tmax), minimum temperature (Tmin), Maximum relative humidity (RHmax), minimum relative humidity (RH min), vapor pressure (VP) at noon and VP at evening, total rainfall (Rt), wind velocity (WV) and bright sunshine hours (BSH) were collected from AICRP on Agrometeorology, Kalyani.

Seven days mean of weather parameters (independent variables) were calculated except rainfall where seven days cumulative were done. The prediction equation was worked out through multiple regression analysis using SPSS computer software. Co-efficient of determination (R^2)were also calculated and tested for significance at 1% level of probability. Disease prediction model were developed by the following equation

Y (PDI) = a+ bixi + e (where Y= Predicted disease severity, a= intercept, bi= regression co-efficient for Xi. And xi= independent variables (i= 1…n)(weather parameters) and e= random error.

Step down multiple regression analysis was applied to disease severity data and goodness of fit was evaluated through co-efficient determination (R^2) and Standard Error of estimate (Coakley *et.al.,*1988).

RESULTS AND DISCUSSION

The result revealed that spraying two fungicides Azoxystrobin 23% SC and Propiconazole 25% EC individually at 500gha^{-1} and their mixture at three different doses 750g; 875g and 1000g per hacter as well as check fungicide Tebuconazole 25.9%EC 750 ml a.i.ha^{-1} reduced the leaf spot and rust disease of groundnut at every date of observation and subsequently increase the karnel yield in comparison to untreated control.

The disease severity in the treatments including untreated check showed different reaction in two different seasons in 2015-16, though the pattern of disease development was similar in both the seasons for both the diseases and thus results were analysed and conclusion were drawn based on the pooled mean of two seasons.

The two years pooled mean showed that all the treatments reduced the disease severity significantly in comparison to untreated control. It was also noticed that two mixture of fungicides formulation (Azoxystrobin 7.5% SC and Propiconazole 12.5% EC) at three different doses (750g; 875g and 1000g) produced minimum leaf spot severity in comparison to individual application of Azoxystrobin and Propiconazole at 500g respectively and their difference were statistically significant. The disease increment at different date of observation were also showed the similar results and minimum disease were observed in the plots spread with Azoxystrobin 7.5% SC and Propiconazole 12.5% EC mixture at 1000g (8.70%) statistically at par with the plots sprayed with same mixture fungicide at 875g (8.75%) and maximum was found in the plots sprayed with Tebuconazole 25.9%EC 750 mlha^{-1} (17.75%) followed by Propiconazole (25%EC) at 500g (16.58%) and Azoxystrobin (23% SC) at 500 g (15.25%) and their differences were statistically significant (Table 1),

Every date of observation showed that the increment was also minimum in the plots spread with the mixture of fungicides Azoxystrobin 7.5% SC and Propiconazole 12.5% EC in comparison to individual application of same fungicide (Table.1).

In case of leaf rust the two seasons pooled data showed that all the treatments like fungicide mixtures Azoxystrobin 7.5% SC and Propiconazole 12.5% EC at their three different doses 750;875;1000g individual application Azoxystrobin 23% SC and Propiconazole 25% EC 500g each and check fungicide Tebuconazole reduced the leaf rust severity significantly in comparison to untreated control. Mixture fungicide at three different doses reduced the maximum disease severity in comparison to individual application of same fungicide and othe check fungicide Tebuconazole 25.9% EC @ 750g a.i./ha. Among the treatments minimum leaf rust severity was noticed in plots sprayed with mixture formulation of Azoxystrobin 7.5% and Propiconazole 12.5% SE @750g/ha (9.16%) statistically at par with the same fungicide mixture @ 1000g/ha (9.20%). Whereas individual application of same fungicides produced the higher disease (Azoxystrobin @500g a.i./ha 14.25% and Propiconazole @500g a.i. / ha 15.50%).

The progress of disease was also minimum in these two sprayed plots in comparisons to individual application of the same fungicides and other check fungicides (Table 2).

In case of kernel yield (q ha^{-1}) it was observed that individual two fungicides Azoxystrobin 23% SC and Propiconazole 25% EC @ 500 g each and pre-mixture of these two fungicides Azoxystrobin 7.5% + Propiconazole 12.5% SE @ 750 g, 875g and 1000g ha^{-1} other check fungicide Tebuconazole 25.9% EC@ 750 ml ha^{-1} at different doses increased the yield of ground nut in comparison to untreated control

(Table 2). premix fungicides (Azoxystrobin 7.5% and Propiconazole 12.5% SE) @1000 gha^{-1} gave maximum kernel yield (21.25 qha^{-1}) statistically at par with the same premix fungicide (Azoxystrobin 7.5% and Propiconazole 12.5% SE) @ 875 gha^{-1} (20.75%) in comparison to individual application of these two Azoxystrobin 23% SC and Propiconazole 25% EC at the concentration of 500 ml ha^{-1} (18.17 qha^{-1} and 17.92 qha^{-1} respectively) and their difference was not statistically significant. Salako (1990) also reported that fungicide mixture such as (Tridemorph + Maneb or Tridemorph +Benomyl were more effective in controlling leaf spots and rust diseases of ground nut.

The result therefore indicated that the premix fungicide Azoxystrobin 7.5% + Propiconazole 12.5% SE 875 gha^{-1} effectively and significantly reduced leaf spot and rust infestation and proportionally increased kernel yield of groundnut by controlling the disease. The cost benefit ratio was also highest also showed maximum in the plots sprayed with premix fungicide (Azoxystrobin 7.5% and Propiconazole 12.5% SE) @ 875 gha^{-1} (1:2.0) followed by the same premix fungicide @1000 gha^{-1} (1:1.2) in comparison to individual application of Azoxystrobin 23% SC and Propiconazole 25% EC at formulation concentration of 500 ml ha^{-1}. The application of these fungicides did not show any phytotoxic effect when applied in crops.

The influence of environmental factors on disease progression was also showed a variation among the two different diseases irrespective of fungicides sprayed in the field. The pooled analysis of individual weather variables with disease severity on leaf spot it was noticed that only maximum relative humidity (RHmax) negatively and bright sunshine hours (BSH) positively significantly influenced on disease progression (r= -0.208 RHmax , -0.195 Rt and 0.399 BSH respectively) where as in case of leaf rust Tmax (r= -0.282), Tmin (r= -0.324), RHmin (r= -0.308), VP noon (r= -0.301),VP evening(r= -0.317), Rt (r= -0.205) and ST (r= -0.318) negatively and RHmax (0.192), BSH (r= -0.232) positively significantly influenced and co-related on disease progression. It was confirmed by high significant co-relation co-efficient value (Table 3).

The step down multiple regression analysis (MRA) with disease severity and weather factors were done to find out the effective weather variables for predicting disease severity when fungicides were applied in field. The prediction equations were different in different diseases irrespective of fungicides used. In case of leaf spot the prediction equation was,

$$Y = 358.023 - 3.347\ Tmax - 1.486\ RHmax - 2.408\ Wv + 3.625\ BSH + 4.230\ VPevening + 0.740\ Rt - 8.121\ ST.$$

The co-relation coefficient, r= 0.94; co-efficient of determination, R^2 = 0.885, residual sum of square, RSS= 135.42 and standard error of estimate, SE of Est= 5.31.

The step down equation showed the elimination of all the weather factors except RHmax, BSH and Rt those were the only variables can predict the future disease severity. It was confirmed by high co-relation coefficient (0.90); co-efficient of determination (R^2 = 0.810) and low residual sum of square, RSS= 111.45 and standard error of estimate, SE of Est= 3.11.

The equation was, $Y = 152.22 - 2.22\ RHmax + 1.57\ BSH - 1.21\ Rt.$

It indicated that in step down analysis the partial regression coefficient of RHmax, BSH and Rt were significantly influenced the increment of leaf spot of groundnut with a change in 2.22 units RHmax, 1.57 units BSH and 1.21 units Rt. It was confirmed by high co-relation coefficient, co-efficient of determination and low residual sum of square and standard error of estimate.

In case of leaf rust the prediction equation was

$$Y = 444.582 - 4.387\ Tmax - 1.974\ RHmax - 3.886\ Wv + 4.911\ BSH + 4.547\ VP\ evening + 1.051\ Rt - 8.856\ ST.$$

The co-relation coefficient, r= 0.93; co-efficient of determination, R^2 = 0.870, residual sum of square, RSS= 145.05 and standard error of estimate, SE of Est = 4.56.

The step down equation was, $Y = 91.404 - 1.21\ Tmax - 1.11\ RHmax + 1.11\ BSH - 1.15\ VP\ evening - 2.11\ ST.$

Table 1
Efficacy of Azoxystrobin 7.5% + Propiconazole 12.5%SE against Leaf spot of groundnut in *pooled mean*

Treatments		*Disease severity (%)*								
	Dosage (gha^{-1})	*40DAS*	*47DAS*	*54DAS*	*61DAS*	*68DAS*	*75DAS*	*82DAS*	*89DAS*	*Cost: Benefit (Ratio)*
Azoxystrobin 7.5% + Propiconazole 12.5%SE	750	0.11 (1.83)	2.39 (8.88)	4.88 (12.85)	9.12 (17.55)	10.46 (18.82)	11.5 (19.77)	12.75 (20.86)	14.75 (22.55)	1:1.5
Azoxystrobin 7.5% + Propiconazole 12.5%SE	875	0.11 (1.86)	1.21 (6.29)	2.46 (8.98)	5.37 (13.29)	6.08 (14.22)	6.74 (15.09)	7.75 (16.14)	8.75 (17.14)	1:2.0
Azoxystrobin 7.5% + Propiconazole 12.5%SE	1000	0.11 (1.83)	1.14 (6.11)	2.34 (8.77)	5.33 (13.23)	5.95 (14.61)	6.28 (14.82)	7.54 (15.85)	8.70 (18.12)	1:1.2
Azoxystrobin 23%SC	500	0.11 (1.86)	2.54 (9.16)	4.96 (12.80)	9.87 (18.29)	11.04 (19.38)	12.25 (20.46)	14.16 (22.04)	15.25 (22.95)	1:0.7
Propiconazole25% EC	500	0.11 (1.83)	3.76 (11.22)	6.12 (14.30)	11.07 (19.47)	12.03 (20.27)	13.31 (21.37)	15.00 (22.84)	16.58 (24.01)	1:0.6
Tebuconazole25.9% m/m EC	750ml	0.11 (1.84)	4.88 (12.83)	7.13 (15.54)	11.08 (19.43)	12.87 (21.02)	14.75 (22.74)	16.25 (23.82)	17.75 (24.91)	1:0.4
Untreated control		0.11 (1.85)	7.50 (15.75)	13.5 (21.53)	22.08 (27.97)	24.12 (29.40)	25.84 (30.85)	27.92 (31.87)	31.12 (34.36)	-
SEm ±		0.03	0.24	0.26	0.13	0.17	0.16	0.11	0.16	-
CD at 5%		NS	0.73	0.79	0.39	0.54	0.49	0.34	0.48	-

(Figure within the parenthesis are the Angular transformed values)

Table 2
Efficacy of Azoxystrobin 7.5% + Propiconazole 12.5%SE against Leaf Rust of groundnut in *pooled mean*

Treatments	*Disease severity (%)*									
	Dosage (gha^{-1})	*40DAS*	*47DAS*	*54DAS*	*61DAS*	*68DAS*	*75DAS*	*82DAS*	*89DAS*	*Yield (qha^{-1})*
Azoxystrobin 7.5% + Propiconazole 12.5%SE	750	0.11 (1.85)	3.96 (11.44)	6.38 (14.55)	8.92 (17.37)	10.17 (18.57)	11.42 (19.66)	12.58 (20.76)	13.84 (21.82)	18.5
Azoxystrobin 7.5% + Propiconazole 12.5%SE	875	0.11 (1.84)	2.24 (8.54)	3.29 (10.36)	5.10 (13.02)	6.00 (14.16)	7.18 (15.53)	8.12 (16.54)	9.16 (17.61)	20.75
Azoxystrobin 7.5% + Propiconazole 12.5%SE	1000	0.11 (1.91)	2.05 (8.01)	3.10 (10.05)	4.86 (12.82)	5.87 (13.97)	7.36 (15.73)	8.20 (16.63)	9.20 (17.65)	21.25
Azoxystrobin23%SC	500	0.11 (1.86)	4.96 (12.86)	7.06 (14.89)	9.33 (17.78)	10.42 (18.81)	12.16 (20.57)	13.08 (21.20)	14.25 (22.17)	18.17
Propiconazole25% EC	500	0.10 (1.81)	5.72 (13.81)	5.38 (16.50)	10.03 (18.55)	11.36 (19.61)	13.08 (21.19)	14.25 (22.34)	15.50 (23.18)	17.92
Tebuconazole25.9% m/m EC	750	0.12 (1.96)	6.63 (14.87)	9.63 (18.05)	12.92 (19.02)	13.78 (21.92)	14.91 (22.71)	16.00 (23.56)	17.33 (22.25)	17.58
Untreated control		0.11 (1.91)	9.79 (18.23)	10.67 (23.51)	20.34 (26.78)	23.66 (29.10)	26.58 (31.03)	28.25 (31.77)	30.92 (33.77)	16.42
SEm ±		0.02	0.19	0.22	0.16	0.26	0.27	0.21	0.28	0.30
CD at 5%		NS	0.58	0.68	0.51	0.79	0.82	0.64	0.85	0.94

(Figure within the parenthesis are the Angular transformed values)

Table 3
Correlation coefficient between leaf spot vs weather parameters and leaf rust vs weather parameters at combined (*kharif and rabi*) season

		Leaf spot	*Leaf rust*
Maximum Temperature (^{0}C)	"r" value	-0.100	-0.282**
	Probability	0.293	0.003
Minimum Temperature (^{0}C)	"r" value	-0.149	-0.324**
	Probability	0.116	0.000
Maximum Relative Humidity (%)	"r" value	0.181	0.192*
	Probability	0.056	0.042
Minimum Relative Humidity (%)	"r" value	-0.208*	-0.308**
	Probability	0.028	0.001
Wind Speed	"r" value	-0.051	-0.013
	Probability	0.593	0.893
Bright Sunshine Hours	"r" value	0.399**	0.232*
	Probability	0.000	0.014
Vapour Pressure (noon)	"r" value	-0.130	-0.301**
	Probability	0.172	0.001
Vapour Pressure (evening)	"r" value	-0.163	-0.317**
	Probability	0.086	0.001
Total rainfall(Rt)	"r" value	-0.195*	-0.205*
	Probability	0.040	0.030
Soil temperature(ST)	"r" value	-0.143	-0.318**
	Probability	0.132	0.001
	N	112	112

*. Correlation is significant at the 0.05 level.

**. Correlation is significant at the 0.01 level.

It indicated that only Tmax, RHmax, BSH, VPevening and ST were in combination increased the disease progression. The partial regression co-efficient showed that the unit change in 1.21 Tmax, 1.11 RHmax, 1.11 BSH, 1.15 VP evening and 2.11 ST can predicted the disease severity of rust of groundnut particularly in fungicide applied plots. It was confirmed by high co-relation coefficient (0.89), co-efficient of determination (0.79) and low residual sum of square (135.45) and standard error of estimate (3.15).

Wang *et al*. (1987) pointed out that the deceptively high of R^2 values should not be taken as an absolute criteria for comparing the rate of epidemics but should be supported by determination of standard error of estimate and residual sum of square values for drawing meaningful conclusion.

It was observed that for the both the two diseases favourable temperature – moisture relation that reduces generation time and exerbates conidia and urediospore liberation and dispersal of both two pathogens *Cercospora* and *Puccinia* respectively (Mayee and Ekbote, 1983; Das *et al.*,1999). In the present investigation the nine selected independent variables were positively , negatively or poorly correlated with the disease severity. Though step down analysis identify the maximum temperature, maximum relative humidity, bright sunshine hours, vapour pressure evening and soil temperature for groundnut rust and maximum relative humidity, bright sunshine hours and total rainfall for leaf spot. They directly favour the growth, multiplication and release and dispersal of conidia and urediospore in the crop canopy in fungicides applied plots (Das and Raj, 1998; Saha and Das, 2015).

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