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IMPACT OF GRADED LEVELS OF NPK FERTILIZERS ON DISEASE INCIDENCE OF BT COTTON IN ALFISOL

T. V. JYOTHI* AND N. S. HEBSUR
Department of Soil Science and Agricultural Chemistry,
University of Agricultural Sciences, Dharwad - 580 005, Karnataka, INDIA
Department of Soil Science and Agricultural Chemistry, UAS, Dharwad
e-mail: veeranna.jyothi@gmail.com

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***Corresponding author**

ABSTRACT
A field experiment was conducted in farmer's field at Jodalli village (Kalghatagi taluk) in 2012-13 and at Pale village (Hubballi taluk) in 2013-14 under protective irrigation to study the effect of graded levels of NPK fertilizers on disease incidence of Bt cotton. Significantly higher incidence of grey mildew, leaf rust, leaf blight and leaf spot (19.01, 17.59, 13.10 and 14.67 PDI per 3 leaves, respectively) were recorded in treatment receiving N_3 (150 kg N ha^{-1}). The application of K @ 100 kg ha^{-1} (K_3) recorded lower grey mildew, leaf rust, leaf blight, leaf spot and wilt incidence (15.45, 13.97, 8.84 and 11.94 PDI per 3 leaves and 1.72 PDI, respectively) compared to rest of the treatments. The interaction of NP, NK and PK levels showed no significant effect on studied foliar and wilt diseases.

INTRODUCTION

India is a second largest cotton producing country in the world (AICCIP, 2014). It plays an important role in the Indian economy involving about 60 million people in cotton cultivation, textile industries and trade (Hargilas *et al.,* 2015). Compared to world average cotton lint yield (600 kg ha^{-1}), India produces around 375 kg lint ha^{-1}. The low cotton lint yield is associated because of number of reasons, of them, its cultivation under rainfed situation and pest and disease infestation. Plant diseases are a major limiting factor in agricultural production. Most growers use high amounts of chemicals to control plant diseases, unaware to the fact that mineral nutrition has an important role in disease control. In addition to the economical consequences, the use of pesticides raises environmental and food safety concerns. All essential plant nutrients influence the health of plants and their susceptibility to disease. Plants suffering a nutrient stress will be more susceptible to diseases, while adequate crop nutrition makes plants more tolerant or resistant to disease. The resistance of plants to diseases is mainly related to genetics. The plant kingdom represents an enormous reservoir of potential chemical compounds and also leads to an increase in the enzyme activity *viz*. peroxidase and polyphenol oxidase. Similarly the chemical compounds like phenols, alkaloids and primary metabolites also increased which it increases the resistance in plants (Seetharamulu *et al.,* 2012). However, the ability of the plant to express its genetic resistance to a particular disease is affected by mineral nutrition. Some nutrients have a greater impact on plant diseases than others. However, it should be noted that a particular nutrient may have opposite impacts on different diseases and in different environments, *i.e.,* the same nutrient may decrease the incidence of one disease, but increase the incidence of others. Nutrient manipulation can be achieved directly by applying adequate fertilizers, or indirectly, through the use of different cultural practices, such as liming for pH adjustment, irrigation, organic amendments, tillage etc. Integrating variety selection, cultural practices, chemical treatments and mineral nutrition is found to be the best approach to plant disease control. The effects of mineral nutrition on plant disease and the mechanisms responsible for those effects have been dealt with comprehensively elsewhere. Disease occurrence may be encouraged by an imbalance between N and K. As production levels are pushed higher, striving for maximum economic yields, K must be balanced with increased additions of N (Parthasarathy, 2015). Chang and Tu (1970) reported that attention should be paid to an adequate nitrogen: potassium (N: K) ratio since N and K play a major role in resistance to adverse pathogens; while N frequently reduces the resistance, K improves it. Potassium (K) probably exerts its greatest effects on disease through specific metabolic functions that alter compatibility relationships of the host-parasite environment (Kafkafi *et al.,* 2001). The intricate relationships between K nutrition and metabolic functions and growth, as well as its interrelationships with various other nutrients within the plant and the soil provide ample

opportunity for K to modify disease resistance or susceptibility. Although disease cannot be eliminated by any particular nutrient, the severity of the disease can be greatly reduced by adequate nutrition. In the present study some efforts have been made to investigate the effects of NPK fertilizer treatments alone and in combination on disease incidence of Bt cotton.

MATERIALS AND METHODS

Field investigations were conducted in Alfisol located in farmer's field one at Jodalli village (Kalghatgi taluk) in 2012-13 which is spread over from 15º19'865'' North latitude and 75º00'65'' East longitude and another at Pale village (Hubballi taluk) in 2013-14 which is spread over from 15º14'404'' North latitude and 75º08'600'' East longitude under protective irrigated condition to evaluate the effect of graded levels of NPK levels on disease incidence of Bt cotton. The farmer of Jodalli village did not agree to take up the experiment during second year. Hence, the experiment was conducted at Pale. The spacing adopted was 90cm and between rows and 60 cm between plants for hybrid cotton. The experimental design was a factorial randomized complete block arrangement with nineteen treatments and three replications. The treatment details are given below.

RESULTS AND DISCUSSION

Treatment details

Factor - I (N levels)

N_1 : 100 kg ha^{-1}, N_2 : 125 kg ha^{-1}, N_3 : 150 kg ha^{-1}

Factor - II (P_2O_5 levels)

P_1 : 50 kg ha^{-1}, P_2 : 75 kg ha^{-1}

Factor - III (K_2O levels)

K_1 : 50 kg ha^{-1}, K_2 : 75 kg ha^{-1}, K_3 : 100 kg ha^{-1}

Absolute control

Entire recommended dose of phosphorus and potassium and 50 per cent of nitrogen were applied after germination by ring method. Remaining 50 per cent of nitrogen was applied at 60 DAS as per the package of practice. Adequate plant protection measures were taken as per the recommended package for Bt cotton as and when required at various growth stages commonly to all the treatments.

Scoring of diseases

The diseases *viz.*, leaf spot, leaf blight, grey mildew, leaf rust (10 randomly selected plants) and wilt were recorded from each plot. The incidence of disease was recorded by using 0-4 scale as per Sheo Raj (1988) and then these grades were converted into per cent disease indices (PDI) by using the formula given by Wheeler (1969).

$$\% \text{ Disease index (PDI)} = \frac{\text{Sum of numerical ratings}}{\text{Total number of leaves observed x Max. disease grade}} \times 100$$

Table 1: Grey mildew, leaf rust and leaf blight incidence (per 3 leaves) in Bt cotton as influenced by different levels of NPK fertilizers in Alfisol

Treatments	Grey mildew PDI			Leaf rust PDI			Leaf blight PDI		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	18.60(25.16)	11.76(19.72)	15.18(22.44)	15.46(23.08)	12.38(20.54)	13.92(21.81)	8.52(16.53)	6.39(14.49)	7.45(15.51)
N_2	18.68(25.14)	16.11(23.53)	17.39(24.34)	19.62(26.20)	13.98(21.86)	16.80(24.03)	11.20(19.08)	8.70(17.08)	9.95(18.08)
N_3	20.15(26.14)	17.87(24.96)	19.01(25.55)	19.58(26.11)	15.60(23.14)	17.59(24.63)	14.26(21.95)	11.94(20.09)	13.10(21.02)
S.Em.±	1.06	0.70	0.63	0.62	0.49	0.39	0.81	0.57	0.54
C.D. at 5%	NS	2.02	1.82	1.77	1.40	1.12	2.33	1.65	1.54
P_1	18.99(25.41)	15.06(22.63)	17.02(24.02)	17.14(24.33)	13.30(21.30)	15.22(22.81)	10.55(18.42)	8.33(16.58)	9.44(17.50)
P_2	19.30(25.56)	15.43(22.85)	17.36(24.20)	19.30(25.93)	14.67(22.39)	16.99(24.16)	12.09(19.95)	9.69(17.86)	10.89(18.90)
S.Em.±	0.86	0.57	0.52	0.50	0.40	0.32	0.66	0.47	0.44
C.D. at 5%	NS	NS	NS	1.44	NS	0.91	NS	NS	1.26
K_1	22.57(28.20)	16.48(23.83)	19.52(26.01)	20.88(27.07)	16.43(23.82)	18.66(25.45)	13.61(21.14)	10.00(18.20)	11.80(19.67)
K_2	18.04(24.58)	15.18(22.63)	16.61(23.61)	17.68(24.74)	13.70(21.65)	15.69(23.20)	10.83(18.61)	8.89(17.14)	9.86(17.87)
K_3	16.83(23.66)	14.07(21.76)	15.45(22.71)	16.10(23.57)	11.83(20.07)	13.97(21.82)	9.53(17.81)	8.14(16.33)	8.84(17.07)
S.Em.±	1.06	0.70	0.63	0.62	0.49	0.39	0.81	0.57	0.54
C.D. at 5%	3.04	NS	1.82	1.77	1.40	1.12	2.33	NS	1.51
N_1P_1	18.33(24.88)	12.77(20.57)	15.55(22.72)	14.26(22.09)	12.00(20.21)	13.13(21.15)	7.59(15.71)	6.11(14.25)	6.85(14.98)
N_1P_2	18.87(25.45)	10.74(18.88)	14.80(22.16)	16.66(24.07)	12.77(20.87)	14.72(22.47)	9.44(17.35)	6.66(14.74)	8.05(16.05)
N_2P_1	19.40(25.76)	15.00(22.71)	17.20(24.24)	17.96(25.04)	12.96(21.07)	15.46(23.06)	10.92(18.58)	7.96(16.33)	9.44(17.45)
N_2P_2	17.95(24.53)	17.22(24.35)	17.59(24.44)	21.29(27.35)	15.00(22.65)	18.14(25.00)	11.48(19.58)	9.44(17.83)	10.46(18.71)
N_3P_1	19.53(25.59)	17.40(24.61)	18.32(25.10)	19.20(25.85)	14.95(22.62)	17.08(24.23)	13.14(20.98	10.92(19.18)	12.03(20.08)
N_3P_2	21.08(26.69)	18.33(25.31)	19.70(26.00)	19.95(26.38)	16.25(23.66)	18.10(25.02)	15.37(22.92)	12.96(21.00)	14.16(21.96)
S.Em.±	1.50	0.99	0.89	0.87	0.69	0.55	1.15	0.81	0.76
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
N_1K_1	20.53(26.64)	13.61(21.54)	17.07(24.09)	17.50(24.65)	14.72(22.52)	16.11(23.59)	9.44(17.18)	7.22(15.51)	8.33(16.35)
N_1K_2	17.77(24.60)	11.39(19.19)	14.58(21.89)	14.72(22.55)	11.94(20.20)	13.33(21.37)	8.61(16.61)	6.39(14.52)	7.50(15.57)
N_1K_3	17.49(24.25)	10.28(18.45)	13.88(21.35)	14.16(22.04)	10.50(18.90)	12.33(20.47)	7.50(15.80)	5.55(13.45)	6.52(14.63)
N_2K_1	22.75(28.44)	16.39(23.80)	19.57(26.12)	21.11(27.25)	15.28(22.95)	18.19(25.10)	13.60(21.46)	9.44(17.82)	11.52(19.64)
N_2K_2	17.76(24.34)	16.38(23.83)	17.07(24.09)	19.72(26.30)	14.44(22.22)	17.08(24.26)	10.83(18.31)	8.61(16.96)	9.72(17.63)
N_2K_3	15.53(22.66)	15.55(22.96)	15.54(22.81)	18.04(25.05)	12.22(20.40)	15.13(22.73)	9.16(17.48)	8.05(16.45)	8.61(16.97)
N_3K_1	24.42(29.52)	19.44(26.15)	21.93(27.83)	24.03(29.31)	19.31(25.99)	21.67(27.65)	17.77(24.78)	13.33(21.26)	15.55(23.02)
N_3K_2	18.59(24.81)	17.78(24.88)	18.18(24.85)	18.60(25.39)	14.72(22.53)	16.66(23.96)	13.05(20.91)	11.66(19.92)	12.36(20.42)
N_3K_3	17.45(24.07)	16.38(23.86)	16.92(23.96)	16.11(23.64)	12.78(20.89)	14.44(22.27)	11.94(20.16)	10.83(19.09)	11.38(19.62)
S.Em.±	1.83	1.22	1.10	1.07	0.84	0.67	1.40	0.99	0.93
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS

Table 1: Contt.....

Treatments	Grey mildew PDI			Leaf rust PDI			Leaf blight PDI		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
P_1K_1	22.02(27.82)	15.55(23.11)	18.78(25.47)	19.58(26.15)	15.32(22.93)	17.45(24.54)	12.40(20.17)	9.07(17.30)	10.74(18.73)
P_1K_2	18.31(24.52)	15.55(22.93)	16.93(23.73)	16.66(23.99)	12.77(20.90)	14.72(22.45)	10.00(17.54)	8.14(16.46)	9.07(17.00)
P_1K_3	16.63(23.87)	14.07(21.85)	15.35(22.86)	15.18(22.84)	11.81(20.08)	13.50(21.46)	9.26(17.56)	7.77(16.00)	8.51(16.78)
P_2K_1	23.11(28.58)	17.40(24.55)	20.26(26.56)	22.17(27.99)	17.54(24.71)	19.86(26.35)	14.81(22.11)	10.92(19.10)	12.87(20.60)
P_2K_2	17.77(24.64)	14.81(22.34)	16.29(23.49)	18.70(25.50)	14.63(22.41)	16.66(23.95)	11.66(19.68)	9.63(17.82)	10.64(18.75)
P_2K_3	17.02(23.45)	14.07(21.66)	15.54(22.55)	17.03(24.31)	11.85(20.06)	14.44(22.18)	9.81(18.07)	8.52(16.66)	9.16(17.36)
S.Em.±	1.50	0.99	0.89	0.87	0.69	0.55	1.15	0.81	0.76
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
$N_1P_1K_1$	19.44(25.92)	13.88(21.65)	16.66(23.78)	16.11(23.55)	13.88(21.83)	15.00(22.69)	8.89(16.90)	6.66(14.97)	7.77(15.93)
$N_1P_1K_2$	17.77(24.25)	13.33(20.80)	15.55(22.53)	13.88(21.88)	11.66(19.95)	12.77(20.91)	7.22(15.28)	6.11(14.29)	6.66(14.78)
$N_1P_1K_3$	17.77(24.46)	11.11(19.27)	14.44(21.86)	12.77(20.84)	10.44(18.85)	11.61(19.85)	6.66(14.97)	5.55(13.49)	6.11(14.23)
$N_1P_2K_1$	21.62(27.36)	13.33(21.43)	17.48(24.39)	18.89(25.75)	15.55(23.21)	17.22(24.48)	10.00(17.47)	7.78(16.05)	8.89(16.76)
$N_1P_2K_2$	17.77(24.94)	9.44(17.58)	13.61(21.26)	15.55(23.21)	12.22(20.46)	13.88(21.84)	10.00(17.94)	6.66(14.76)	8.33(16.35)
$N_1P_2K_3$	17.22(24.04)	9.44(17.63)	13.33(20.84)	15.55(23.23)	10.55(18.95)	13.05(21.09)	8.33(16.64)	5.55(13.41)	6.94(15.02)
$N_2P_1K_1$	22.17(28.00)	14.44(22.34)	18.31(25.17)	19.44(26.17)	13.33(21.40)	16.39(23.79)	12.22(20.19)	8.33(16.73)	10.27(18.46)
$N_2P_1K_2$	19.98(25.65)	15.55(23.15)	17.76(24.40)	17.77(24.91)	12.77(20.89)	15.27(22.90)	11.11(17.70)	7.77(16.13)	9.44(16.91)
$N_2P_1K_3$	16.07(23.62)	15.00(22.66)	15.53(23.14)	16.66(24.05)	12.77(20.92)	14.72(22.48)	9.44(17.85)	7.77(16.12)	8.61(16.99)
$N_2P_2K_1$	23.33(28.87)	18.33(25.27)	20.83(27.07)	22.77(28.33)	17.22(24.49)	20.00(26.41)	14.99(22.73)	10.55(18.91)	12.77(20.82)
$N_2P_2K_2$	15.53(23.04)	17.22(24.52)	16.38(23.78)	21.66(27.68)	16.11(23.55)	18.89(25.62)	10.55(18.91)	9.44(17.79)	10.00(18.35)
$N_2P_2K_3$	15.00(21.69)	16.11(23.26)	15.55(22.48)	19.42(26.04)	11.66(19.89)	15.54(22.97)	8.89(17.11)	8.33(16.78)	8.61(16.95)
$N_3P_1K_1$	24.44(29.55)	18.33(25.35)	21.38(27.45)	23.20(28.72)	18.75(25.54)	20.98(27.13)	16.11(23.43)	12.22(20.19)	14.16(21.81)
$N_3P_1K_2$	17.18(23.67)	17.77(24.85)	17.48(24.26)	18.31(25.19)	13.89(21.86)	16.10(23.52)	11.66(19.64)	10.55(18.95)	11.11(19.30)
$N_3P_1K_3$	16.07(23.54)	16.11(23.63)	16.09(23.58)	16.11(23.63)	12.22(20.46)	14.16(22.05)	11.66(19.85)	10.00(18.40)	10.83(19.13)
$N_3P_2K_1$	24.39(29.50)	20.55(26.95)	22.47(28.22)	24.86(29.90)	19.86(26.44)	22.36(28.17)	19.44(26.12)	14.44(22.34)	16.94(24.23)
$N_3P_2K_2$	19.99(25.95)	17.78(24.91)	18.89(25.43)	18.88(25.60)	15.55(23.21)	17.22(24.40)	14.44(22.18	12.78(20.89)	13.61(21.53)
$N_3P_2K_3$	18.84(24.61)	16.66(24.08)	17.75(24.34)	16.11(23.65)	13.33(21.32)	14.72(22.49)	12.22(20.46)	11.66(19.78)	11.94(20.12)
S.Em.±	2.59	1.72	1.55	1.51	1.19	0.95	1.98	1.41	1.31
C.D. at 5%	NS	NS	NS	NS	NS	NS	NS	NS	NS
Control	36.66(37.28)	39.44(38.91)	38.05(38.10)	36.11(36.89)	28.75(32.30)	32.43(34.60)	30.00(33.05)	20.55(26.95)	25.28(30.00)
S.Em.±	2.60	1.70	1.56	1.65	1.35	1.02	2.11	1.38	1.39
C.D. at 5%	7.45	4.89	4.48	4.73	3.88	2.91	6.06	3.97	3.98

Note: FYM – 5 t $ha^{-1;}$ $_1$ – 100 kg $ha^{-1;}$ N_2 – 125 kg ha^{-1} ; N_3- 150 kg ha^{-1} ; P_1 – 50 kg $ha^{-1;}$ P_2 – 75 kg ha^{-1} ; K_1 – 50 kg $ha^{-1;}$ K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing; PDI – Per cent disease index ; Figures in the parentheses indicate angular transformed values ; ASIN = ASIN (SQRT (value/100))*(180/3.14)

Table 2: Leaf spot (per 3 leaves) and wilt incidence in Bt cotton as influenced by different levels of NPK fertilizers in Alfisol

Treatment	Leaf spot PDI (per 3 leaves)			Wilt PDI		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
N_1	12.68(20.79)	10.37(18.66)	11.52(19.73)	1.97(7.61)	2.18(8.25)	2.07(7.93)
N_2	14.81(22.39)	12.13(20.30)	13.47(21.35)	2.00(7.67)	2.23(8.32)	2.12(7.99)
N_3	15.92(23.37)	13.42(21.40)	14.67(22.39)	2.10(7.87)	2.53(9.10)	2.32(8.48)
S.Em.±	0.63	0.59	0.42	0.66	0.44	0.42
C.D. at 5%	1.81	1.70	1.20	NS	NS	NS
P_1	13.64(21.53)	11.79(19.98)	12.71(20.76)	2.01(7.69)	2.27(8.49)	2.14(8.09)
P_2	15.31(22.84)	12.16(20.26)	13.73(21.55)	2.04(7.74)	2.36(8.63)	2.20(8.18)
S.Em.±	0.51	0.48	0.34	0.54	0.36	0.34
C.D. at 5%	NS	NS	NS	NS	NS	NS
K_1	16.57(23.87)	13.42(21.35)	15.00(22.61)	2.40(8.92)	2.68(9.35)	2.54(9.13)
K_2	13.79(21.63)	11.62(19.88)	12.73(20.76)	2.20(8.54)	2.28(8.69)	2.24(8.61)
K_3	13.05(21.06)	10.83(19.13)	11.94(20.09)	1.47(5.69)	1.98(7.63)	1.72(6.66)
S.Em.±	0.63	0.59	0.42	0.66	0.44	0.42
C.D. at 5%	1.81	1.70	1.20	1.90	1.27	1.20
N_1P_1	12.96(21.06)	10.37(18.72)	11.66(19.89)	1.97(7.62)	2.06(7.79)	2.02(7.70)
N_1P_2	12.40(20.53)	10.37(18.59)	11.39(19.56)	1.96(7.60)	2.30(8.71)	2.13(8.16)
N_2P_1	13.14(21.11)	11.85(20.07)	12.50(20.59)	1.99(7.64)	2.26(8.65)	2.12(8.14)
N_2P_2	16.48(23.68)	12.40(20.53)	14.44(22.11)	2.01(7.69)	2.20(8.00)	2.11(7.84)
N_3P_1	14.81(22.42)	13.14(21.15)	13.98(21.79)	2.07(7.81)	2.49(9.03)	2.28(8.42)
N_3P_2	17.03(24.32)	13.70(21.65)	15.37(22.98)	2.13(7.92)	2.57(9.18)	2.35(8.55)
S.Em.±	0.89	0.84	0.59	0.94	0.62	0.59
C.D. at 5%	NS	NS	NS	NS	NS	NS
N_1K_1	13.61(21.54)	11.39(19.67)	12.50(20.60)	2.30(8.71)	2.40(8.92)	2.35(8.81)
N_1K_2	12.50(20.65)	10.28(18.50)	11.39(19.57)	2.18(8.50)	2.25(8.63)	2.22(8.57)
N_1K_3	11.94(20.19)	9.44(17.81)	10.69(19.00)	1.43(5.61)	1.89(7.21)	1.66(6.41)
N_2K_1	16.94(24.11)	13.05(21.06)	15.00(22.58)	2.37(8.85)	2.64(9.29)	2.51(9.07)
N_2K_2	14.16(21.89)	12.22(20.44)	13.19(21.17)	2.16(8.46)	2.24(8.60)	2.20(8.53)
N_2K_3	13.33(21.18)	11.11(19.40)	12.22(20.29)	1.47(5.69)	1.82(7.08)	1.64(6.38)
N_3K_1	19.16(25.96)	15.83(23.33)	17.50(24.64)	2.55(9.19)	2.99(9.85)	2.77(9.52)
N_3K_2	14.72(22.35)	12.50(20.70)	13.61(21.53)	2.26(8.64)	2.37(8.85)	2.31(8.75)
N_3K_3	13.89(21.80)	11.94(20.18)	12.91(20.99)	1.51(5.77)	2.24(8.61)	1.87(7.19)
S.Em.±	1.09	1.03	0.72	1.15	0.77	0.72
C.D. at 5%	NS	NS	NS	NS	NS	NS

Table 2: Contt.....

Treatment	Leaf spot PDI (per 3 leaves)			Wilt PDI		
	2012-13	2013-14	Pooled	2012-13	2013-14	Pooled
P_1K_1	15.92(23.41)	13.14(21.08)	14.53(22.24)	2.38(8.87)	2.60(9.24)	2.49(9.05)
P_1K_2	12.77(20.79)	11.48(19.76)	12.13(20.27)	2.19(8.52)	2.24(8.62)	2.22(8.57)
P_1K_3	12.22(20.40)	10.74(19.10)	11.48(19.75)	1.46(5.68)	1.97(7.61)	1.72(6.65)
P_2K_1	17.22(24.33)	13.70(21.62)	15.46(22.98)	2.43(8.96)	2.76(9.47)	2.59(9.22)
P_2K_2	14.81(22.48)	11.85(20.00)	13.33(21.24)	2.21(8.56)	2.33(8.77)	2.27(8.66)
P_2K_3	13.89(21.72)	10.92(19.16)	12.40(20.44)	1.47(5.69)	1.99(7.65)	1.73(6.67)
S.Em.±	0.89	0.84	0.59	0.94	0.62	0.59
C.D. at 5%	NS	NS	NS	NS	NS	NS
$N_1P_1K_1$	13.33(21.42)	11.11(19.39)	12.22(20.41)	2.30(8.73)	2.41(8.93)	2.36(8.83)
$N_1P_1K_2$	12.77(20.84)	10.55(18.88)	11.66(19.86)	2.18(8.49)	2.20(8.54)	2.19(8.52)
$N_1P_1K_3$	12.77(20.92)	9.44(17.89)	11.11(19.40)	1.43(5.62)	1.58(5.90)	1.51(5.76)
$N_1P_2K_1$	13.89(21.65)	11.66(19.95)	12.77(20.80)	2.29(8.69)	2.40(8.91)	2.34(8.80)
$N_1P_2K_2$	12.22(20.46)	10.00(18.11)	11.11(19.29)	2.19(8.51)	2.30(8.72)	2.24(8.61)
$N_1P_2K_3$	11.11(19.47)	9.44(17.72)	10.28(18.60)	1.42(5.60)	2.19(8.51)	1.81(7.06)
$N_2P_1K_1$	15.55(23.04)	12.78(20.79)	14.16(21.92)	2.30(8.73)	2.44(8.98)	2.37(8.85)
$N_2P_1K_2$	12.22(20.40)	11.66(19.95)	11.94(20.18)	2.17(8.48)	2.19(8.51)	2.18(8.50)
$N_2P_1K_3$	11.66(19.88)	11.11(19.47)	11.38(19.67	1.48(5.72)	2.16(8.45)	1.82(7.08)
$N_2P_2K_1$	18.33(25.18)	13.32(21.32)	15.83(23.25)	2.43(8.97)	2.85(9.59)	2.64(9.28)
$N_2P_2K_2$	16.11(23.38)	12.77(20.94)	14.44(22.16)	2.16(8.45)	2.28(8.69)	2.22(8.57)
$N_2P_2K_3$	15.00(22.49)	11.11(19.34)	13.05(20.91)	1.45(5.66)	1.48(5.72)	1.47(5.69)
$N_3P_1K_1$	18.89(25.75)	15.55(23.06)	17.22(24.40)	2.52(9.14)	2.96(9.80)	2.74(9.47)
$N_3P_1K_2$	13.33(21.11)	12.22(20.46)	12.77(20.79)	2.22(8.57)	2.34(8.79)	2.28(8.68)
$N_3P_1K_3$	12.22(20.41)	11.66(19.95)	11.94(20.18)	1.48(5.72)	2.17(8.48)	1.83(7.10)
$N_3P_2K_1$	19.44(26.16)	16.11(23.60)	17.78(24.88)	2.57(9.23)	3.02(9.91)	2.79(9.57)
$N_3P_2K_2$	16.11(23.60)	12.77(20.94)	14.44(22.27)	2.29(8.71)	2.40(8.91)	2.35(8.81)
$N_3P_2K_3$	15.55(23.19)	12.22(20.40)	13.88(21.80)	1.54(5.82)	2.30(8.73)	1.92(7.28)
S.Em.±	1.54	1.45	1.02	1.62	1.08	1.02
C.D. at 5%	NS	NS	NS	NS	NS	NS
Control	28.78(32.37)	27.22(31.29)	28.00(31.83)	5.99(14.82)	7.14(15.51)	6.56(15.16)
S.Em.±	1.66	1.57	1.20	1.58	1.05	1.00
C.D. at 5%	4.77	4.49	3.43	4.54	3.02	2.86

Note: FYM – 5 t ha^{-1}; $_1$ – 100 kg ha^{-1}; N_2 – 125 kg ha^{-1}; N_3- 150 kg ha^{-1}; P_1 – 50 kg ha^{-1} ; P_2 – 75 kg ha^{-1} ; K_1 – 50 kg ha^{-1} ; K_2 – 75 kg ha^{-1} ; K_3 - 100 kg ha^{-1} ; NS – Non significant ; DAS – Days after sowing; PDI – Per cent disease index; Figures in the parentheses indicate angular transformed values; ASIN = ASIN (SQRT (value/100))*(180/3.14)

Effect of NPK fertilizers on disease incidence in Bt cotton in Alfisols

The disease incidence recorded during 2012-13, 2013-14 and pooled data in Bt cotton are presented in Table 1 and 2. The foliar diseases *viz.,* grey mildew, leaf rust, *Alternaria* leaf blight and *Cercospora* leaf spot and *Rhizactonia* wilt were significantly affected by different levels of nitrogen, phosphorus and potassium application. Significantly higher incidence of grey mildew, leaf rust, leaf blight and leaf spot (19.01, 17.59, 13.10 and 14.67 PDI per 3 leaves, respectively) were recorded in treatment receiving N_3 (150 kg N ha^{-1}). At high N rates the metabolism of the plant changes: as some key enzymes of phenol metabolism have lower activity, the content of the phenolics decreases and the lignin content may be lower - all these are part of the defence system of plants against infection (Grosse-Brauckmann, 1957; Volk *et al.,* 1958).

The phosphorus effect was non significant. In case of potassium levels, with the increase in levels of potassic fertilizers there was a decrease in disease incidence. The application of K @ 100 kg ha^{-1} (K_3) recorded lower grey mildew, leaf rust, leaf blight, leaf spot and wilt incidence (15.45, 13.97, 8.84 and 11.94 PDI per 3 leaves and 1.72 PDI, respectively) compared to rest of the treatments. The interaction of NP, NK and PK levels showed non significant effect on studied foliar and wilt diseases.

The effect of combined application of graded levels of NPK fertilizers remained non significant on disease incidence during first and second years of experimentation and in pooled data. However, the treatment $N_3P_1K_2$ (150:50:75 kg N:P_2O_5:K_2O ha^{-1}) recorded lower disease incidence over rest of the treatment combinations. These results corroborate the findings of Mengel and Kirkby (1978) who reported that potassium promotes the development of thicker outer walls in epidermal cells, thus preventing disease attack. Furthermore, plant metabolism is very much influenced by potassium; therefore, plant's defense against diseases may be favoured by changes in metabolism associated with high plant potassium content.

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